Science and Mathematics Education Centre

Portfolio Assessment in Primary School Mathematics: A Study of Pedagogical Implications

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Declaration

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university. To the best of my knowledge and belief this thesis contains no material previously published by any other person except where due acknowledgement has been made.

Signature:

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The teachers, students and parents of classes within the school involved in the study were pivotal in providing me with the opportunity to involve them in what became a large part of the classroom mathematics program for two years, and continues to spread its influence today. Stimulation through robust professional discussion is crucial in the professional development and vitality of any practising teacher, regardless of career phase, and the teacher focus group certainly offered ample opportunity for such fruitful interaction. Among other things, it reaffirmed my already strong belief in the adaptability and resourcefulness of passionate primary teachers. The work that we completed together has seen marked changes in many mind-sets and approaches, not only in relation to mathematics, but learning and assessment in general, and not only within the teacher focus group. I look forward to continuing and broadening the collaborative effort that we have begun.

To the person who found herself a ‘thesis widow’ for an extended period of time, my wife, Kay, I can only say a heartfelt thank you for her patience, unswerving support and the tedious typing of interview transcripts. She has supported this ‘late bloomer’ over several decades of study of various forms.

ABSTRACT

This thesis records a study of major change. The study was designed to reveal and address the implications for teachers of primary mathematics, of moving from test-based assessment to a base built upon a balanced blend of norm-referenced and criteria-based assessments. In developing embedded authentic assessment through a *process* portfolio model, the teachers looked to change from the assessment *of* learning to assessment *for* learning. Consequently, through the efforts of the teachers involved, their students and those students' parents, the study traced a substantial pedagogical restructure.

Based on an interpretative methodology, this study of significant assessment restructure used mainly qualitative approaches to data collection and analysis, supplemented by limited quantitative data. Interviews, participant observer interactions, surveys and joint teacher discussion and planning sessions were effective in mapping the change. Through frequent interaction, participating teachers shared their emerging understandings, along with difficulties and successes in the evolution and implementation of an effective, flexible process portfolio.

From the beginning of the evolution, teachers working together to bring about improvements that would lead to students perceiving mathematics as meaningful, engendered a strong feeling of excitement, curiosity and 'team'. As the change progressed the team identified and met a range of challenges, not the least of which was gaining an understanding of the nature and function of a process portfolio strategy as against the product portfolio which was in use at that time in the study school.

The resultant change was not implemented without barriers. Of prime concern across the group of teachers involved was the perennial problem of finding development time in what were already busy teaching days. However, for the change to be meaningful and lasting, it was imperative that the teachers invested considerable time in assuming ownership through genuine engagement in the evolution of the new concept. The engagement saw teachers experience first-hand the application of constructivist learning theory. It was an approach to learning that was largely

unfamiliar to them and one they needed to understand in developing a successful process portfolio model.

The study of that learning and the resultant change illustrated that a well-designed process portfolio structure offers widely diverse opportunities for teachers and students to work meaningfully with authentic mathematics. The enthusiastic prolonged engagement on the part of the students, with notable parental support, was deemed by the participant teachers to be suitable reward for the time and effort that they invested over the two years of the study.

Following the teachers’ prolonged commitment, the emergent portfolio was shared through an in-house booklet written to encourage other teachers to adopt authentic assessment, *Process Portfolios in Primary Mathematics: A Guide.* Within the booklet, explanation and illustration of the rationale, form and function of the unique process portfolio model offers starting points for others, should they embark on a similar course of assessment change in search of real student engagement in understanding mathematics. Subsequent sharing of the results of the study with the wider profession through journal articles and conference workshops is to be based on the contents of the guide booklet.

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SETTING THE SCENE

This thesis is based upon a study which took place within a century-old, conservative, traditional, independent day and boarding boys' school that is part of the school system controlled by the Anglican Church of Queensland. It describes a study of problems faced by teachers as they sought to modify their pedagogies by designing and implementing a process portfolio as part of the assessment structure within their mathematics teaching and learning programs. The study examined the contextual factors related to a group of teachers teaching across the middle to upper primary years, their students and their students' parents, in a school which utilises a conventional curriculum. In essence, the variations to pedagogy which began during the study, as contextually substantial as they were, and continue to be as they expand across the school, merely 'scratched the surface'. They initiated what will be a lengthy process in pursuit of meaningful, lasting change in the teaching of mathematics at the school.

If teachers are to answer calls to change to an approach which resonates with international sentiment for improvement in the relevance and utility of mathematics courses, a great deal of work needs to be done to unearth, examine and solve problems inherent in any change (NCTM, 2000; von Glasersfeld, 1995). The change facilitated by this study sought to develop and strengthen a sense of mathematical relevance and understanding within students while establishing a flexible accountability framework. The purpose of this study was to foster, guide and report the investigation and implementation. By extrapolation, it was to identify and investigate the broad difficulties confronting teachers when they attempt to introduce alternative assessment formats. Therefore, the intention of the study was to gain insight into the issues and present pragmatic solutions found by practising teachers in order to offer worthwhile, realistic alternatives to those that may follow on a similar transitional path.

For some time, accountability has been a reverberating catch-cry upon the educational path and never more so than at present (Barton, 1999; Dale, 2005; Nelson, 2002a, 2003, 2004a). Therefore, questions upon which the study evolved centred on the need to assist teachers gain satisfaction from the time invested in teaching while simultaneously meeting and satisfying the needs of other stakeholders. Under that expanding accountability umbrella, how would teachers who were seeking pedagogical change go about moving away from the accepted and expected methods of assessment? Which measures would those teachers consider of significant value in gauging student progress? Would they prefer to develop entirely new measures to replace the old or seek to develop a blend of old and 'new'? Within the demanding climate of a high fee private school, how would teachers satisfy student, parent and school information needs? Indeed, would the stakeholders be willing to accept and assimilate change to current assessment and feedback structures? Across all facets of that change process, of obvious interest in the study was the professional growth of the teachers involved. Teachers are at the very heart of schooling. Knowledge of the form of the professional development that teachers undertook in making the change was important as it had the potential to offer powerful guidance for future change agents.

CONTEXT OF THE STUDY

The process and repercussions involved in a significant assessment paradigm shift generated the need for a study of this type within an Australian primary school context. If such a shift is to be meaningful and lasting there is a need for teachers to establish a clear rationale for selecting portfolios as a means of assessing understanding and achievement in mathematics (Cicmanec & Viechnicki, 1994). This study took place across four consecutive year levels of a P-7 primary school, a cross section deliberately selected in an attempt to seek possible *transferability* of results (Guba & Lincoln, 1989) to the wider school and schools of a similar form. A group of five primary class teachers undertook to be part of the study.

During a primary teaching career that has spanned three decades I have seen many changes to primary mathematics syllabi, many of which have been aberrations of brief influence. Essentially, the courses that I have been expected to teach have been content-driven and text-based, inherently limited in scope as texts must be easily adaptable to an extensive variety of teaching situations in order to sell widely. Publishers are in the business of earning profits and base their briefs to authors on research based on the most popular current texts, not best pedagogical practice. In my view, in some schools not a great deal has really changed in relation to the teaching of mathematics over past decades. Substantial evidence in the literature supports such claims (Reys, 2001). To a notable extent teaching and assessment remain rooted in behaviourist pedagogy

(Lerman & Tsatsaroni, 1999; Prawat, 1989). However, traditional pedagogies, while continuing to promise success, have largely failed students, if decades of poor performance revealed by National Assessments of Educational Progress (NAEP) and the third Trends in International Mathematics and Science Study (TIMSS) are to be considered valid guides (Reys, 2001).

During the latter half of the previous century, the re-emergence and strengthening of the constructivist learning theories, their widening acceptance and the implicit variations to instruction, have proved promising (Hiebert & Carpenter, 1992). However, contrary to that apparent acceptance is the politically-based accountability drive centred on standardised testing generally developed around multi-choice question banks, the same testing which reveals the failures of what remain the dominant pedagogies (Barton, 1999). Government accountability thrusts of recent years reveal that Australia is heavily influenced in this regard by the United Kingdom and the United States of America, a country that currently is experiencing a great deal of struggle across states in regard to educational accountability (Dale, 2005; Hoff, 2005; Ravitz, 2005). The question as to what all of the testing achieves as far as learning and understanding are concerned continues to be debated heatedly (Barton, 1999).

While embedded assessment *should* be an integral consideration in mathematics syllabi seeking to foster lasting understanding, a major driver has become achieving satisfactory test results, a somewhat ephemeral return for the enormous investment of time. As a teacher, I seek far more than mere comparative test results for my students. Indeed, apart from checking to ensure that all students have achieved at least the benchmarks in tests such as the Years 3, 5 and 7 annual tests demanded by government, teachers in the school involved in the study pay little heed to results. The testing is out of context and the nature of the results, dots within continua, offers little in the way of useful formative feedback to students, teachers and parents.

Therefore, the major thrust of the study was to have teachers identify and develop an assessment structure which was strongly formative and provided useful contextual feedback to teachers, students and parents about students' progress towards learning goals or outcomes. Teachers' learning through changing the assessment base was a primary study focus, with the impact that that learning had on students' learning and the supportive role of parents in the learning process important secondary focuses.

RATIONALE FOR THE STUDY

While private schools in Queensland must satisfy a level of government regulation, they enjoy significant freedom in establishing curricula as well as in assessing and reporting student progress and achievement. Whether the school involved in the study was to move to process portfolios as part of its assessment regime was to be a school-based decision based on the results of a local cost-benefit analysis, namely this study. It was foreseen that whilst the school was open to improvement, the transition to a method of assessing mathematics which varied substantially from current practice would present problems. The problems would need solution through consideration and negotiation with all stakeholders during the transition period.

School Accountability in Queensland

Under the auspices of the State Minister for Education and the Arts, and to a lesser extent the Federal Minister for Education, two types of school system, state and independent, operate along parallel lines in Queensland. The schools service the needs of some 380 000 primary school age children (Dept of Education and the Arts, 2004). It could be claimed that the state and independent systems operate in tandem in many ways, although the relationship between the two groups is affected adversely at times by the apparent constant drift of students from public to independent schools.

Public schools are controlled by Education Queensland, with curricula and accountability procedures formulated by the Queensland Studies Authority. Independent schools in Queensland operate under The Education Accreditation of Non-State Schools Act 2001. Under this legislation private schools have significant freedom in developing and implementing curricula provided they uphold stipulated standards. That level of freedom is influenced by whether non-state schools operate autonomously or as part of a system, such as those controlled by the Catholic and Anglican churches. Within the independent systems, levels of autonomy allowed by the controlling bodies can vary, yielding yet further curriculum control and design permutations.

Within Queensland’s Anglican system there are sub-systems as each diocese controls the schools within its boundaries. Within its particular sub-system the school involved in the study enjoys a high level of autonomy in determining its offerings in the primary school. However, the offerings are influenced by constraints such as government regulation, clientele perception and secondary school preparatory expectations. The secondary school, Years 8-12, comes under strong outside control through the Queensland Studies Authority, as the majority of students are being prepared to undergo assessments aimed at tertiary entrance.

The primary years of the school involved in the study take part in mandatory annual standardised Years 3, 5 and 7 testing. Schools have little choice as to participation as government funding is tied to compliance, just as recent federal funding was coupled to schools supporting government-imposed values (Nelson, 2002a, 2002b, 2002c, 2004b). In recent years, results of the testing have shown that the school is ‘succeeding’ because with few exceptions, its students are working at or above the stipulated benchmarks. However, the feedback has done little to quell teacher concerns regarding current pedagogy and has failed to extinguish their interest in the formative role of assessment. In fact, discussion with teachers at the school revealed that the non-contextual nature of the testing added impetus to their motivation to investigate contextually authentic assessment.

Structure of the School Involved in the Study

The wider school caters for students across Queensland’s Preparatory Year (4.5 year olds) to Year 12 (17 years old). Within the school structure there are two sub-schools spread over two campuses, with 500 boys in the P-7 primary school and 800 boys in Years 8-12. The administrative structure has the Headmaster responsible to the School Council for the school’s operation. Within the senior administrative structure, the Headmaster retains direct control of the senior campus while delegating daily responsibility for the P-7 sub-school to the Head of the Primary School. As that Head, I am responsible for all facets of the primary campus from daily routine, pastoral care, budgetary control through to the design and implementation of the curriculum. Originally, the curriculum was tightly linked to that of the state education department but under local influence over the years it has undergone many changes.

The structure and curriculum of the school are strongly traditional. Classes have the one class teacher and cater for students in conventional age groups. Teachers are expected to teach reading at all levels using phonics, children learn lists of sight words as part of early reading preparation while spelling and contextual dictation skills have always remained in the curriculum. Despite changes over the years in public schools, a level of rote learning has remained and number facts, multiplication tables and mental arithmetic skills have always been part of the syllabus, as has summative testing.

However, the school is progressive in other ways. The most recent innovation is the teaching of basic engineering principles to all students from Years 1-7 using Lego-robotics kits. In short, the school has sought to implement worthwhile educational advances with the benefit of changes for students judged by various stakeholders. Within that desire to improve student learning, the level of early interest by teachers in establishing process portfolios in mathematics strongly supported some form of change to the teaching and assessment of mathematics in the school.

The Mathematics Syllabus of the School Involved in the Study

In teaching mathematics, teachers follow the local syllabus of the school. The syllabus recognises that boys will exhibit a range of strengths, weaknesses and learning interests. The document specifies topics which under normal circumstances would be taught in each year level. The syllabus structure is derived from the QSA (2004) syllabus and is spiral in nature (Smith, 2002), seeking further development of what has been studied in previous years. In my role as head of the school I have encouraged on-going revisions to the syllabus, reducing the quantity of material covered in order to give teachers more time per topic and foster an emphasis on the quality of student learning. Teachers have been made aware of the ‘Myth of Coverage’ (Battista, 1999) which sees vast quantities of material taught in the vague hope that students will retain at least some elements of the content. To counter the myth, content has been reduced and crafted iterative teaching programs designed to deepen and broaden students’ *understandings* of mathematical ideas and concepts.

Largely, pedagogy is not prescribed in the school mathematics syllabus. In reality, however, factors such as the remaining breadth of topics that requires coverage, the historical educational environment of the school, peer group influence and parental expectations continue to exert considerable influence on the traditional manner in which mathematics is taught. Such pressures increased my motivation to foster change.

MOTIVATION TO CONDUCT THE STUDY

My initial motivation to conduct the study stemmed from my concern as a leader in the school about the capacity of students to apply their mathematical skills to ‘real’ or unfamiliar situations and problems. According to Battista (1999), in today’s ‘Information Age’ the problem in teaching and learning mathematics is not just about obtaining facts but in their use. No longer is the acquisition and recall on demand of disconnected facts seen as the *prime* goal of education. The exponential increase in information and the demands of changing workplaces have resulted in curriculum reform which is moving away from traditional content. Although content retains importance, emphasis is increasingly on competencies such as reasoning, problem solving and evaluation. Schools must now look to offer experiences that advance the acquisition of skills applicable to the ‘real world’ outside of school (Porter, 1995).

Further impetus to conduct the study came from a group of motivated teachers who were eager to understand authentic assessment and the implications for their classroom practice. Preliminary investigation revealed that there was limited, rather disjointed information available on the practicalities of adopting a process portfolio approach to the assessment of mathematics. This study looked to assist practising teachers fill the information gaps and gain the understandings sought.

Teachers Teaching and Children Learning

Investigation into how children learn mathematics led to my interest in the correlation between students’ mathematical experiences and understanding, and how students reacted to feedback during learning. Traditional ‘absorption’ pedagogies which promote a mindless mimicry in mathematics continue to be applied within classrooms. Such methods continue to ignore recommendations by the National Council of Teachers of Mathematics (NCTM, 2000) and recent research as to how children learn mathematics. My concerning perception that original ideas embraced by a syllabus can be diluted and distorted by teachers with inaccurate beliefs about how mathematics is learned concurred with those of Battista (1999).

In teaching mathematics, teachers have to follow extensive syllabi which make little allowance for how learning occurs. Time pressures related to coverage mean that developing crucial understanding is difficult (Byers & Herscovics, 1977; Buxton, 1978;

Nesher, 1986). Hence, within mathematics generally, the ‘spiral curriculum’ is not simply a convenient philosophical stance, it is an absolute necessity. The content-heavy syllabus ensures that teachers must return to topics repeatedly. The premise is that revisiting reviews the fundamentals and previously acquired knowledge, with new knowledge then built on those foundations. However, in years past I have spent considerable time revising fundamentals entirely, because a lack of understanding had not seen earlier learning form lasting scaffolds. Indeed, Fogarty (2002) explained that unlike earlier perceptions of the brain resembling a sponge, it can more accurately be likened to a sieve. When the input is meaningful the brain attaches it to existing understandings. If meaningful attachment does not occur the information is discarded.

Fogarty’s sieve analogy illustrates the ‘myth of coverage’. Uniform meaningful learning is not possible across a class because the gaining of meaning in mathematics is iterative, often fragmented and a very difficult undertaking for many learners (Sfard, 2003). Since mathematics has been taught, students have been treated as machines that can be programmed to achieve a pass in testing (Sfard, 2003). For many, the sheer extent of the syllabus interferes with overall high quality learning.

The ‘myth of coverage’ can be dissipated through social constructivist pedagogy, with responsibility granted to students to develop understanding at a personally relevant rate (Clements & Battista, 1990; von Glasersfeld, 1995). Unfortunately, such learning is often conceived as intellectually anarchic pedagogy that allows students to follow their interests, inventing methods as they are inclined whether the methods are correct or not (Battista, 1999). For whatever motive, some educators incorrectly classify constructivist learning as ‘discovery mathematics’ linked to the use of manipulatives and based in cooperative learning. Well-planned, worthwhile constructivist learning retains academic rigour. The expanding influence of constructivist pedagogy within the school involved in the study and its place in the process portfolio methodology generated enormous incentive for the change that this study fostered.

Teacher Assessment: A Key Judgement

As the key overall judgement in evaluation of student learning is local teacher assessment (“School tests …”, 2003) further motivation for the study arose from the opportunity to assist teachers enhance and expand their assessment skills. While studies have addressed problems involved in introducing portfolios in literacy, the issues in the complexities of revising mathematics assessments have received much less attention (Darling-Hammond, Ancess & Falk, 1995). This study centred on issues arising from the reforming of assessment, reforms based on the notion that mathematics is more than discrete concepts requiring mastery that can be assessed effectively through traditional methods.

Traditionally, instruction and assessment are often seen as serving separate purposes (Graue, 1993). Traditional testing fails to evaluate performance in ‘real’ applications and is a poor measure of higher order thinking (Romberg, 1995). Because students only have to master routines, not the underlying concepts, indicated mastery often does not transfer to unfamiliar contexts (Shepard, 2000). The dominance of tests has influenced the form of subject knowledge and shaped beliefs about the nature of evidence of student progress (Shepard, 2000). According to Kuhs (1997), society is committed to assessments that include items written so that not all can succeed. That comparative assessment is now being questioned as it becomes widely accepted that student engagement in learning is influenced by the nature of assessment (McMillan, 2000).

Unlike in embedded assessment, tasks in content-driven mathematics courses still tend to be treated like hurdles that students jump and discard (Kuhs, 1997). Students need to link new learning to develop strong understanding but the assessment of that strength is influenced by tensions, not the least of which is learning versus auditing, a facet which focuses heavily on teachers (McMillan, 2000; Wiggins, 1993). Teachers need to be engaged in the development and application of new forms of meaningful assessment. They need to understand the nature of student thinking and the connections between learning and performance. Student performance can increase if assessment is embedded in learning. The origin of that change is as important as the nature of the change (Darling-Hammond et al., 1995). Early educators such as Chamberlin, Chamberlin, Drought and Scott (1942) found that the process of collective struggle produced the vital shared vision which helped schools innovate. In some schools collective struggle has seen teachers remove the limits that testing imposes and encouraged students to show what they know through individualised performance (Darling-Hammond et al., 1995). This study facilitated one such collective struggle.

Parental Influence on Teachers and Students

Regularly, I have been informed by parents that they were never good at mathematics. As did Battista (1999), I interpret such admissions as celebrating survival and emergence after a painful and useless experience. By contrast, I have never heard a parent admit to experiencing reading difficulties. I often asked parents not to share their negative perceptions of mathematics with their children. I have suggested that if they found themselves unable to assist their child, they should refer the student to someone who can. A central issue for me in the study was the need to re-educate parents to remove that impediment to learning that significant others can foist on to children.

Re-education, the changing of mind-sets, cannot be superficial. Teachers and parents are beginning to recognise that fundamental knowledge alone is insufficient for meeting modern complex societal needs and are calling for a closer match between school-learned skills and the skills students need upon leaving school. The expectation upon teachers is that they help students develop competencies in authentic situations and that students can then demonstrate the abilities by performance (Winking & Bond, 1995). Teachers need to be aware that to be useful to students and thereby society, assessment has to advance education not simply record its status (MSEB, 1993).

Helping Teachers Meet Changing Assessment Needs

As a school leader I was motivated to assist teachers expand their assessment repertoire as changes in pedagogy are changing learning and assessment goals. Consequently, strategies must change to tie assessment to its new purposes (Bond, Herman, & Arter, 1994; Bond, Herman, & Arter, in press). Quality alternative authentic assessments have high fidelity goals and require students to solve complex, real-life problems. Findings from cognitive psychology on the nature of meaningful learning support the use of authentic assessments tied to instruction that emphasises higher-order thinking. However, in designing quality assessment the purpose must be explicit before the structure is developed (Higuchi, 1997). For a new regime to succeed it must be based on local student needs and well designed. Ferrara (1996) claimed that the only way to understand a student's performance is through assessment that is posited in local reality. Situated assessment can measure performance equitably. The culturally tied conceptions that students bring to assessment situations are best understood and interpreted by those familiar with the context (Ferrara, 1996). Local teachers are best able to judge local students' work; yet further motivating impetus in this study.

The Authentic Assessment Alternative

Historically, teachers have relied on norm-referenced testing in order to award students a grade according to set descriptors (Barton, 1999; Perso, 1999). Since the late 1980s support has grown for assessment through the use of authentic procedures (Burke, 1992; Darling-Hammond & Wise, 1985; NCTM, 2004; Romberg, 1995; Shepard, 2000). Assessment, if instructionally supportive, adapted to local context, meaningful to students, and seeking breadth in skill and knowledge assessment, is authentic (Shepard, 1992). Authentic assessment allows differing standards of accuracy and is conducted in a climate of trust. The authentic form is set by local teachers so they are able to respond to students' questions of clarification and accept alternative appropriate solutions (Parke, Lane, Silver & Magone, 2003). According to Bond (1996), Popham (1998) and Killen (2000), authentic assessment is a more effective means of assessing learning than traditional testing. Teachers need to assess authentic learning through authentic assessment (Darling-Hammond et al., 1995; Klenowski, 1996). However, teachers at the study school needed to acquire sound working understandings of such assessment forms. In order for teachers at the school involved in the study to ascertain whether students were understanding mathematical concepts and were able to work effectively in reaching and supporting viable solutions to problems they needed to understand and be involved in the development of a means of authentic assessment. This study of change was the vehicle through which they gained knowledge and skills in using authentic assessment.

One such means utilises the student portfolio, a format which broadens the assessment base by facilitating a wide range of applications. Criterion-referenced tasks, such as those found in portfolios, have students apply skills in context, not simply complete on cue tasks that are only loosely connected to class work and serve vague purposes (Brualdi, 1998; Wiggins, 1993). Criterion-referenced assessment provides teachers with greater insights into what is *actually known*. It is an evaluative method where the synergetic whole becomes greater than the sum of the parts (Kuhs, 1997). It identifies coherence of knowledge and used in problem solving, blended with metacognitive skills, yields clear indications of competence (Glaser, 1988, cited in Shepard, 1992). In doing so, it allows teachers to pose what could at first be seen as ambiguous questions in seeking higher-order thinking. In the envisaged comprehensive process portfolio display an even more complete 'picture' of student progress was sought than in the widely used product portfolio. That picture was to emerge from the wide display of evidence of problem interpretation and solution development.

Within a flexible portfolio display, mathematical thought can be displayed through a wide range of components, such as charts, presentations, and open-ended questions. Portfolios are both effective and efficient as they require students to become engaged actively in their learning (Darling-Hammond et al., 1995; Killen, 2000). This is a paradigm shift from the passive student model in earlier ‘knowledge-transfer’ pedagogies (Duit & Treagust, 1998). If teachers were to facilitate the shift from students ‘knowing’ to students ‘doing’, teachers needed a deep understanding of the underlying nature of process portfolios. This study was designed to assist teachers develop an understanding of the myriad possible facets of process portfolios**.**

Seeking to Expose the Implementation Pitfalls

De Lange (1995) proposed that all students should learn to value mathematics and become confident in solving problems while learning to reason and communicate mathematically. Teachers at the school involved in the study did not believe that De Lange’s goals for learning were being met completely. Whilst students were seen as meeting one or more of the goals, teachers expressed a wish to develop all goals strongly. The process portfolio concept, which utilised the often overlooked goal of student reflection, was considered worthy of scrutiny. Clearly, not only developmental issues required clarification and solution, the exposure of implementation pitfalls and barriers to change also needed attention and proved further urgent prompt for this study.

Motivation to Involve Teachers as Researchers

The National Research Council (1999) and National Academy of Education (1999) called for more research into assessment. Shepard’s (2000) suggestion that teachers might undertake projects which have them take responsibility for school-based inquiry was accepted within the design of this study. Lambdin and Walker’s (1994) claim that such research could lead to improvement in pedagogy as teachers develop skills in assessment *and* reflection and in utilising the resultant communication increased my motivation to involve teachers in the change. Ellsworth’s (2002) claim that through exposure to such work teachers identify and seek appropriate professional development and move into the role of peer and student facilitator added further incentive.

Effective facilitators base instruction on current learner knowledge, help learners share what they wonder about, guide them as they search for related information, have them share their learning and encourage further questioning. Challenges face teachers in finding strategies to help learners learn how to learn but acceptance of the role of researcher has the potential to assist them gain greater understanding (Ellsworth, 2002).

Teachers also need in-depth understandings of the nuances of process portfolios if they are to implement them and argue positively in their support. Questions as to whether the criteria-based assessment strategy used in process portfolios interferes with or complements learning have been raised (Arter, Spandel, & Culham, 1995; Brualdi, 1998; Woodward & Nanlohy, 2002). The reliability and validity of such assessments are challenged frequently (Elbow, 1994). If portfolio assessment is confined to a single classroom the issue is not so complex, but when they are used for comparison across year levels in student ranking such as that demanded by recently introduced federal regulations, the complexity increases (Elbow, 1994; Nelson, 2003; Commonwealth of Australia, 2005). This study was designed to motivate and assist teachers involved in devising an effective process portfolio strategy that would meet such demands.

Teachers Motivated in Professional Development

Through the regular sharing of education journal articles and professional development days, teachers at the school involved in the study are encouraged to investigate best practice. Within the school, teachers frequently discuss programs, practice and performance. They are encouraged to spend time in each other’s classrooms, sharing through practical interaction and possible team teaching. From that interaction, the teacher voice expressing discontent with current mathematics assessment practices and generating motivation for change steadily grew.

From that background emerged teachers who sought to join me in exploring ways of assessment which enhanced learning, not simply produced summary results. Amongst other things, the teachers expressed disappointment in the lack of student knowledge and skill retention revealed by current assessments and the associated apparent lack of student ‘ownership’ of true understanding in relation to mathematics.

As a result of the concern, it was resolved that teachers would constitute a group which would investigate assessment that enhanced learning and motivated students while generating useful formative and summative feedback. The investigation needed to assist teachers learn about and develop an alternative approach while not markedly increasing teacher work loads after initial development and implementation. Assessment needed to become embedded, fit the school's purpose, philosophy and clientele while supporting and supplementing the school's accountability and reporting structure.

A Motivating Authentic Impetus

For the process portfolio assessment concept to be adopted, teachers needed to assume ownership. They needed to establish the portfolio structure as well as the nature of tasks and the manner of their assessment. Teacher perceptions and pre-requisite knowledge of the concept needed to be understood. Regular monitoring would be required to ensure that teachers' expanding needs were met and that they were confident in working within the evolving authentic assessment paradigm. The wide range of contextual variables that enter into such professional judgements and processes added an authentic impetus to the study.

Building on that provocation, the nature and depth of students' ability to apply their understandings in working mathematically needed study by teachers. Learners influence effective teaching through their learning needs. Students would need to comprehend the basic structure and purpose of the process portfolio, as they would be much more deeply involved in the assessment process than in a content-based summative testing paradigm. Criterion-referenced as against norm-referenced assessment would mean major changes in the way in which material was presented to students, how they were expected to respond, and how their responses were evaluated (Manning, Manning, & Long, 1994). Students would need to *understand* assessment and teachers would have to take the guiding role (Swanson, Norman & Linn, 1995; Wiggins, 1993). For instance, student reflective input is vital in authentic assessment within process portfolios. To a significant extent, teachers would be responsible for interpreting that input. How teachers did so needed to be revealed through the study as the responses evoked would be crucial in determining the nature of future learning.

However, Kuhs (1997) warned that if the portfolio concept is introduced as something revolutionary teacher response would be limited and only the most confident and those willing to take large risks would be willing to attempt change. Fortunately, indications are that teachers are recognising the true extent of assessment's impact on learning programs (Burke, 1992) and have begun to display a willingness to explore alternative ideas and structures (Levenson, 2000). Criterion-based assessment is gaining a growing following as it is accepted as valid in facilitating learning. As a group, teachers also demonstrate a willingness to share experiences and expertise that they understand and support (Perso, 1999). So, the shift to portfolio assessment continues to gain momentum and support in many quarters (Killen, 2000). As teachers are the front-line directors of education any real shift has to be driven by them.

Primarily, the enhancement of student learning through improving the skills of front-line teachers in the assessment of mathematics was the motivation for this study. Consideration of all of the aforementioned factors only served to increase my motivation. It was found that while many writers had offered teachers advice regarding portfolios as assessment tools a very large proportion of the issues discussed were related to showcase or product portfolios and to the teaching of literacy, not mathematics. This study was specifically designed to trace the actions of practising teachers developing and adopting a potentially more complex comprehensive student learning narrative in mathematics. Through the development of a process portfolio model as its central focus the study aimed to facilitate meaningful teacher action research designed to expose and solve the problems confronting teachers as they embraced substantial pedagogical change in mathematics.

AIMS OF THE STUDY

With the factors which motivated the study in mind, the study was guided by the general research question, 'What are the problems that face teachers who seek to foster robust understanding of mathematics by broadening the teaching, learning and assessment base through utilising process portfolios?' Answers to questions faced by practising teachers as they moved to utilise authentic assessment in their mathematics teaching programs were sought.

Through the general research question the study set out to describe the design and impact of process portfolios as an assessment instrument of major import within the mathematics program of an Australian primary school. For assessment change to be successful across the wider school it was seen as potentially helpful if teacher change agents, having been exposed to existing relevant literature, became aware of the currently unexposed, undiscussed problems that needed solutions. Therefore, the aims of the study were to facilitate the exposition and confrontation of issues not discussed in pragmatic depth in the literature, and to design an efficient process portfolio model which was seen as effective by stakeholder teachers, students and parents. The resultant aims of the study are shown in Table 1.1.

Table 1.1: Study Aims and Research Questions

AIMS OF THE STUDY	LINKED RESEARCH QUESTIONS
1. To ascertain the process by which teachers move away from their existing methods of assessment, develop a new approach and then adapt and implement the process portfolio structure so as to provide evidence of students’ progress in mathematics.	**1.** What are the issues facing teachers as they realign their teaching, learning and assessment practices with the process portfolio approach?
2. To describe the nature and extent of teacher professional growth and reflective practice, a central tenet of teaching, learning and assessment through the process portfolio.	**2.** What is the nature and form of professional development that facilitates teachers changing to an approach which utilises the process portfolio as an instrument of major import?
3. To investigate how teachers select and/or develop instruments/tasks suitable for the collection and recording of assessment data, both formative and summative, to be utilised in a mathematics process portfolio.	**3.** How do teachers formulate a balance in the use of summative and formative assessments within their approach in order to foster robust understanding?
4. To examine how teachers incorporate process portfolio assessment mathematics teaching and learning experiences in order to develop robust student mathematical understandings.	**4.** What are the advantages and disadvantages related to the use of process portfolios in the assessment of performance and progress?
5. To identify how teachers develop a portfolio assessment structure that dovetails into reporting to stakeholders, such as parents and school administration.	**5.** Taking process portfolios into account, how do teachers develop and implement an appropriate format for the reporting of student performance and progress?

From the five aims the research focus for the study was cast through five research questions. The questions were designed to ensure that the study addressed the significant gaps in the literature in a manner useful to the teachers involved. Further detailed discussion of the aims and research questions forms part of the methodology discussion in Chapter Three. At this point only an overview of both the aims and the linked research questions guiding the study is shown.

SIGNIFICANCE OF THE STUDY

While not disrupting the mathematics program too radically, the study set out to revise parts of the assessment structure. Participant teachers needed to explore assessment possibilities within a guiding structure. This study aimed to provide that crucial format.

Based on the iterative experiences of a group of teachers which explored potential solutions, the study sought to provide teachers with an insight into what for some were seen as conflicting pressures, accountability and creativity. Process portfolios appeared to be a means of students learning creatively while expanding their skill levels and their understanding of the relevance of mathematics in their lives, all within a climate of challenge. Process portfolios offered accountability and evidence of student achievement within a viable mode of informative, authentic, embedded assessment.

Assessment and indeed the teaching of mathematical processes such as reasoning, problem solving and communicating ideas can generate anxiety for some teachers. The processes require much more than the ‘chalk-and-talk’ teaching and testing that have been used traditionally in teaching topics often treated as discrete. In order to embrace effectively the expected creativity, teachers involved in the study were asked to design activities that involved conspicuous mathematical breadth with cross-curricula applications where possible. That was seen as likely to create assessment problems, one of which was likely to be that traditional written tests are inadequate measures of broad application skills. That prompted further interest in alternative forms of assessment. Process portfolios appeared to offer a solution to the dilemma as they displayed the complete ‘story’ of a student’s grappling with a problem, from initial interpretation through to a supportable, viable solution. The study aimed to reveal and address the challenges teachers faced in moving to authentic assessment approaches.

In doing so, the study offered real significance and benefits as it was not about individual student or teacher scrutiny, but concerned with developing best professional practice through group synergy aimed at extensive professional development; improving pedagogy through assessment for the benefit of students and teachers. A goal was to assist teachers “to find ways to fend off the negative effects of … imposed tests and to develop instead classroom assessment practice that could be trusted to help students take the next steps in learning” (Shepard, 2000, p.12). At first, the study was designed to be of pronounced value to local teachers as it sought to broaden their assessment perspective through the experience of developing a range of assessment options. However, it was considered possible that the influence of the study would carry impact outside the school if an applicable practical guide to process portfolios resulted.

With that in mind, the plan was to guide participants in experimenting with and reflecting upon meaningful pedagogical change with no time ‘lost’ to research which had no direct bearing on their classroom practice. The study was integrated into the school’s mathematics teaching and learning program. In line with recommendations from the Mathematical Sciences Education Board (MSEB, 1993) regular teacher reflection was included to ensure that all aspects of the study remained relevant to the central purpose of teachers teaching and students learning and building understanding. Other aims of the study were to encourage teachers to examine current practice, to view assessment as a valuable source of formative insight into student learning and to reconstruct the teaching contract through the selection, design, trialling and modification of appropriate assessment tasks. During the revision, supported opportunities for participant teachers to examine, develop and test emerging authentic assessment practices and to share the results of their learning with colleagues were plentiful.

The work of participant teachers was designed to assist them go beyond an assessment regime which used tests as the sole mode of assessment and to utilise ‘real world’ tasks in order to produce comprehensive formative feedback. The participants’ efforts were aimed at moving from behavioural to cognitive learning objectives assessed through a balanced approach to both discrete and embedded assessment. They were not always to demand only correct answers from students but seek plausible solutions when appropriate. They were to stop simply producing scores for students, to develop a reasoned profile and to supplement student reports with comprehensive maps of learning. To what extent teachers changed their assessment methods and how that fitted into the school’s accountability structure completed the aims of the study.

CONCEPTUAL FRAMEWORK OF THE STUDY

Education's macro-structure, as described through documents such as South Australia's Curriculum Standards and Accountability Framework (SADETE, 2001) and Queensland's Mathematics Years 1-10 Syllabus (QSA, 2004a), requires the implementation of constructivist learning guidelines and experiences in developing and assessing students' lasting understandings. However, when education's micro-structure, the classroom, is considered the reality differs. Classroom teachers at the school involved in the study, while working through the syllabus, at times attempted to work within constructivist parameters but to a marked extent still used teaching and assessment models rooted in behaviourist methodology. The traditional dichotomous test seeking correct versus incorrect responses, continued to prevail. However, teachers were keen to explore the possibility of embracing assessments that genuinely enhanced and supported learning. They agreed that testing would still have a place but that assessment needed to be spread across a range of formative and summative strategies. Emphasis needed to be placed on introducing components such as journals, tasks and reflections all of which can add effective depth to a process portfolio structure. Teachers were seeking greater balance in their approaches to the assessment of mathematics.

Whilst this study was considered to be of major importance to the teachers seeking that balance, reality meant that it was minor within the macro-structure of education, at least initially. However, within the structure of the school involved in the study the opportunities presented held a great deal of potential. Although it is a systemic school, it operates with a good deal of freedom in regard to pedagogy. Within classrooms, the emergence of constructivist practices was evident to varying degrees but in all rooms the pedagogical contradictions mentioned earlier were apparent across syllabus material, learning activities and assessments. Many teachers were facing something of a minor professional crisis because they felt drawn in opposing directions with regard to learning and assessment. They were pulled between constructivist and behaviourist practices. With that in mind, the conceptual framework of the study, based upon the possible realignment of the teaching and learning 'packages' with a view to influencing and guiding other teachers in the school became a driver.

Three Conceptual Referents

The tensions created by the contradictions between behaviourist and constructivist teaching punctuated by non-contextual assessment permeate all facets of assessment. All that teachers attempt to accomplish in the teaching of mathematics is marked by such tensions. This study aimed at addressing and relieving a relatively minor but concerning part of those pressures. While it appears that the government standardised testing framework will remain for the foreseeable future, this study was important because it aimed to reveal effective ways in which assessment procedures could be modified at a school level so that tensions were relieved and students, parents and teachers could be better informed about student progress through improved feedback.

Within the macro and micro structures, the study was structured around three conceptual referents formulated to clarify the transition from current assessment policy and procedures to a foreseen markedly modified situation. The intersecting nature of the three referents is apparent in Figure 1.1.

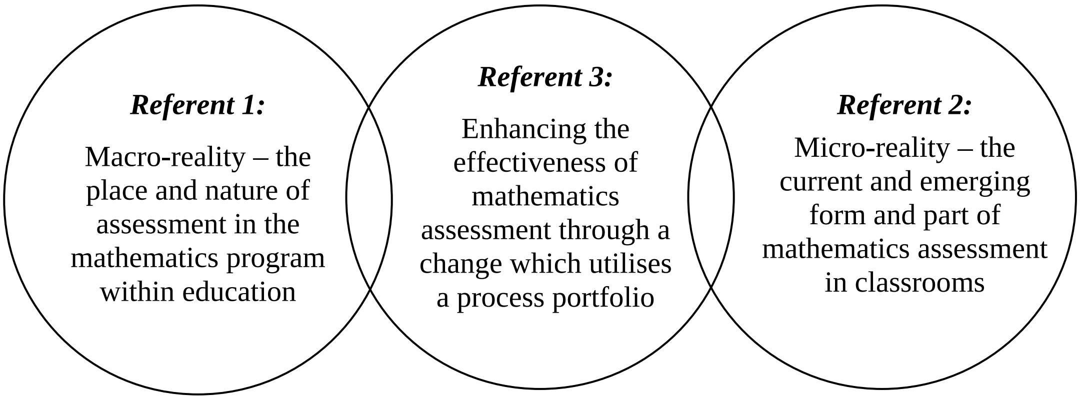

Figure 1.1: ***The Intersecting Nature of the Study Referents***

The first referent concerned the current macro-structure of assessment. It was examined through an extensive review of the literature including discussion of the current focus of governments on standardised testing as greater accountability of schools is demanded. An awareness of assessment traced through the literature allowed the study to be positioned in relation to two distinct views. Bureaucrats and politicians seek cost-effective accountability while educators seek a balanced approach to assessment through the inclusion of authentic assessment. Chapter Two compares and contrasts the two positions.

The second referent, discussed in Chapters Four, Five and Six, addressed the micro-reality of classrooms and the influence that changes could have upon teaching practice. From the initial broader picture, the focus on classroom assessment reality was refined through this referent. The evolution of the process portfolio model within classrooms was traced and linked to participant teachers' subsequent impact on other members of staff through the sharing of resultant student work. The exciting nature of the evolving portfolio model saw participants' influence on the wider staff steadily gain impetus.

The third referent, discussed in Chapters Five, Six and Seven, was to form a picture of what was gained by teachers, students and parents through the changes made to assessment through the components of the process portfolio model developed. Improvement and change to an existing framework can open a plethora of potentialities, not always new, but often revealed in a new light to those involved in the revelation. This final referent was to consider the possible functions made available through the development and implementation of well-designed and contextually sound process portfolios. Those functions include motivation, reflection and communication.

Combined, the referents embraced and lauded a theme of change. They allowed for the examination of the assessment structure that existed within education and the school's mathematics program at the commencement of the study and traced the local development and change process. The later enlargement of the number of teachers involved in assessment change was a result of participant teachers developing an expansive, flexible approach to process portfolios. The approach allowed other interested teachers to select from a number of possible portfolio entrance points with an abundance of paths to follow as they embraced the new assessment mode. The conceptual framework permitted the tracing of the professional development path followed by the teachers involved, and how they influenced the wider staff during the two years of the school-based research.

THE RESEARCH DESIGN

Methodology

The study methodology was selected to enable an insightful appreciation of the impact of the development and implementation of the process portfolio. The small size of the study and the high level of autonomy enjoyed by the school contrasted with large scale assessment innovations as in Vermont, California and Kentucky discussed by Myford

(1999) and Daro (1996). Teachers in those particular studies were somewhat remote from decision making. The setting of the study in my workplace meant that daily access to the decision-making teachers and the students directly involved in the process portfolio initiative was possible with unhindered reference to parents. This was a considerable advantage and one that would not have been enjoyed by researchers from outside the school. It allowed me to be a participant observer, frequently involved in classroom mathematics activities. My participant observer status, prolonged engagement, ready access to those making teaching decisions and the low administrative impact were significant aspects of the study. They distinguish it as a study that placed process portfolios in mathematics under sustained insider scrutiny.

Thus, the methodology of the study is framed in an interpretive paradigm. The initiative was implemented with no out-of-the-ordinary financial outlay by the school. It had no impact on school routine and structure. There was no requirement to rearrange classes or relocate teachers. Overall, the only marked ramification was that participation meant some additional work for the teachers involved, mainly through task and rubric preparation and the provision of study feedback.

Stakeholder Samples

Three stakeholder groups participated in the study. As teachers were the central focus, the first group assembled was the teacher focus group. Naturally, with the process portfolio initiative impacting on students, the students in classes taught by those teachers were the second group invited to participate in the study. The third group, parents of those students, was invited to participate at a later stage. Full details as to how each of the groups was formed and involved are discussed in Chapter Three.

For the most part the school was represented by me as Head of the Primary School. As stated earlier, my initial motivation for such a study stemmed from my wish to see teachers' strengthen the teaching and learning of mathematics and my early suggestions as to possible avenues of investigation. The dual roles of principal researcher and participant observer, where I engaged "in the regular activities of the community … [regularly withdrawing] to check perceptions, record field notes and analyse data" (Anderson, 1998, p. 128) as well as facilitator of change sat comfortably with me. In fact, my central, supportive, flexible roles strengthened facets of my own work and that of the participating teachers.

Data Collection

The recursive nature of the study meant that data were collected from all participants on several occasions as in order to review the effects of assessment changes each of the sources had to be revisited. Surveys, interviews, conversations and formal and informal gatherings were used as data collection opportunities. Interviews were taped for subsequent transcription and interpretation with notes being taken during meetings and after other forms of interaction whenever practical. Numerous and varied opportunities for interaction provided plentiful data on which to judge the success levels enjoyed during the study and the pitfalls encountered along the way.

Data Analysis

Data analysis involved immersion, incubation, illumination and creative synthesis. While collecting and considering the data, I was part of the mathematics teaching team and became immersed in the teaching, learning and assessment processes in each participating class. Incubation took place over the entire data collection period with the teachers involved encouraged to reflect on their teaching and assessment practices. Interpretation and explanation followed collection as part of synthesising the analysis to draw together results against the research questions and formulate recommendations.

To enhance the validity of my interpretations based on data analysis and synthesis, triangulation (Anderson, 1998) was also part of the study process. Field analysis, where information was collected during the immersion process, then interpreted and clarified within the classroom context, was integral to the research framework. Post-field analysis, where the data were sorted, led to content analysis and creative synthesis. The study needed to assess, describe, document and inform the range of problems from the stakeholders’ perspectives. This allowed a number of approaches in order to interpret and bring meaning to the research questions in a creative, interactive manner.

RESEARCH STANDARDS

To ensure that the integrity of the study was maintained, research standards needed to be tightly structured. The ‘audit-trail’ was established and maintained through the filing of all material circulated, surveys, transcripts, observation notes and the keeping of a general study log.

However, no method of data collection is without problems which are capable of affecting the veracity of the results. Guba and Lincoln's (1989) six criteria in respect of qualitative research quality control were applied in the study to overcome possible problems regarding research quality.

1. Prolonged engagement had a significant influence on study quality. The study was conducted over two years. As far as practicable, contact was close and continuous with participant teachers throughout that time.

2. Persistent observation was constantly undertaken throughout the study. The key question here was whether sufficient observations were made to identify the important aspects of the situation and to focus on them in detail. Constant, ready access to all teachers and students involved in the study facilitated high levels of observation. Hermeneutic feedback was constantly and easily gained.

3. Peer debriefing was an ongoing, iterative strategy throughout the study. Peer debriefing in the strict interpretation of the term was not possible as no professional peer within the school was able to pass Guba and Lincoln's (1989) contractual interest test. However, many indicated that they were willing to share and review the educational experiences which resulted from attempted variations to pedagogy. Discussion with education colleagues within other institutions offered something akin to the spirit of Guba and Lincoln's criterion.

4. Negative case analysis, the process of rejection of negative hypotheses, was difficult to apply in this descriptive study. However, each phase of data collection and synthesis was based on working hypotheses which were then tested as part of data analysis.

5. Progressive subjectivity could not be fully implemented in the study as I spent every working day as a participant researcher at the research site. However, to ensure that new information and changing attitudes were taken into account, notes were kept of observations and unscheduled interactions.

6. Member checks with each of the participants were carried out but with some limitations. The presentation of hypotheses, data, preliminary categories and interpretations to stakeholders was rated by Guba and Lincoln (1989) as absolutely crucial in establishing the credibility of a study. However, the technique is not always totally appropriate when conducting research with primary school students. Whilst member checking was carried out with the adult participant groups in a straightforward

manner, students became a limited part of the process through being reminded of their previous responses to questions and tasks as and when appropriate. Teachers were supplied with unascribed copies of their students' responses to surveys and interviews, while parents were referred to relevant data as opportunities arose.

Finally, on the point of quality control, serious attempts were made by me to avoid the label of personal bias being applied to my viewpoints expressed as a result of the synthesis of tacit knowledge and data generated as part of this study. Suitable supportive data and verbatim quotations are used to support discussion in this thesis.

Ethical Considerations

As the research centred on data generated through interaction with and observation of people a number of issues needed to be considered. Issues associated with the study included communication with participants as to its purpose, the safeguarding of participants' rights as well as their privacy. Measures were taken to ensure that the collection of data impacted minimally on the normal routine of the school and classrooms. All prospective participants were informed of the possible benefits of the study, likely risks, the parts expected of them and their ability to withdraw from the study at any time without prejudice.

As part of the informed consent protocol, participating teachers were asked to give written consent in relation to their involvement in the study. As members of the study they were made aware of all relevant data generated and given access to results related to their participation. Through sharing, teachers were constantly engaged in checking, modifying, and confirming my interpretations of data. Of course, data were always shared on the basis of anonymity.

Before students or parents were engaged in the study, parents were given sufficient information to enable them to make an informed decision as to their child's participation. Explanation during parent-teacher evenings and a detailed letter were parts of the informed consent process. Parents were assured that should they give permission for their child to be involved, teaching would continue to cover the mathematics syllabus, all students would participate in class activities, and that data would only be collected in order to inform the study. They were made aware of the full extent of the data collection, including the possible need for me to discuss various points of the study with their child either whilst I was in the classroom for mathematics lessons or through an interview. They were offered opportunity to be present at any interviews involving their child.

Subsequently, students for whom consent forms were completed were told that their parents had been informed of the study and that although their parents had given consent for them to be involved the choice as to actual involvement was still theirs. Importantly, students were assured that their participation in the study was part of the normal mathematics program and would not mean extra work for them. They were told that we were hoping that they would enjoy the new aspects of the program and that it would add renewed interest to their learning.

The confidentiality of any data gathered was safeguarded throughout the study. No data were transferred to secondary researchers. Data collected specifically for this study were kept secure with no personal details of any participant released. That security was reflected in all written material issued and during discussions with teachers, students and parents. Everyday data continued to be collected by teachers with common themes uncovered shared amongst teachers as part of the hermeneutic process. Students were not identified in the discussions. As recommended by Bibby (1998), all participants in the study were accorded the right to examine data that related directly to them.

The maintenance of the naturalistic setting and the accuracy of data depended on the study causing minimal disruption to classes. I am well known to the students, with my presence in classrooms accepted in both observational and participatory roles. Therefore, I believed that I avoided the Hawthorne Effect (Anderson, 1998) of students altering their behaviour because of my presence. Students were long aware of my deep interest in their mathematics. To a large extent, data collection was treated as part of the classroom assessment environment. Interview schedules created minimal disturbance to classes and importantly throughout the study no complaints about ethical matters were brought to my attention.

STRUCTURE OF THE THESIS

This thesis is organised into eight chapters. The remaining seven chapters are structured to reveal the transitional path followed by a group of teachers who developed a process portfolio for the assessment of mathematics. The transition is traced through a review of current relevant literature, an explanation of the methodology employed and the evolution of a unique process portfolio model utilising stakeholder input and reactions. The thesis closes with a summary of study findings, the strengths and limitations of the research methodology and recommendations for the implementation of findings and further research. An outline of the thesis structure is as follows:

Chapter 2 Literature Review: In Looking to Assessment Change

This chapter provides an in-depth account of what are largely two conflicting points of view regarding assessment forms and substantiates many claims made regarding the general value of the portfolio assessment concept in mathematics, claims which prompted this study. The macro-reality of assessment becomes apparent as does the dearth of practitioner pragmatic research related to the problems uncovered and explored in this study in relation to process portfolios. Significantly, this study produced results which offer teachers clear and explicit guidance in developing and implementing an effective process portfolio model. It therefore addresses many of the gaps evident in the current literature and provides a basis upon which teacher change agents can build an authentic assessment platform.

Chapter 3 Methodology

Naturally, as the study dealt with a number of stakeholders, a wide variety of instruments and data collection formats were utilised. Samples, schedules, survey instruments, interview protocols and discussion formats are described in this chapter. However, the description does not encapsulate a single closed methodological approach. Chapters Four, Five, Six and Seven further describe the research design in relation to the chronological development of the study.

Chapter 4 Focus Group Formation, Early Fieldwork and Process Portfolio Development

The micro-reality of the classrooms examined in the study is described in the fourth chapter. Early fieldwork, evolution of the teacher focus group as it evolves a common purpose and the early development of the process portfolio are discussed.

Chapter 5 Professional Learning and Application

In expanding the micro-reality opened in early fieldwork, Chapter Five covers the professional development of teachers and the further extensive development of the resultant unique process portfolio model. Barriers to change are also discussed.

Chapter 6 Students - The Real Focus

The point of the work documented by this thesis was to engage students in order to develop their understanding of mathematics. Student attitudes and their substantial contributions to the transition to process portfolios are discussed in this chapter.

Chapter 7 The Part of Parents

In any major change it is vital to gain input from all stakeholders. While parents were seen as playing relatively minor roles in relation to the time and effort committed to changes to assessment as in this thesis, they have a great deal at stake in the education of their children. This chapter discusses parental contributions, levels of interest in and support for the process portfolio concept.

Chapter 8 Conclusions and Recommendations

The final chapter reviews the aims and draws a number of conclusions as a result of the study. The many problems facing teachers in realigning their teaching practice and the wide variety of unique solutions generated are reviewed in relation to the research questions. The evolving roles of the newly derived forms of assessment also come under discussion. While many of the resultant implications are discussed throughout the results in earlier chapters, several major implications for teaching and learning receive particular emphasis in the closing chapter. Limitations of the study are shared as are recommendations for the wider implementation of process portfolios across the study school and other schools. In line with the evolving nature of teaching and learning, possibilities for further research arose from the study and suggestions for subsequent research are offered. The thesis closes with a personal comment in relation to what I gained as a practising teacher by carrying out the study.

CHAPTER TWO: LITERATURE REVIEW

IN LOOKING TO ASSESSMENT CHANGE

Over the past half century there has been an unprecedented level of research related to education (Popham, 2004). The level of publication reflects increasing interest, pressure and demands upon the education process. Part of that intensity has been generated through the escalating diversity of employment, which in turn has led to an increase in the years spent in education. For example, the Queensland government recently increased the compulsory education and training age to 17 years (Barton, 2004). The increased investment in education which has accompanied its expansion exerts pressure for change as greater relevance is sought in return on the investment.

Today’s educational structure is heavily effected by its history, with broad truths in H.G. Wells’ 1951 declaration that human history was becoming a race between education and catastrophe. This chapter examines aspects of the time since Wells’ declaration in relation to mathematics education, with particular regard to assessment. From a situation where education was left to educators, the political influence over the latter half of the last century saw many aspects of education change. From teaching and learning, to assessing and reporting, calls for reform have been relentless. Frequently, the nature of the reforms has been debated. This chapter addresses that debate in relation to its impact upon assessment in mathematics.

Assessment has always been an important facet of the accountability framework in the education process. Since schooling began, the testing of students to ascertain their achievement has been part of the structure. With governments responding to increased public pressure to ensure that education produces higher quality student results, accountability has gained primary importance for many, such as Australia’s former Minister for Education (Nelson 2002a, 2002b, 2003, 2004a). For a number of reasons discussed within this chapter, accountability currently remains concentrated on imposed centralised testing (Nelson, 2004a). However, a review of the literature exposes the multitude of shortcomings in relying principally on such testing as an indication of student learning (Black, 1994; Kilpatrick, 2001; Kuhs, 1997). The fact that assessment within a well-balanced accountability framework is multi-faceted and requires a variety of formats is discussed in depth throughout this chapter.

From an historical perspective, through a review of the current situation, the presented standpoint shifts to what is demanded by researchers such as Black (1994), Burke (1992), Popham (2004), Shepard (1997), and Wiggins (1993), a more authentic, balanced form of assessment in mathematics. They want a blend of formats with emphasis on the need for assessment which possesses broad potential for indicating the true breadth of student understanding in mathematics. As the discussion proceeds, focus falls upon authentic assessment instruments such as the process portfolio and its potential to provide clear indications of student progress to education's stakeholders.

However, major change brings with it difficulties, problems which must be addressed if change is to be successful and lasting. Initially, at least, the main drivers for change of the nature on which this study concentrated were teachers. Several researchers have stressed that teachers' attitudes to change depend on how change effects them personally. Hord et al. (1987) stated that it is critical to understand the point of view of those involved in the change effort. Hord et al. identified seven developmental stages of concern related to innovation in schools. The 'self' stage of concern occurs during the early stages of change, when teachers' primary interests relate to the personal effects. Provided that concerns are addressed at each level, teachers then progress through anxieties about the impact of change to finding even better ways to teach students.

In looking at students and change, Fullan (1991) identified four images as representing student attitudes toward change; indifference, confusion, temporary escape from boredom and heightened interest and engagement with learning. Fullan also claimed that students' interpretations of their traditional classroom roles can impede change. Actual student participation will determine whether innovation that requires students to do something succeeds. Teachers need to be aware that it is likely that students will participate if they understand, acquire the appropriate skills and are motivated to try. Heightened student interest and engagement are the keys to any school improvement effort (Fullan, 1991).

This study recorded the actions of teachers who addressed such concerns regarding a change in the assessment of mathematics**.** Hence from an examination of current assessments, the literature review moves through questions surrounding portfolios and on to those issues confronting teachers as they attempt to realign their teaching and learning programs in order to embrace assessment of mathematics through process portfolios. Moreover, the perceived lack of information in the literature about the precise shape and functionality of process portfolios and how teachers go about designing locally applicable, flexible, learner responsive models is highlighted.

THE CURRENT ASSESSMENT CULTURE IN MATHEMATICS

> Assessment is defined as the process of obtaining information that is used to make educational decisions about students, to give feedback to the student about his or her progress, strengths and weaknesses, to judge instructional effectiveness and curricular adequacy, and to inform policy. (American Federation of Teachers, National Council on Measurement, & National Education Association, 1990, p. 30).

The last fifty years have witnessed marked evolution in education with accountability through assessment receiving particularly heavy attention (Black, 1994, 1995; Burke, 1992; Darling-Hammond et al., 1995; Kilpatrick, 2001; NCTM, 1989, 2000; Wiggins, 1990). Measurement of student achievement became highly political, leading to constant questioning in pursuit of 'effective schools' and the means by which to identify them (Anderson, Holland & Palincsar, 1997; Duit & Treagust 1998). Over the time, the results of testing have been used by policy makers to bring pressure to bear on educational bureaucracies (Barton, 1999). During the 1980s and 90s elected officials in the United States of America pressed for even higher levels of norm-referenced standardised testing. Officials saw testing as a means whereby they could pressure schools through berating and threatening, claiming that the results revealed shortcomings in education and that any who opposed increased testing were ignoring students' needs (Barton, 1999). Unfortunately, though testing is part of evaluation, too often it is seen as the essential core of the process, when in reality it is generally a case of testers looking at the scores only to check for variations with little further use made of the data (Madaus, Haney & Kreitser, 1992).

The United States of America exerts strong influence in education, particularly in the area of accountability (Barton, 1999; Kilpatrick, 2001; Shepard, 1992). Test results such as the third Trends in International Mathematics and Science Study (TIMSS) and the Program for International Student Assessment (PISA) reveal that influence to be based more on economic influence than educational achievement. Fifteen-year-old students in the United States ranked only 24th out of the 29 participating countries in PISA 2003 (NCTM, 2005). TIMSS 2003 ranked that age group at 15th, one place behind Australian students (NCES, 2005). However, of local concern is the fact that fourth grade Australian students ranked only 16th in TIMSS 2003, four places below their American counterparts (NCES, 2005). Worryingly, in that category, Australia was almost 100 points behind top-ranked Singapore. That gap emphasises the need for Australia to address the issues related to effective teaching and learning of mathematics. Both Singapore and the United States school systems rely heavily on standardised testing in centralised accountability so its increasing presence within Australian education should not be surprising.

Standardising Testing in Australia

As Australian bureaucracies follow the foreign lead in the quest for measures of success, it is apparent that testing is gaining a growing foothold in accountability structures (Nelson, 2002a, 2002b, 2004a; QSA, 2004b; State of Queensland, 2005). Governments require annual benchmark standardised testing in literacy and numeracy at Years 3, 5 and 7. Further testing in English, Mathematics and Science, as well as Civics and Citizenship is to be introduced into Years 6 and 10 in the near future (Nelson, 2004b). High stakes testing is now seen as essential by policymakers in their quest for accountability measures which they see as a means of improving teaching standards (Nelson, 2003). Policymakers claim that it forces teachers to cater for *all* students. In fact, it has been claimed that without the threat of testing they would not do so (Baker & O’Neil, 1994). This threatening environment focuses squarely on the ‘factory’ metaphor of schooling, one which purports that students can be formed into ‘standard’ products through a common process which can be measured through standardised assessment measures (Romberg & Wilson, 1995).

Often, such testing, which is but a small part of comprehensive assessment, is seen to be the principal means of bringing about teaching reform and more effective programs (Barton, 1999; Linn & Dunbar, 1992). However, standardised tests are more a measure of what students *do not know* than a teacher’s capabilities. It is a deficit model of assessment (De Lange, 1995). Students are presented with a specific problem of narrow focus which has only one solution. If the student cannot work that particular problem, there is no way to gauge what the student actually does know about that topic. Barton (1999, p.9) declared that “the use of such tests for accountability without meeting standard and well-known methods of validation amounts to testing malpractice.”

If education policymakers looked carefully, they would see that teachers do not use standardised tests as their chosen form of evaluation (Madaus, Haney & Kreitser, 1992). Teachers use assessments that they formulate, or that come with published materials, because the instruments are seen to give a more valid, equitable indication of the level of student success in context (Barton, 1999). Positive assessment models enable students to show what they *do know*. Stimulating and invigorating assessment counsels and informs learning, whereas for many years testing has been treated as an end in itself (Killen, 2000; Kyle, 1997).

Limited Depth of Tests

Assessments in the form of tests emphasise recall of basic content, not process, which limits the depth and breadth of content (Klenowski, 1996). By their nature and inherent restraints, tests cannot cover the full range of instructional objectives. Arguments claiming that teachers are pushed toward narrow programs that only prepare students for tests, that the tests become the instructional program, have been ignored by policymakers (Barton, 1999). Mehrens and Kaminski (1989) and Shepard (1992) warned that when test scores are important, particularly in regard to accountability, teachers will teach to the test. However, teaching to the test leads to a ‘dumbing-down’ of instruction, potentially diminishing the quality and depth of student learning (Darling-Hammond & Wise, 1985; Lazear, 2000).

Lazear (2000) suggested that the ‘dumbing-down’ occurs through assessments that simply require students to recall information. Added to that is the use of norm-referencing which embraces the normal curve of grading distribution and all forms of testing being related to a base of time efficiency, reduced cost and administrative ease. Tests which generate a grade, supply little or no feedback or suggestions for improvement, compound that dumbing-down effect. Compounding the issue is an assumption by some assessors that the only valid form of reliable assessment is a formally administered written test. Such an assumption reflects a failure to recognise that individuals learn, understand and know in myriad subtly different ways. Popham (1987) partially negated the concern regarding the effect of testing on instructional quality. He stated that mastery of content can be promoted effectively by creative teachers who then simply get on with what they consider to be more contextually meaningful pursuits. They side-step the testing issue and do not let it interfere in the overall teaching and learning programs.

Whilst it has been claimed that effective schools are able to close the achievement gaps revealed by testing programs, strong criticism related to one test score being the sole determinant in decisions about achievement continues (Barton, 1999; "Building Tests …", 2001). Performance standards in broad tests are set by measurement experts, not practising teachers. The University of New South Wales Testing Centre is staffed by such professionals. UNSW tests are designed to rank students' results. They fail to provide sound indication of mastery of a range of topics. One such test cannot give a clear overall indication of student achievement. Students receive an overall grading together with minor detail indicating which of their answers were incorrect and the percentage of the group tested that gave correct answers to each question. But the feedback's instructional value is negligible. In line with earlier claims, because the nature of the test places limitations on the scope of topics covered, such tests are negative forms of assessment (De Lange, 1995; Madaus, Haney & Kreitser, 1992).

Claims such as those made by Barton (1999) that the simplicity of testing is at odds with the complexity of teaching have reinforced the claim that better assessment practices will lead to better teaching and learning (Murphy, 1996). There is a need to concentrate attention on the basic abilities that underpin performance, rather than solely upon performance itself at a particular time (Blais, 1998). Achievement should be judged through tasks that require the application of skills over time (Pandey, 1990).

Isolated Testing Fails

Mismatches between current dominant closed testing and the nature of mathematics are readily apparent. Students are generally tested in a static mode using pen-and-paper and involving abstract thought and concepts. Such methods cater for only a limited range of intelligences leaving little scope for the integration of a wide range of intelligences in solving a given problem (Gardner, 1993; Greenhawk, 1997; Murphy, 1996). Time-constrained pen-and-paper testing, the traditional form of assessment, is only one of many useful formats. The attempt to standardise the way in which students think, and the speed at which they are supposed to do so, creates further inequities and questions of validity (Grouws & Cebulla, 2002a; Levenson, 2000; Murphy, 1996; Pandey, 1990).

In relation to validity, some assessment procedures have inherent bias (Baker & O'Neil, 1994; Murphy, 1996; Parker & Rennie, 1998). However, the question as to whether an assessment method, or instrument, is biased is difficult to answer because of the myriad faces of bias. Limited English skills in some immigrant students and mathematical terminology steeped in jargon are but two such issues. The fact that girls' success in mathematics is not greeted as with boys' is another concern (Hawkes, 2001).

Students, boys and girls alike, feel isolated from the assessment process (Murphy, 1996; Romberg, 1995). That isolation yields little consideration of student difference as personal characteristics are ignored in developing broad generic assessment instruments. The sense of ownership and relevance that can accompany student participation in the process through alternative assessments has the potential to alter student achievements and learning outcomes (Black, 1995; Ferrara & McTighe, 1992).

Students' achievements in mathematics are often narrowly defined (Murphy, 1996). In mathematics the common right or wrong dichotomy creates many issues in what is seen incorrectly as a non-creative subject (Devlin, 2000). Devlin points out that there are often a number of possible, acceptable methods yielding plausible solutions to problems, that there is far more to mathematics than dichotomous algorithms.

In what could be the 'bottom line' in relation to learning in the secondary years, Black (1995) declared that five years of cramming in order to succeed under dichotomous testing stifles the eagerness of students to explore, thereby negating the natural human drive to learn. Tests, the focus of the crammers, are used to mark the end of a period of learning, measure the content retained and rank students. Throughout much of the developed world the ability to rank lends administration an efficient accountability tool (Asli Koca, & Lee, 1998; Barton 1999; Costa, 1992; Hammerman and Musial, 1997; Nelson, 2002b; Pandey, 1990). Policymakers claim that accountability legislation has the dual goals of both assessing and improving student performance ("Building Tests …", 2001; Nelson 2004a). However, the results of testing are of minimal value when looking to improve teaching quality, a fact not appreciated by those with low levels of assessment literacy (Danielson & McGreal, 2000).

Within education's stakeholders, to a previously unseen extent, there is a distinct lack of assessment literacy (Popham, 2004; Stiggins, 1992). Most defenders of traditional tests are unable to appreciate that it is the form of testing, not the content, that has the potential to retard learning (Wiggins, 1990). Wiggins believes that if the aim was to simply monitor student performance, then conventional testing may well suffice. Costa

(1992) added that student competency might be demonstrated in a test but that the effectiveness of their learning is demonstrated only through performance across situations that require cognitive linkages, not simply isolated reactions.

Isolated reactions to non-contextual dichotomous questions are inadequate as available knowledge is at least doubling every three years (Stiggins, 1991a). “A critical characteristic of intellectual ability is not only having information, but knowing how to act upon it” (Costa, 1992, p. 213). It must be realised that teachers do care about outcomes generated through such application and are eager to learn how to assess student achievements fairly and reliably (Stiggins, 1992). In seeking alternatives to testing in determining growth in intellectual abilities, there is also a need to know how learners behave when they do not know (Costa, 1992). Teachers need to be able to interpret and assess such actions as integral parts of worthwhile assessment procedures.

Worthwhile assessment demands many qualities in teachers including insightfulness, perseverance and craftsmanship (Costa, 1992). Portfolios offer teachers opportunities to assess the breadth and depth of student work in an authentic multi-dimensional manner. Such is more likely to encourage students to accept a stake in their achievement as it cultivates higher order thought and useful problem solving abilities (Newmann, 1992). It is designed to produce understanding that “has value beyond the mere demonstration of competence in school” (Newmann, 1992, p. 139).

The Need for Change

All concerned with assessment agree that it must be defined by a number of characteristics in order to serve its purpose adequately. Those qualities, as shown in Figure 2.1 overleaf, must also be present within any form of alternative assessment if it is to be viewed by the educational community as an acceptable substitute for testing.

Tests are being used for too many purposes. In order to become a tool of genuine overall value, the current content-heavy boundaries of assessments need to be expanded to allow evaluation of students’ conceptual understanding and broad problem-solving capacities (Shepard, 1992). To make assessment a more powerful tool, it must be changed from the end-of-the-week, end-of-the-chapter summative model. It must take the form of ongoing formative assessment (Boston, 2002; Burke, 1992). The purpose of assessment is to monitor student growth, and measure understanding and ability to apply skills to ‘real’ situations (Burke, 1992).

Assessment must be:

- valid
- correctly targeted in relation to students assessed
- reliable, giving consistent results
- fair to all from all backgrounds
- aimed at important concepts and understandings
- clear and specific, covering all facets of concepts examined
- designed to extend students in reflecting upon experiences, revealing their new knowledge and understanding
- varied in order of thought to allow student individuality to be displayed
- ‘embedded’ – i.e. an integral, dynamic part of the teaching and learning process
- authentic, offering opportunities for learners to demonstrate what they have learned and what remains to be learned in as broad a manner as possible

(Burke, 1992; Herman, 1992; Killen, 2000; Kyle, 1997; Lesh & Lamon, 1992)

Figure 2.1: ***Characteristics of Sound ‘Alternative’ Assessment***

In ‘real’ situations there is a need to set tasks worth completing. The tasks must require students to use higher mathematical literacies and be able to be assessed effectively through criteria-based instruments (Burke, 1992; Wiggins, 1993). Criterion-referenced assessment sets benchmarks against which students’ achievements are measured (Popham, 1998; Spady, 1994). Such sound assessment differs from processes that simply quantify results by way of scores, course completion rates and post-course employment rates (Killen, 2000; Perso, 1999). It does not quantify nor is it empirical. It is not based on a deficit model. It seeks to engender and assess true understanding of concepts, those abilities that support performance (Blais, 1998). If students are to become proficient at thinking and reasoning, they need practice in comprehending and solving complex problems on their learning journey (Shepard, 1992).

Contrary to the factory metaphor, the journey metaphor sees students travel a path of knowledge and skill growth, following a route that recognises and values diversity and achievement (Greenhawk, 1997). On the journey it is through assessment of students and programs that changes are made to meet emerging needs. Difficulties continue to arise in formulating and implementing the changes as the true nature of assessment has varied little over the years (Baker & O’Neil, 1994; Barton, 1999; Madaus et al., 1992). Unfortunately, many still see testing as the core of assessment, while in reality testing is not much changed from what it was many years ago (Barton, 1999). In classroom assessment today, pronounced incongruities between accountability testing and testing for instructional purposes are evident (Shepard, 1992). Those incongruities highlight the differences between imposed testing and teachers' methods of assessment.

Since the 1980s, the emergence of support for assessment through teachers' alternative strategies has been a significant evolution in the teaching of mathematics (Burke, 1992; Darling-Hammond & Wise, 1985; NCTM, 2000; Romberg, 1995; Shepard, 2000). The call has been to shift the emphasis, to de-emphasise high stakes testing and to probe learning of a wider nature. The focus needs to be on how students produce knowledge, as against how they reproduce knowledge (Costa, 1992). The growing demand for formative assessment, opportunities for students to demonstrate understanding, as well as diagnostic teaching tools, has seen increasing attempts to change the methods used in measuring the effectiveness of teaching and the learning journey travelled by students ("Britain gives," 2002; "Enterprise return", 2003; Tucker, Glover, Long, Haas & Alemany, 1999).

Glaser (1988) identified coherence of knowledge, principled problem solving and automatised and self-regulatory skills as indicators of competence in a domain of knowledge. All are able to be assessed accurately by teacher-set assessment tasks rather than the haphazard approach of standardised testing. Students given instruction and tasks centring on understanding gain better results in assessments than those simply drilled on skills to be tested (Carpenter et al., 1988).Teachers realise that what matters is understanding and the habits of mind that students become disposed to employ (Costa & Kallick, 2000; Wiggins, 1997). Such qualities are examined in depth through authentic assessment.

Authentic assessment provides teachers with greater insights into what a child knows by promoting learning which is aligned with classroom practice and reflects local values, standards and control (Paris & Ayres, 1994). Unlike closed testing, it provides a synergetic evaluative method (Kuhs, 1997; MSEB, 1993). If within that process we give students the opportunity to describe their own thought processes through reflection, we can determine if students are becoming cognitively more aware (Costa & Kallick, 2000). Reflection encourages metacognition and its use in principled problem solving can improve appreciably student competence (Glaser, 1988). Reflection allows teachers to pose what under a traditional dichotomous approach could be seen as potentially ambiguous questions in seeking higher-order thinking (Shepard, 1992).

Assessment Tensions

The nature of assessment influences the level of student engagement in the learning process (McMillan, 2000). In seeking to enhance student understanding through greater engagement, the nature of assessment demands marked consideration in relation to the impinging tensions that influence that nature. The tensions are generated between syllabus fidelity and innovation, learning and auditing, formative and summative assessment and criterion-referenced and norm-referenced assessments. The list continues with value-adding versus absolute standards, traditional versus alternative assessment, authentic versus contrived assessments, speeded tests versus power tests and standardised versus classroom generated tests. Those tensions are key issues which require consideration in any broad discussion on the nature of assessment.

Undeniably, there is a need for strong ties of similarity between syllabus, teaching and assessment if syllabus fidelity is to be maintained. Over the years, syllabus changes have rarely been accompanied by assessment changes. For instance, constructivist theory has altered mathematics pedagogy, yet Noddings (1984), von Glasersfeld (1993) and Cobb, Wood, Yackel and McNeal (1992) found that dichotomous testing remains dominant in assessment. Unfortunately, this indicates that limited progress has been made in addressing major tensions, such as conceptual versus procedural knowledge and the development and measurement of understanding (Hiebert & Carpenter, 1992).

Learning versus auditing tensions are catalysts of current debate, much of which centres on performance assessment (Darling-Hammond et al., 1995; Romberg, 1995; Sowder & Schappelle, 2002). Performance assessment assesses learning through tasks that are meaningful in their own right (Lesh & Lamon, 1992). Questions about that role include, ‘Does such assessment need to take either a formative or summative format, or can it be an harmonious, constructive blend, utilising criterion-referencing?’ Criterion-referencing is an effective, constructive strategy, particularly in formats such as portfolios. The tension between traditional norm-referenced and authentic criterion-referenced assessments does not mean that one must supplant the other in a balanced approach. Meng and Doran (1990) concluded that pencil-and-paper tests are adequate for ascertaining whether students have mastered facts and terminology. Authentic tasks need to complement the broad measures.

Current broadly used assessments are inadequate for measuring comprehensive standards (Levenson, 2000). Criterion-referencing provides a better setting against which to assess achievement (Killen 2000) and the approach means that the process is built around essential educational goals (Spady, 1994). The entire package, the syllabus, the teaching, the learning and assessment, is then organised to facilitate the realisation of those goals.

Black (1994) asked whether the public could understand that learning based on such goals shows that traditional assessments are often inadequate and damaging. Students' emotional states must be considered in relation to assessment adequacy and the potential stress-related damage induced through testing. Goleman (1995) said in consideration of that potential, some assessment tasks need to be reformatted as success in life is governed more by one's Emotional Intelligence Quotient (EQ) than the traditional Intelligence Quotient (IQ). Recognition of such factors in the design of equitable assessment which offer choice of assessment tasks has the potential to reduce student stress (Gordon, 1991). However, in order for that potential to be realised and stress minimised, students need the prerequisite knowledge and skills to complete such tasks (Baker & O'Neil, 1994).

Stress is further reduced in an environment in which students have some control and in which it is acceptable to make mistakes. Yet further reductions can be linked to the provision of context-embedded tasks which make the tasks clearer and more interesting, rather than abstract, isolated problems (Parker & Rennie, 1998). The reduction of stress stimulates greater serotonin levels, producing a positive effect on brain chemistry and assisting the development of well constructed, logical thought (Sprenger, 1999). There is, therefore, a need for teachers to create local authentic assessments which communicate purpose, style and standards to students.

Authentic criterion-referenced assessment, with students working on problems with local context at their own pace, becomes value-adding, whereas closed contrived assessment, as in centralised testing, offers no such quality. While reasonable time controls need to be set in many instances, the absolute control over the time that students spend on tests fails to account for their individual differences (McMillan, 2000). Authentic assessment ensures that adequate time is allowed, catering for student difference while not detracting from accountability.

While the debate continues, schools maintain high-stakes testing to avoid accusations of avoiding accountability with government funding tied to participation (Nelson, 2004b). However, teachers harbour fears regarding the potential negative impact testing has on learning (“Building tests …”, 2001). Teachers should be the judges of student success, the umpires of their performance (Barton, 1999). Barton claimed that for assessment to facilitate an increase in the levels of student achievement teachers must shift assessment from a summative position at the end of the learning cycle to a formative function central to the learning focus; it must become embedded.

Standards

In all facets of education standards are important. Different strategies used in authentic assessments do not mean a lowering of standards in relation to student achievement (Darling-Hammond, 1997; Lazear, 2000). The standard of what is done must be measurable in a valid manner if levels of quality control are to be established and maintained. Wiggins (1997) made a number of points in discussing standards. Standards relate to tasks done by individuals, are judged within a context and are not the result of standardisation. Standards vary with a performer’s aspirations and purpose. Raising performance standards requires not standardisation of expectation but heightened demands of each student in each course (Wiggins, 1997).

Appropriate assessment material must be provided if higher-order thinking leading to higher standards is to be incorporated into the syllabus (Bell, Burkhardt & Swan, 1992). Well-designed assessment, seeking the application of a wide order of literacies and skills, focuses on the nature of student achievements. This allows teachers to adjust and modify learning programs in order to satisfy emerging student needs and offer all students a chance to shine (Boston, 2002; Krechevsky, 1992). Opportunities to shine are offered through tasks which span Bloom’s (1956) taxonomy, from the recall of knowledge up to evaluation and the high point of thought, creativity (Lazear, 2000).

Students’ real understanding is demonstrated through the application of knowledge and skills to unfamiliar circumstances. The cognition involved in application, evaluation and creativity takes a student into higher realms of thought (Gardner, 1991). Indeed, the National Council of Teachers of Mathematics, the NCTM, (1989) stated that mathematics should be taught as a thinking activity. If that is to be done, there can be little doubt that the implementation of higher-order thinking depends on the provision of appropriate assessments (Bell, Burkhardt & Swan, 1992). Authentic assessment provides a robust perspective of the learner's deeper understanding of mathematics (Lajoie, 1995). Authentic, meaningful assessment of appropriate cognitive complexity offers students challenge and yields a high level of quality information reflecting the standard to which the student has understood and applied the learning (Dietel, Herman & Knuth, 1991; Linn, Baker & Dunbar, 1991).

THE PORTFOLIO – AN AUTHENTIC ALTERNATIVE

One of the forms of assessment that has received a notable proportion of the attention given to alternative formats is the student portfolio, a tool which broadens the assessment base by embracing a wide cross section of knowledge application formats (Burke, 1992; Darling-Hammond et al., 1995; Kuhs, 1997; Sowder & Schappelle, 2002). Such criterion-referenced assessment has been classified as authentic as it has students apply their knowledge and skills in a meaningful, real-world context.

Within that context, learning centres on students *making* not just receiving meaning (Brown, 1992). A large proportion of knowledge and understanding is personally and socially derived (Duit & Treagust, 1998; von Glasersfeld, 1993). People are creating it all the time (Brown, 1992; Costa, 1992). In order to comprehend and assimilate new meanings, students need to embrace higher literacies where they learn how to think critically, communicate effectively, synthesise and evaluate information and become more involved in their learning than has been the case traditionally (Brown, 1992; Lazear, 2000). When students have to demonstrate their skills in observable ways they become active learners (Brown, 1992; Delisle, 1997). Portfolios are a key alternative assessment instrument as they require the demonstration of skills. They are a major part of the paradigm shift in evaluating student achievement (Klenowski, 1996).

Portfolios Defined

Portfolios have been defined by Arter and Spandel (1992, p. 36) as "a purposeful collection of student work that tells the story of the student's efforts, progress, or achievement in given areas.” Later work by Arter, Spandel and Culham (1995) reaffirmed that definition. According to Brady (2002) the definition would be sharpened by the replacement of ‘purposeful’ with ‘strategic’. Clarification increases with reference to the multidimensional, continuous and ongoing characteristics of portfolios, as well as the inherent opportunities for formative and summative assessment (George, 1995).

Several discussion points arise from the definition. Whilst the definition is apt for portfolios generally, this study centred on a particular form of portfolio, the process portfolio. George’s (1995) points regarding continuity and ongoing formative assessment possibilities in a portfolio are emphasised in the process portfolio concept which through its display of all steps in task completion displays the entire learning journey. By far the greater part of the literature concentrates on product or showcase portfolios, which as their name implies display only the finished product for summative assessment; a limited window on achievement. Brady’s (2002) description of them as a ‘strategic collection’ implies a ‘strategic selection’, one that displays only ‘the best’.

The best portfolios, product or process, have clearly delineated purposes around which tasks and assessment criteria are established. Clarification of the criteria used in determining performance and level of success is essential (Brualdi, 1998). Students feel empowered when the criteria are in writing, ensuring that all clearly understand and have a ready reference as to what is sought in the assessment tasks (Stenmark, 1991). Assessment tasks displayed in the portfolio must clearly illustrate effort, skill and knowledge growth and achievement over time, the core of authentic assessment (Arter & Spandel, 1992). To be broadly effective, portfolio displays need to reveal the purpose of tasks, the judgement criteria and each step of the completion or solution process. Process portfolios are intended to offer such detailed displays, but the literature concentrates heavily on assessment through the showcase or product model.

Generally, within a portfolio, whatever the model, teachers are responsible for task creation and criteria clarification. Ideally, criteria and rationale for tasks could be written by students but once again, there is little guidance in the literature for teachers interested in such a direction. Sinclair and Woodward (1997, 1998, 1999, cited in Woodward, 2000) stated that clear task rationale and assessment criteria are necessary as they facilitate strong student engagement. Student involvement in generating criteria would make one of the functions of the portfolio task instructional. It stands to reason that student generated tasks and criteria would add even greater value in seeking to build well-designed student-centred portfolios enveloped in a strong sense of learner ownership.

Well-designed, student-centred portfolios do display a rich array of what students know and can do, allowing broad evaluation (Arter & Spandel, 1992; MSEB, 1993; Stenmark, 1991). Performance-based assessment of learning in portfolios presents open-ended challenges in which students can demonstrate their understanding and skills (Baker & O'Neil, 1994; Black, 1995). They reflect the contexts and processes whereby students produce their work. Judgement of performance in context using explicit criteria is an acclaimed strength of the portfolio (Darling-Hammond et al., 1995). They align assessment with what is of lasting value by way of specific useful learning goals and offer continuous feedback on student progress. Within the process portfolio, higher order skills could be revealed and judged through a wide variety of authentic open-ended tasks. They could be designed to encourage students to reflect upon that growth, an activity claimed as crucial in bringing about deep and lasting understanding (MSEB, 1993). It is clear that they have marked potential to use assessment as both learning tool and monitor by collecting continuous diverse authentic evidence of learning (Burke, Fogarty & Belgrad, 1996; Loef, Carey, Carpenter & Fennema, 2002; Stiggins, 1992). It appears that by incorporating all facets of the learning process, process portfolios could be used to align teaching, learning and assessment. In order for the teachers at the school involved in the study to develop a process portfolio, engaging their students in both the design and functioning processes, the lack of practical guidance available through the literature needed to be addressed through applied research by the teachers involved in the transition.

Framing the Study in the Light of Current Literature

In relation to portfolios as strategic teaching tools, mathematics has not received anywhere near the same level of emphasis as literacy (Arter & Spandel, 1992). A large number of studies centring on portfolios in literacy are available, whereas a search of publications reveals a very much smaller number of studies on the use of portfolios in mathematics. In both areas the studies centre on product portfolios, *'boast books'*. Scant few examine the process portfolio and obstacles to its implementation. Exceptions are in the works of Kuhs' (1997) discussion of the working portfolio and

Brady's (2002) brief paper on process portfolios. Conjecture as to the relative shortfall between language and mathematics sees a reasonable point in language being widely acknowledged as the basis upon which all learning is built as against the dichotomous, isolated perception that surrounds mathematics.

The literature implies that through their authentic approach to assessment, portfolios generally offer inherent opportunities to dispel mythical perceptions such as 'mathematics requires special ability which most students do not have'. Studies claim that personalised product portfolio tasks completed over variable time frames and assessed using a selection of tools is one way of doing so (Linn & Dunbar, 1992). Tasks can be designed that do not require students to use unrelated skills. For instance, a student who experiences difficulties with reading could be set work that explores mathematics skills without copious reading needed to reveal the problem (Arter & Spandel, 1992). General benefits available through product portfolios are broad but the perceived even wider potential benefits to be gained from the 'whole' student learning story as developed and displayed in the process portfolio approach deserved much greater attention.

As a result, several issues identified for investigation in the study emerged as a result of their absence in the literature. My motivation to mount the study lay in assisting the teachers unearth and solve the problems in broadening their assessment bases from their current strictly traditional summative approach to those which utilised embedded formative assessments. Additionally, the study was designed to facilitate teachers acquiring an understanding of the gains to be made in student learning through the use of the comprehensive process portfolio rather than the limited product portfolio. To be of lasting benefit the new understandings needed to be grounded in the reality of teachers' daily classroom practice. The lack of relevant literature on these matters provided further justification for the study. The discussion which follows provides the foundation upon which the aims and research questions for the study were based.

PROBLEM SOLVING – THE APPLICATION OF MATHEMATICS

Just what is problem solving? According to Arcidiancono, professor of mathematics education at Portland State University, a problem is simply explained as "any situation in which the solution wasn't immediately obvious to the problem solver" (Ostrow, 1999, p. ix). Based on that, any inquiry situation which sees the use of prior knowledge and skills in attempting to reach a feasible, supportable solution can be classified as problem solving.

What is the relevance of problem solving? Students of all ages should be engaged in activity through the seeking of solutions to problems set in meaningful contexts (NCTM, 1989; NCTM, 2000). Problem solving should be seen as both a goal and a means of learning mathematics; it should be the central focus of the syllabus (NCTM, 1989). Students should be offered opportunities to devise solutions for complex problems that require an appreciable amount of effort, with reflection on the process an integral part of the activity (NCTM, 2000). Such an approach is seen as part of ‘reform mathematics’ where students move beyond listening to instruction and replicating the demonstrated method through repetition (Hufferd-Ackles, Fuson & Sherin, 2004). Copious quantities of repetition have long been viewed as the time-tested way of assimilating mathematical procedures. The approach falls under the traditional, ‘rote learning’ banner, a banner now subjected to rigorous questioning in the reform of the learning of mathematics (Duit & Treagust, 1998).

Traditional approaches to problem solving generally share the feature of inflexible, predetermined conclusions which see the teacher ignore generalisations suggested by students (Becker & Shimada, 1997). An aim of the study was to assist teachers bring about discourse-based classrooms in which students were encouraged to sift through previously learned skills looking for methods that they could apply to completing an unfamiliar authentic task, to restructure the responsibility for learning.

The envisaged process portfolio was to bring about a redistribution of the responsibility for learning to where students formulated questions and applied mathematics in solving real-life problems. However, Goldin (1992) worried that concentration on real-life mathematics could inhibit students acquiring wide understanding and their ability to transfer understandings to new situations while gaining an insight into the simplicity and attraction of mathematical reasoning. This study was to ascertain whether or not a well-balanced embedded assessment structure which explored broad challenges offered useful and fulfilling mathematical experiences and offset Goldin’s concerns. It was also to examine teachers’ perceptions of a possible optimum shape for the resultant process portfolio structure.

Process Portfolios and Potential Problems

To date many advantages of portfolios generally have been acknowledged through the literature. However, this study concentrated on the process portfolio rather than the more common product portfolio. The product model contains a *carefully selected* range of artefacts designed to highlight student achievements in chosen areas or topics. As its name implies, to be effectively different from the product model the process portfolio needs to carry evidence of the complete learning process by displaying all of a student’s work from the beginning of *each and every* assessment task through to the concluding products. It should present a sequential learning narrative conveying an holistic story of student empowerment through achievement.

The drive to empower students through developing their ability to examine, conjecture and reason while developing that holistic view of achievement required a change in current assessment practices at the school involved in the study. It was recognised that in such change the primary agents are teachers as they function within the students’ context. In examining change, multiple studies have addressed processes, although not necessarily problems, involved in introducing student product portfolios in literacy. However, the precise and intricate nature of the issues faced by teacher change agents in the complexities of designing comprehensive embedded assessments in mathematics suited to process portfolios and linking them to school reporting systems, with students heavily involved in all facets, has received much less attention. In the re-alignment and interfacing of any assessment structure the teacher is the pivotal point of reform.

Reforming mathematics teaching and assessment is a huge task, with teachers often not knowing where or how to begin (Hufferd-Ackles et al., 2004). Given the right environmental constructs, the classroom undergoes a paradigm shift and Sparrow’s (2004) mathematical awareness becomes the norm. Such a classroom gives major impetus and importance to learning by facilitating crucial mathematical discourse (NCTM, 2000). Students within such a classroom form meaningful links with the outside world through carefully designed activities, learning within Vygotsky’s constructivist perspective of knowledge acquisition (Cobb, 1994). For such a classroom transformation to occur, the framework upon which the new learning community is constructed needs to incorporate questioning, explanation and responsibility for learning on the part of all involved (Hufferd-Ackles et al., 2004). The study aimed to guide the teachers in constructing an embedded, open, assessment framework.

The literature states that within an embedded open assessment structure, teachers design tasks to give students opportunities to provide evidence of their ability to use techniques with which they are confident, at times allowing them to compensate for any shortcomings that they may experience in trying to apply other methods. Baker and O'Neil (1994), Kohn (1999) and Pandey (1990) warned that that meant the manner in which students of various skill levels conceptualised problems needed consideration. However, the study sought to take the transformation discussed in the literature much deeper by teachers exploring the learning possibilities created when students designed the authentic 'open-ended' assessment tasks and the assessment criteria.

Critics of open methods claim that the openness means a lack of challenge and non-standard means substandard. It has been claimed that they do not collect hard, comparable data, indicating an erosion of educational opportunity, not an expansion (Baker & O'Neil, 1994). In the United Kingdom, classrooms were criticised as lacking real attention to learning following the adoption of student-centred practices (Black, 1994). The study centred on the adoption of student-centred assessment practices, so needed teachers to test such criticism through the consideration of local classroom data.

Difficulties in Learning and Assessing Mathematics

If students are to progress in the acquisition of both mathematical skills and concepts at higher levels, Skemp's (1976) relational and instrumental concepts of understanding need to be appreciated. Comprehension of the why and how of mathematics is vital if attempts to bring the higher learning goals of teachers and students closer together are to be effective (Hiebert, 2003). Skemp (1976) pointed out that many of the difficulties students experienced in learning mathematics can be attributed to a mismatch between such goals.

> When a teacher demands that students use set mathematical methods, the sense-making activity of students is seriously curtailed. Students tend to mimic the methods by rote so that they can appear to achieve the teacher's goals. Their beliefs about the nature of mathematics change from viewing mathematics as sense making to viewing it as learning set procedures that make little sense. (Clements & Battista, 1990, p. 35)

Relational understanding, the why, is more difficult to assess than the instrumental how with traditional methods (Byers & Herscovics, 1977). Questions and tasks calling for predictions and reasoning face similar issues (Nesher, 1986). Open-ended questions and explanations address such difficulties with marked effect (Wolf, LeMahieu, & Eresh, 1992). Authentic assessment as used in process portfolio appeared to address such issues but the teachers needed to go about gaining the skills and understandings to create authentic assessments through an immersion approach, the pitfalls of which were unknown to the participant teachers at the beginning of the study.

The literature states that authentic assessment stands upon establishing clear learning goals with criteria for assessment established at the outset (Killen, 2000). The approach promotes designing-down from assessment taking both student needs and syllabus learning outcomes into account, thereby generating an integrated approach (Newmann, 1996). Integration of assessment and instruction, not an easy task for traditional teachers, ensures that teachers are informed about what learning activities are most useful and the style of teaching required to achieve the planned learning outcomes (McMillan, 2000). Sewell, Marcsak and Horn (date unknown) stated that broad learning opportunities supply plentiful assessment data, allowing teachers to modify instruction as appropriate. Through the formative feedback generated, teachers know when to move to new work, when to question, when to offer examples, and which responses are appropriate to students' questions. These features of teaching are not always evident under traditional content-based, norm-referenced assessments (McMillan, 2000). However, for a teacher working from a content-driven syllabus, in a traditional school with stakeholders seeking student achievement at predictable rates, assessment transformation is no simple process. With little Australian-based literature available as a guide the teachers involved in the study began with the syllabus in designing-down to develop an integrated authentic approach to mathematics learning and assessment.

Recent Australian syllabus documents, such as the South Australian Syllabus Standards and Accountability Framework (SADETE, 2001) and the Queensland's Mathematics Years 1 to 10 Syllabus (QSA, 2004a), in line with earlier guidelines published by the Australian Education Council (1991), state that students should individually and collaboratively develop their ability to solve mathematical problems. This is a pronounced shift from the objectives which dominated much of the last century. Those objectives were based on notions of learning that saw content broken into small segments that were to be mastered in a linear, sequential fashion (Duit & Treagust, 1998; Romberg & Wilson, 1995). The essence of the changes sought by the reform movement accentuates cognitive objectives emphasised by Booker, Bond, Sparrow and Swan (2004). An “ability to think with and about mathematics has come to be the dominant feature of what has to be learned rather than the set procedures and directed solving of straightforward problems that occurred in the past” (Booker et al., cited in Sparrow, 2004, p. 8). The study was designed to assist teachers gain the ability to support such a stance.

Contextual Connections Crucial

Askew (1999, cited in Sparrow, 2004) stated that in order to be effective teachers must pay attention to the connections between the various facets of mathematics. Teachers need to attend to the connections between student’s mathematical thinking and procedures. They must have students share their thinking and methods, thereby attaching value to their work and emphasising the interconnections between symbols, words, objects, pictures and diagrams. Such an approach sees concepts naturally conflated by students, yielding a blend of content and effective application of mathematics in learning through solving authentic problems.

If teachers are to promote the relevance of applied mathematics, students must be placed in contextually rich learning situations. Teachers must abandon the premise that understanding and assimilation of complex information can be achieved merely through the imparting of information (NCTM, 1989). Opportunities for the integrated application of concepts, skills and terminology are vital. Such opportunities encourage students to construct meaningful connections to prior learning. Links formed through a clear sense of purpose, form the framework of enduring understanding, motivating further learning (Griffiths & Clyne, 1994; Reys et al., 2001). Genuine lasting success is reliant on students using authentic learning to build upon existing knowledge within their zones of proximal development (ZPD) (Vygotsky, 1978).

A crucial key to that constructive learning is the use of mathematical language in context, which is integral to the detail of well-planned process portfolio tasks. Although teachers regularly emphasise context in English instruction, often they fail to recognise its importance in students learning mathematical terms and symbols (Capps & Pickreign, 1993). Capps and Pickreign added that whilst everyday language is used constantly in the classroom, the same cannot be said for mathematical language. They claimed that when one speaks of an ‘operation’, students think of doctors, not addition or subtraction, ‘degree’ creates thoughts of temperature, not angles, ‘order’ brings thoughts of a shop not a sequence, while ‘sum’ sees them think of putting in some, not finding a total. Students need to assimilate both everyday and mathematical meanings and switch easily from one to the other in context.

Studies cited above acknowledge that authentic assessment addresses a number of the above assessment issues. Early reading implied that a well-designed process portfolio model could assist teachers integrate authentic assessment. However, the teachers needed to develop local understandings and structures. How they went about that assessment change and the problems that confronted them demanded far greater attention and received it within this study.

CURRENT SUMMATIVE AND PROSPECTIVE FORMATIVE ASSESSMENTS

Summative assessment, mainly in the form of testing, has been addressed at length earlier in this chapter. It advances strongly the closed, dichotomous, non-creative perception of mathematics held by many. On the other hand, formative assessment assists students achieve higher standards by supplying *informative* feedback *during* an application task. Within the process portfolio, the rubric is the key formative, criteria-based feedback instrument, able to serve both summative and formative functions.

In order to formatively assess learning through portfolios, students’ responses to substantial, meaningful tasks are judged using previously set and understood criteria. Burke (1993) affirmed that in seeking effective performance in the demonstration of learning, judgement criteria need to be set in advance. Baker and O’Neil (1994) and Grouws and Cebulla (2000b) added that criteria-based assessment rubrics are a highly effective method of communicating the pre-determined standards at the outset. Frequent referral to the rubric standards can assist students reach a high standard; such action is formative.

Rubrics stipulate levels of performance against the aspects of a task being assessed (Paris & Ayres, 1994). Generally, they are set out in tabular form to simplify reference to facets of the task and the related criteria. As feedback instruments, rubrics have summative application in product portfolios but are of potentially high formative value within the process portfolio (Brady, 2002). Rubrics may vary in content and style, but all need to communicate clear criteria. If required, they can lead to a grade or supply constructive feedback as to the standard of achievement and *most importantly*, how students can increase their standard (Wiliam, 2005). Rubrics convey information regarding the evaluation of work; they are not meant to categorise the student themselves (Stenmark, 1991). Rubrics explained and discussed as part of the introductory activity, create a transparent, fair assessment environment (Burke et al., 1996; Lazear, 2000). They can be a powerful formative teaching tool when understood by the facilitating teachers and created for local conditions.

That power is increased by having students involved in the creation of the rubric, an action which empowers students thereby offering dramatic learning benefits, as against the unseen rubric which can decidedly disadvantage (Stenmark, 1991). Yet another issue that needed addressing was how students and teachers created rubrics together when teachers had little early understanding of rubrics. When students and teachers use similar rubrics to evaluate work the collaboration provides valuable insight for both parties by enhancing student understanding of expectations (Stenmark, 1991). Time and means for teachers to discover effective, efficient ways in which teachers and students could together create advantageous assessment styles using instruments such as dual-user rubrics was another issue that this study needed to explore.

Assessment styles can advantage or disadvantage learners but formative assessment, being to hand constantly, assists all. Time, format and familiarity of context as well as teacher expectations come into play (Kilpatrick, 2001; Madaus et al., 1992). Goycochea (1998), Parker and Rennie (1998) and Barton (1999) all supported the view that within the value-added approach, individuals should be given tasks that stimulate their interest and relate to prior knowledge. Baker and O’Neil (1994) added that tasks need to be adapted to students’ backgrounds. However, minimum outcomes are needed to stop students coasting in what through a change in assessment emphasis and style may be perceived as a less rigorous program (Goycochea, 1998). Standards and expectations can be easily shared through context-rich tasks linked to well-designed rubrics (Burke et al., 1996; Lazear, 2000). Open and frequent discussion and referral to linked task and judgement criteria can be advantageous to all learners.

Exploration of students' ability through contextual application rather than trial by question can also be advantageous as it motivates learners (Wiggins, 1992); the process portfolio concept appeared to offer such an advantage. Burke's (1992) claimed *ongoing narrative* quality of product portfolio displays must be markedly enriched through a *complete ongoing narrative* as displayed in a process portfolio. It should foster a complete expression of learning according to individual learning styles. Learning is decidedly enhanced by focused, detailed disciplined enquiry as within comprehensive portfolio tasks. According to Newmann (1992) the features of such enquiry are the use of the learner's prior knowledge, generation of in-depth understanding and production of knowledge in an integrated manner. Instead of merely recalling a string-of-facts as in summative testing, portfolios provide scope for students to show what they can actually do, and process portfolios do this with greater totality than the product model (Brady, 2002). Paradoxically, mathematics, often seen as a list of dichotomous facts and rules to be memorised and applied in a predetermined way, has been classed as the key to opportunities and careers (Linn & Dunbar, 1992).

Through the use of problems or tasks which support a number of possible solutions or outcomes, the simplistic, blanket dichotomy of pre-determined right and wrong can be dispelled (Becker & Shimada, 1997). The myth that most mathematics has to be learned in isolation can be broken through the teacher-student *collaborative* process of exploring tasks in a genuinely formative way. The study aimed to examine the proposition that the joint *process*, the artefacts of which comprise the *process* portfolio, has the potential to encourage and document problem solving activities, while concurrently fostering independent, critical thinking and confidence.

POTENTIAL ADVANTAGES AND DISADVANTAGES OF PROCESS PORTFOLIOS

While product portfolios display only *selected* pieces of work, the process portfolio concept exhibited the capacity to illustrate the entire learning journey travelled by a learner through a progressive series of tasks. Each step towards the final product and assessment could be displayed sequentially. The entire 'learning narrative' could be displayed for regular review and reflection. During explanation of their work, students could use the artefacts to take their audience on an illustrated journey, retracing the learning along a path which at its optimum should convey a degree of struggle.

Zull (2004) stated that learning that occurs through struggle is readily apparent when students explain their thoughts and actions. Recounting also demonstrates that deep learning comes through contextual experience, active testing of theories and solutions, appropriate abstraction and reflection (Zull, 2004). Many of Costa and Kallick's (2000) sixteen Habits of Mind could be readily evident within a well-designed process portfolio. Thinking independently and flexibly, questioning and posing problems, applying past knowledge to new situations, striving for accuracy, persisting and metacognition are some of those habits of mind that could be demonstrated through a student's process portfolio artefacts.

Student Motivation

Kuhs (1997) claimed that carefully designed process portfolios are powerful learning tools as they have students take ownership and marked responsibility for and enhanced levels of control of their own learning. Burke (1993) and Paris and Ayres (1994) indicated that opportunities for students to reflect on their work with other thoughtful persons enhance that control. It was envisaged that a well structured process portfolio would offer such opportunities as a regular implicit function. According to Black (1995) and Romberg (1995), the empowering reflection process is inherent when students are involved directly in the planning of assessments.

Student involvement in the portfolio through the design and completion of assessment tasks, the design and use of the criteria by which the work will be judged and post-task reflection is vital (Arter, Spandel, & Culham, 1995). Student self-evaluation, a thinking strategy, termed 'metacognitive introspection' by George (1995) provides a path for a paradigmatic shift in assessment, where the focus is on learning rather than the measurement of learning. Klenowski (1996) claimed that if students are encouraged and guided in acquiring skills to evaluate their work, and that of peers, they are using and expanding their powers of interpretation and judgement. Recent research, summarised by Black and Wiliam (1998), revealed that self-assessment skills, learned and applied by students enhanced student achievement with a consequent positive effect on motivation. These issues cut to the heart of the study. How would a group of teachers go about gaining the unfamiliar skill-set that they needed in order to strongly engage their students in every facet of an unfamiliar concept, authentic assessment? This study focused on unearthing and resolving such major issues.

Parents: Collaboration and Reporting

Parents can become supportive partners in student learning (Paris & Ayres, 1994); process portfolios appeared to offer opportunities to engage parents. According to Woodward (2000), if parent interest and support could be fostered, guidance and collaborative reflection opportunities would follow. However, parental input into portfolio contents reiterates an earlier concern expressed as to the validity of the work (Arter, Spandel, & Culham, 1995). Authorship issues need to be clearly addressed within criteria establishing the purpose, scope and structure of tasks. Nevertheless, parents have potentially significant roles.

Parents gain a rich oversight through viewing an organised collection of their child's products blended with their reflective and anecdotal records. Process portfolios offer promise as instruments of motivation with both parents and students. Sweet (1993) claimed that they could be used to re-engage parents in their child's learning through discussion and guidance. Displayed evidence of task exploration, completion and feedback can give clear indications as to student progress and future needs.

As in the case of students, where the most useful feedback is specific comments about errors and suggestions for improvement, interested parents gain most from specificity about their child's performance (Bangert-Drowns, Kulick & Morgan, 1991; Elawar & Corno, 1985). The literature implies that well-designed process portfolios can offer opportunities for teachers and students to provide parents with illustrated comment on performance. Such formative feedback has the potential to encourage parents to focus on how they can best assist their child benefit from each learning experience, thereby helping student and teacher in the learning progression.

It is apparent that process portfolios offered numerous potential strengths in relation to engaging parents in their child's learning. However, once again, the literature revealed and implied available benefits but offered little in the way of direct 'complete' guidance as to how teachers could realise those gains. Through involving parents in the developmental work, the teachers needed to unearth parental concerns and construct a process portfolio model that addressed them; they had to assemble a local model.

ACCOUNTABILITY, RATING AND REPORTING ISSUES TO BE ADDRESSED

In relation to accountability, death through drowning in detail, where criterion-referenced assessment examines every syllabus point, is best avoided (Black, 1994). The collection of enormous quantities of data can be used to avoid making judgements and is counter-productive. The time required for such detailed assessment can detract from teaching and create a situation where data collection is pointless as the results have little effect on programs. Assessments need to be embedded in the syllabus so that instead of distorting, they enrich learning (Black, 1994). The literature implies that effective process portfolios can yield an holistic, focused ‘picture of progress’.

Whilst in creating that picture portfolios can contain a wide variety of materials that utilise a number of tools, they may not suit all assessment situations (George, 1995) and teachers have only limited time for each of teaching’s facets, including assessment. In considering the feasibility of portfolios as an assessment and reporting tool, thought must be given to achieving a balance between purpose and the time required to develop an effective balanced portfolio design, as well as the skills required by the teachers to complete and perfect the design process (McMillan, 2000).

An important factor for consideration within a balanced portfolio is validity of the artefacts displayed in relation to a portrayal of the student’s achievements. The concept of validity needs to be fully understood by teacher change agents (McMillan, 2000). If the portfolio process is to be valid it must be part of an assessment structure that fundamentally supports the needs of the learners (Wiggins, 1990). Results of assessments need to be supportable through valid student-generated evidence. Thought must also be given to the place of testing within the display. Questions over the validity of portfolio inclusions and conclusions drawn using judgement criteria permeate the argument facing teachers over authentic assessment (Arter, Spandel, & Culham, 1995).

The literature states that criteria must be carefully tailored so as to be the most suitable for examining what was accomplished (Parke et al., 2003). It also warns that validity and balance in portfolio assessment requires the inclusion of a wide range of tasks that examine a broad breadth of skills with strong rigour (Black, 1995). However, in reality, in looking to meet the demands, the teachers involved in this study needed to develop a set of understandings and skills, once again with little pragmatic guidance available.

Results of Portfolio Assessments

In relation to the assessment of individual tasks, Koca and Asli-Lee (1998) and Kerka (1995) stated that there are multiple dimensions to the subjective evaluation of portfolio tasks, as against impersonal objective, traditional testing. Those dimensions include a number of available ways to record results within portfolios including checklists and rubrics (Grace, 1992; Stiggins, 1994). Student metacognitive notes and reports are excellent means of recording progress as they encourage even greater depth of thought (Arter & Spandel, 1992). The teachers involved needed first hand, in-depth exposure to all dimensions of portfolio assessment as each facet had a potentially significant importance in providing fair and valuable feedback to learners.

However, Wiggins (1992, p. 69) felt so strongly about product portfolio’s positive influence on learning that he declared, “design them and worry about a fair, efficient, and objective method of grading them as a *secondary* problem”. Those assessment results may be recorded and communicated to stakeholders using criteria which can take several forms. One example of particular interest in relation to the process portfolio is the tabular rubric which might have columns headed ‘novice, apprentice, proficient, and excellent’ against the list of learning outcomes (Brualdi, 1998). As with all reporting, in using the rubric full value is gained where teacher, student and parent are all involved in conferences discussing a student’s progress. Implementing teachers needed to become aware of and address stakeholders’ concerns as to the accuracy of the evaluation of portfolio content and the communication of those judgements. The study was designed to yield such knowledge.

Teachers also need to be aware that portfolios offer numerous authentic assessment advantages (Arter & Spandel, 1992), but that offering does not necessarily mean those advantages will materialise. For instance, the level of task explanation may prove a problem, although astute teachers will realise that language ability should not obscure capacity to demonstrate competence. It can be difficult to construct appropriate, open-ended tasks and problems across different ability levels (Becker & Shimada, 1997). Along with the issues in drafting tasks, teachers could face difficulties in foreseeing the range of possible responses. Making task purposes clear, posing problems in which meaning is easily understood, establishing clear expectations, making problems attractive and motivational while allowing enough time for investigation in an already full timetable may be issues creating further concern and the problems may well be broader than those between teachers and students.

Broader audiences, which can include the parent body and school board members, can add to the list of difficulties facing teacher change agents. Such groups may form views of a school through portfolio assessments (Arter & Spandel, 1992). Rudner and Boston (1992) warned that a complete collection of student portfolios should not be used for school accountability purposes. While portfolios can be designed to address large-scale assessment issues, questions of equity and comparability, through various forms of standardisation, would demand careful consideration. Above all, any scale of assessment carried out through portfolios must not be allowed to interfere with the primary purpose of the portfolio which is student instruction, whether it is the product or process model. However, they must form an integral and meaningful part of a school's accountability and reporting structure. These issues create yet another series of issues of which teachers have been made aware but offered little in the way of practical resolutions and which need to be addressed by teachers through this study.

PROFESSIONAL DEVELOPMENT NEEDS EXPOSED

The entire course of the research and development in this study related to professional development; it was inherent in all facets of the work. However, a number of points related to teachers as learners and their learning need to be crystallised at this point.

All learners will perform more effectively in contexts where they are free to explore ideas, question, and make mistakes, building new understandings within their ZPD (NCTM, 1989). Without such understanding, answers are simply answers (Ostrow, 1999). Learners need to be able to conceive new ideas and to change those conceptions as necessary (Becker & Shimada, 1997). Frequently, conceptions will alter as a result of reflection, an invaluable facet of teacher development (Ellsworth, 2002; Friel, 1992). This form of learning sees learners able to transfer successfully new knowledge to previously unencountered situations. Sparrow's (2004) comments on observed successful teaching practices infers that teaching needs to be simultaneously strategically directive while not being prescriptive regarding thinking. Sparrow said that to make students aware of mathematics, teachers need to learn how to draw attention to the links between the mathematical aspects of what students are dealing with and things with which they are already familiar; again working in their ZPDs.

Training Teachers for the Assessment Change

> It is hard for teachers to adopt new teaching practices, even those that offer innovative learning experiences focused on higher-level skills, if the teacher cannot see how the skills acquired will be recognised in their students.
> (Bell, Burkhardt, & Swan, 1993, p. 119)

Attempts to transform mathematical pedagogies have been studied by many. Darling-Hammond and Wise (1985), Cohen (1990), Fennema and Nelson (1997), and Wood, Cobb and Yackel (1991) have called for teachers to possess high levels of subject knowledge and intimate understandings of effective methodologies. Such skills allow teachers to move into higher-order thinking in an open-ended approach to solving developmental problems encountered, making it feasible for them to guide their students along a similar path (Becker & Shimada, 1997).

Black (1995) declared that travelling that path without assessment feedback is akin to travelling blind. Barton (1999) called for teachers to be skilled in assessing on a day-to-day non-intrusive manner. In the meantime, the optimal balance across formative and summative assessments must be sought (Boston, 2002). Those requirements need holistic consideration as isolated redesign fails if reduced value is placed upon it subsequently (Wolf**,** LeMahieu & Eresh, 1992). That value has less chance of being diminished if teachers gain a deep understanding of mathematical processes and of how non-traditional methods, such as process portfolios, are intended to address and strengthen student understanding (Goldin, 1992).

In the non-traditional approach, assessment of mathematical process must be built into the design of the thinking syllabus from the beginning (Black, 1995). Whilst Hawkes (2001) warns that care is needed with any assessment driven ‘recovery’, as it has the potential to give an educationally unsound profile to assessment, performance-based assessment is seen as a critical component of integrated reform by Baker and O’Neil (1994). It has the potential to take myriad student and contextual differences into account as teachers encourage students to pursue relevant high learning goals (Baker & O’Neil, 1994).

Each child should be expected to achieve through the joint setting of high personal goals. It must be assumed that most students can achieve high standards, if given opportunity (Spady, 1994). Teachers have a responsibility to ensure that students aspire to challenging, enriching standards. The active engagement of students in various forms of assessment such as demonstration and testing of ideas allows the crucial assessment-in-context (Gardner, 1992; Kyle, 1997). According to Kohn (2000, para. 46) Gardner is sceptical as to schools succeeding using current syllabi as they try to “cover everything from Plato to NATO in one year”. Traditional organisation of schools and teacher training makes provision of greater learning opportunities in a feasible timeframe extremely difficult (Killen, 2000). Professional associations “are concerned about the inadequacy with which teachers are prepared for assessing the educational progress of their students” (American Federation of Teachers et al, 1990, p. 30).

Inadequacy of teacher training in such crucial areas fails to equip teachers to address many of the questions raised, such as the level of objectivity in tests and whether there can ever be a fair test (Baker & O’Neil, 1994; Parker & Rennie, 1998). Questions regarding the omission of particular mathematics from tests also arise (Kilpatrick, 2001). Yet questions of measurement reliability also hang over some forms of performance-based assessments (Barton, 1999). Acceptance of any form can only follow consistent valid assessment results. Teachers looking to change will need to address the many complex issues raised through engaging in contextually rich professional development.

Classroom-relevant, quality professional development in assessments must become part of teacher training. To date, such has not been the case to any marked level (Stiggins, 1992; Woodward, 2000). Teachers trained through pre-service portfolios, an ‘infant’ concept, are still found wanting in relation to concepts and procedures required to address the breadth of assessment demands in classrooms (Woodward, 2000). “When so few teachers are trained to assess student learning, does this sound like a profession that cares whether learning is occurring?” (Stiggins, 1992, p. 113).

Teachers, the final assessors of student artefacts, require quality in-depth training in making sound judgements, as their responses are the concluding assertions as to the quality of student performance. Teachers’ knowledge of content, expectations and experience, will influence those judgements (Baker & O’Neil, 1994). Teachers need the knowledge and skills that allow them to tap into all available sources of data in order to form balanced opinions as to student progress (Kilpatrick, 2001; Lidstone, 1991). With the literature confirming the general short-fall in teachers' data collection skills, it was clear that assessment change demanded pertinent teacher professional development.

With the gathering of data gaining more recognition as the vehicle of reform as well as its measure, its importance requires acknowledgment (Baker & O'Neil, 1994; "Building tests …", 2001). Through professional development, the teachers needed to be exposed to frequent opportunities to understand how students learn and demonstrate that learning through assessment. They needed up-skilling in assessment, so that they could become involved in leading the community in reform. This needed to occur through experience in developing and using assessments, together with interaction with other teachers seeking similar change. If "more complex, more intensive, and more relevant assessment systems are to be embraced, communities must understand and formulate assessment solutions cooperatively" (Baker and O'Neil, 1994, p.14).

The fundamental core of complex assessment solutions is judgement criteria (McMillan, 2000). Substantial emphasis needs to be placed on development of the skills utilised in writing criteria and in helping students reflect upon and learn from experiences. Teachers needed time, a frequently mentioned constraint, to explore the possibilities of process portfolios. It was foreseen that time devoted to such exploration would lead to models suited to classroom contexts.

Within those contexts, assessing the merit of student-generated tasks and making appropriate responses to students' self-assessments and reflections were other skills needed. Rudner (1992) stated that training teachers as feedback providers is crucial, as training can reduce distortions brought about through perceptual differences and leniency or stringency errors. It can also diminish the hesitancy of some to introduce portfolios through feeling that they do not know enough about assessing performance in a more subjective manner (Brualdi, 1998). With literature having exposed many of the demands upon the profession, the teachers needed to accept the challenge and grapple with assessment change to meet the emerging need. This study was designed to foster and guide that struggle by teachers investigating effective change.

SUMMARISING THE SIGNIFICANCE OF THE STUDY IN RELATION TO THE LITERATURE REVIEWED

Current literature states that assessment must be authentic and embedded, used for the enhancement of learning, offering students occasions to demonstrate their learning and how they are able to apply their knowledge to worthwhile tasks (Burke, 1992; Kyle, 1997). Additionally, assessment needs to offer teachers opportunities to review and validate their pedagogy, to develop best practice through which students are assisted to realise authentic learning goals; portfolios offer such opportunities. However, indications are that only process portfolios, by far the least mentioned in the literature, offer the potential advantage of solid formative feedback opportunities throughout all tasks while revealing the complete complex student learning narrative.

Product portfolios offer marked advantages over testing in relation to assessing understanding (DeFina, 1992). However, it appears that process portfolios offer even greater advantage in that they elicit complex applications of wide learning and offer purposeful and meaningful collections of students' applied problem solving skills from problem or task formulation through to completion. They thereby generate abundant opportunity for broad in-depth formative and summative feedback. By inference, comprehensive process portfolios have the potential to promote widely varying inputs from the spectrum of stakeholders including students, teachers, school administrators and parents; maximum buy-in by all concerned across *all* facets of learning. Cooney and Friel (1992) infer that they are potentially multi-dimensional with the capacity to inform every facet of the learning process through shared learning goals.

In linking the learning of mathematics and pedagogy, judgements as to what makes good mathematics are required and in turn good mathematics teaching is required (NCTM, 1991). The teachers involved in this study were seeking guidance on how they should go about making such judgements, how they could develop a process portfolio model that centred on learning goals shared by teachers and students. Through shared goals, the foundation only of which could be formed through the literature discussed in this chapter, the teachers were determined to develop a process portfolio model that satisfied their local needs and offered genuine pragmatic potential for others looking to authenticate their approach to assessment in mathematics.

Crystallising the Process Portfolio Vision

The teacher change agents involved in this study realised that process portfolios are only one means to achieve part of an assessment end and should not be seen as an end in themselves. Through piecing together relevant parts of the literature they formed a vision of that ‘end’; they sought functional formative feedback for their students leading to the creation of an holistic learning narrative capable of comprehensively informing all stakeholders as to student progress and achievement. As *users*, the teachers used the available literature to develop and clarify *the vision* of their portfolio purpose, a work-in-progress, a dynamic collection of human artefacts, a *living document*. The teachers were aware also that the process portfolio model that they designed needed to accurately and realistically portray achievement reality in relation to each individual student owner. They realised that the process portfolio could become a core assessment strategy but as Woodward (2000) warned, it was not necessarily going to be the key to every assessment door. The teachers sought a balanced approach to mathematics assessment while designing the process portfolio model.

In beginning the design process the literature review drew together many previously unconnected threads related to product and process portfolios. It also revealed major gaps in the guidance available to teacher change agents seeking to realign their practice by embedding the assessment of mathematics in their teaching and learning programs through implementing process portfolios. For instance, interpretation of the literature showed that in realigning their vision of assessment, teachers would need professional development, but initially the exact nature and breadth of that training was only broadly indicated through the published material. Therefore, the study needed to unearth and satisfy teachers’ learning needs as the vision developed and the change progressed.

Teachers, particularly teacher change agents, acknowledge the importance of vision. This chapter began the crystallisation of a vision of lasting improvement in the teaching and learning of mathematics based firmly on a realignment of assessment and its designing-down effect on pedagogy. In meeting its goals, the study sought to extend the literature base available to teachers through the development of a challenging but straightforward, flexible process portfolio model. The purpose and function of each component of the portfolio and its contribution to the overall model were key developmental points requiring examination and explanation. In further seeking to assist teachers who accepted the challenge of authentic assessment, it was also planned to address some of the identified gaps in the practical facets of the literature through the production of a process portfolio implementation guide that could be used by teachers in order to suit their particular classroom or school situation.

While the many gaps in the literature related to what the teachers involved in this study sought to achieve through assessment change have been highlighted and provided strong focus for the revision, a final cautionary note needs to be sounded. Elliott (1993), LeMahieu, Eresh and Wallace (1992) and Darling-Hammond (1997) warned that until sufficient opportunities to learn under challenging instruction were accompanied by high expectations of all students, authentic assessments may reveal even greater achievement gaps across mathematics classes than the traditional forms.

The overall significance of this study was that it reviewed the work of a group of primary teachers who seized an opportunity to risk that potentially disparaging revelation. It provided an opening for the teachers to gain insight based on classroom reality into balanced blends of learning and assessment. Through the synergy of the teacher change agents the study sought to move them forward, to guide them in learning and developing challenging instruction based on those high expectations of themselves and their students, expectations that they believed could be realised through authentic learning using authentic assessment. They recognised that the teaching and learning contract needed to be reconstructed to take student understandings in mathematics to an appreciably higher level. For all learners, progress was to be assessed and recorded through a higher form of skill and thought-promoting assessment; the individual learning narrative facilitated and illustrated through a well-designed process portfolio.

THE NEXT CHAPTER

This thesis records an assessment innovation which took place across a number of classrooms within a single school. To monitor the change, check its relevance to the wider school and primary mathematics in general, care was taken to engage local stakeholders, examining and reacting to their perceptions as the change progressed. The research questions upon which this qualitative study of assessment change centred and the methodology used are discussed in the next chapter.

CHAPTER THREE: METHODOLOGY

This chapter describes the means by which the research aims were satisfied. It provides details of the size and composition of the groups involved in the study and the variety of means, including interviews, surveys and meetings by which data were collected. The research aims and questions, ethical considerations, data collected, procedures used and interpretation formats followed are discussed.

The main focus of this chapter is concerned with describing the wide variety of data collection strategies used over the two years the study was conducted. Much of the data were collected and enhanced by means of my immersion as a participant observer in the ‘daily business of mathematics’ in the classrooms of the teachers involved. That meant that synthesis and analysis of data were immediately grounded in a classroom reality formed through my knowledge of the school’s academic purpose, the teachers’ pedagogies and the abilities and attitudes of their students. Consequently, data rich in meaningful depth in relation to assessment changes and the links to learning in mathematics were able to be collected and considered, emphasising the realism.

THE GENERAL APPROACH

This study was guided by the general research question ‘What are the problems that face teachers who seek to improve students’ understanding of mathematics by broadening the assessment base using process portfolios?’ For the purpose of this study several assumptions were considered necessary. Underlying the study were assumptions about the challenges and frustrations that teachers faced when seeking to strengthen students’ understanding of mathematics and that there would be questions about whether or not process portfolios would effectively broaden the base for assessing students’ understandings. However, in posing any research question assumptions are required, often based on grounds such as the researcher’s experience, training and reading.

The general research question contributed five aims and in turn five research questions. In pursuit of the aims and exploration of the questions, the study was undertaken in naturalistic settings; functioning classrooms in the context of a particular school. As a result, the enquiry used applied qualitative research through surveys, interviews, conversations and observations, supported at times with some quantitative data. As the study progressed in a staged approach, it evolved by way of the progressive consideration, distillation and synthesis of data collected.

Research Aims

The sheer quantity of general literature on the topic of assessment in mathematics indicated that the research could easily have become overwhelming and of little practical use if it was not focused on a clearly defined, manageable task. Therefore, if this study was to be of genuine value to the practising teachers involved and those interested in becoming involved with portfolios later, research aims of a practical nature which sought to address the large gaps in the literature were essential. Formative and ongoing discussions with teachers and natural evolution during the early stages of the study saw the emergence of the five aims as stated in Table 3.1 overleaf. The table provides an illustration of the links between the aims of the study, the data collected and the general methodological structure of the research design framing the study.

Research Questions

From the general aims, the study focus was cast through five research questions. Just as a well-designed process portfolio was purported to communicate a detailed reflection of student performance, the inter-related nature of the research questions, shown in Figure 3.1, meant that there would be opportunity to combine research results in creating a detailed 'picture' of student performance through the process portfolio.

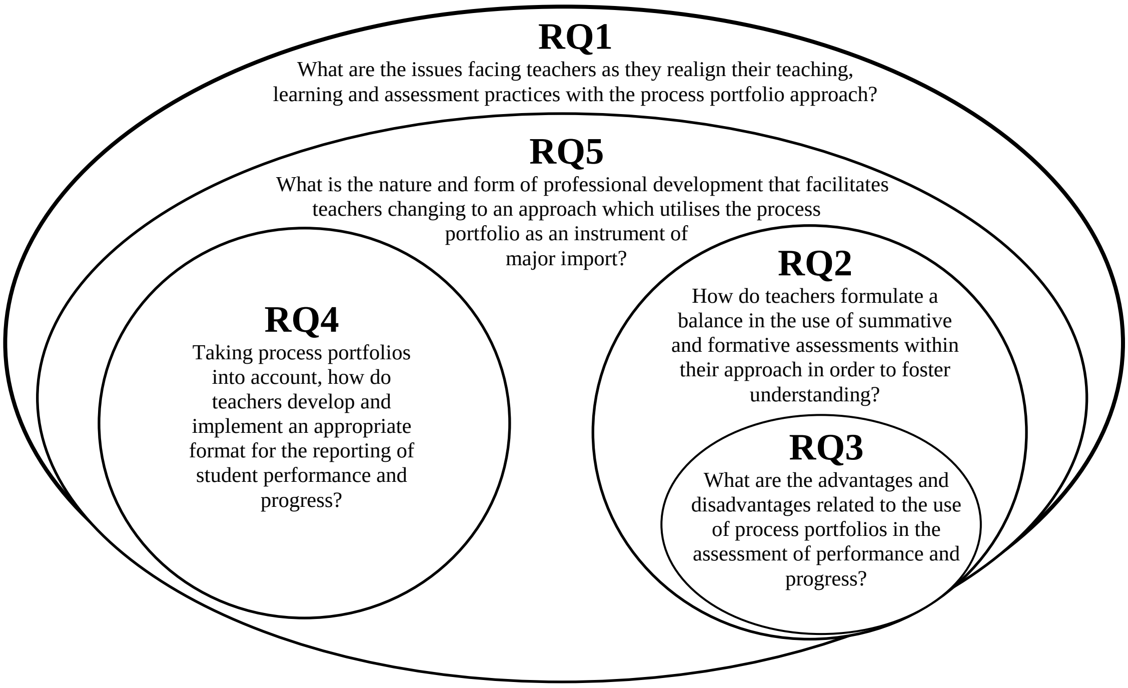

Figure 3.1: ***The Research Question Interface***

Table 3.1: Aims Linked to Methodology

Aims and Data Required	**Participants**	**Strategies for Data Collection**	**Sample Size**
Aim 1: To ascertain the process by which teachers move away from their existing methods of assessment, develop a new approach and then adapt and implement the process portfolio structure so as to provide evidence of students' progress in mathematics. ***Data required:*** Find where teachers were regarding the nature of their existing assessments. Find where they needed/wanted to go in order to implement process portfolios in mathematics	Teacher Focus Group	Questionnaire Interviews Focus Group meetings Written and verbal feedback Observations	Initially **(5)** to **4** upon the later withdrawal of a teacher
Aim 2: To investigate how teachers select and/or develop instruments/tasks suitable for the collection and recording of assessment data, both formative and summative, to be utilised in a mathematics process portfolio. ***Data required:*** Consider the range of suitable instruments and identify the attributes of each. Identify the methods of collecting and recording data. Ascertain teachers' selection of assessment methods; do the methods vary according to what is being assessed?	Teacher Focus Group Students Years 4-7	Interviews Questionnaire Interviews	**(5) 4** **125** **24**
Aim 3: To examine how teachers incorporate process portfolio assessment mathematics teaching and learning experiences in order to develop student mathematical understandings. ***Data required:*** Determine teachers' perceptions as to the place/role of formative assessment in program planning; find 'the link' to portfolios. Attempt to determine teachers' perceptions of 'understanding' and see if there are noticeable variations across students' and teachers' perceptions of learning for understanding?	Teacher Focus Group Students Years 4-7	Interviews Questionnaire Interviews Surveys	**(5) 4** **125** **24** **25-125**
Aim 4: To identify how teachers develop a portfolio assessment structure that dovetails into reporting to stakeholders, such as parents and school administration. ***Data required:*** Trace the developmental path taken by focus group teachers in shifting from current practice to portfolio assessment and how it dovetails into reporting. Establish stakeholder's perceptions of reporting and process portfolios as part of the reporting/accountability system.	Teacher Focus Group + wider staff Parents	Group discussions Interviews Questionnaire Interviews	**(5) 4** **53** **22**
Aim 5: To describe the nature and extent of teacher professional growth and reflective practice, a central tenet of teaching, learning and assessment through the process portfolio. ***Data required:*** Trace the professional development path taken by teachers who have adopted the structure, or part thereof, with particular emphasis on each teacher's reflection as to starting point, destination and pedagogical journey travelled.	Teacher Focus Group + wider staff	Interviews Reflections	**(5) 4**

An Overview of the Study

At the outset, having garnered interest amongst teachers, I sought permission from the Principal of the school to conduct the study. With his approval, the process portfolio concept was to be investigated as an extension of the existing assessment system within the primary section of the P-12 school, with relevant data collected and the investigation documented. Having agreed that the process portfolio had potential to strengthen the assessment base in the school's mathematics curriculum, the Principal approved the study (see Appendix 1). It was acknowledged that the study would involve up to two years investigating teachers' problems in making the transition to the unfamiliar process portfolio format and would focus mainly on five teachers, their students and the parents of their students. It was agreed that if the study, which was essentially a cost-benefit analysis, revealed that the process portfolio was able to deliver marked gains, implementation across the primary school was a possibility.

Initially, a sense of currency in relation to mathematics and its assessment was obtained through survey questionnaires, interviews and informal discussions with the teacher focus group, the composition of which is detailed in Chapter Four, and as large a proportion of their students as possible. At various times, teachers shared their emerging understandings and ideas as well as the problems they encountered. Although all discussion was professionally beneficial, structured professional development also occurred during some of the sharing sessions. Sharing of professional journal articles and presentations on a variety of subjects, including learning theories and emerging forms of assessment, were considered. Discussion generated through the sessions proved an invaluable source of data for the study and provided the springboard for the teachers to consider changing their classroom assessment practices.

Further information was collected over the ensuing months through observation, participation, collaborative preparation and joint planning involving the participants in the study. Informal conversations and structured interviews with members of the teacher focus group produced further data. As the work involved interacting with teachers and their students in classrooms, data were generated directly and indirectly during the many forms of normal school activity. Parents, a generic term applied to those primarily responsible for a student's care, also became a source of data, particularly in relation to the accountability and reporting aspects of process portfolios. Parental data were gathered through a questionnaire, an interview and parent-teacher interactions within the general functioning of the school. Details about all aspects of data collection are discussed later in this chapter as each participant group's part is expanded and explained.

Conceptual Framework of the Study

The framework for the study was established using the research aims and questions, all of which were encompassed by three referents. The interlocking nature of the study referents is illustrated in Figure 1.1 on page 20. They are expanded here to describe the conceptual framework of the study.

Referent 1: *Macro-reality – the place and nature of assessment in the mathematics program within education*

The initial source of data against this referent was the review of literature focusing on past and current forms of assessment relevant to this study. A wide variety of published formats was consulted, including books, journal articles, newspaper articles as well as a number of refereed papers, news bulletins and media releases available through the World Wide Web. Of course, borne in mind was the fact that publication on the web does not necessarily bestow authenticity and the bona fides of authors and sources were considered. The discussion of the literature forms Chapter Two of this thesis.

Referent 2: *Micro-reality – the current and emerging form and part of mathematics assessment in classrooms*

Surveys, interviews, conversations and observations revealed the ideas surrounding this referent as the teacher focus group put the functioning of their classrooms into context. It is in this context that teachers have an appreciable level of influence over students' learning of mathematics and that influence is discussed in Chapters Four, Five and Six.

Referent 3: *Enhancing the effectiveness of assessment through a change which utilises a process portfolio*

The potential move to process portfolios across the school was to require marked change within the mathematics pedagogy of all teachers. The teacher focus group involved in the study provided the leadership for change. Acceptance and support of that change was gauged through considered interaction with the study participants. Once again, interviews, conversations and observations provided the data upon which judgements were made. The judgements form part of the discussion within Chapters

Five through Eight. From the discussion, recommendations were formed for continued work within the school after the study concluded.

RESEARCH DESIGN

Methodology

The study was based on an interpretative model of research and centred on the problems confronting teachers as they developed and implemented what was, for the school involved in the study, a radical method of assessing achievement in mathematics. As the revised approach to assessment held repercussions for the teaching of mathematics, the issues were across all aspects of the teaching and learning of the subject. Therefore, the entire process, from planning through teaching and learning to assessment, required consideration within the study structure.

There were three stakeholders directly involved in the study; teachers, students and students' parents. From each of the three groups, samples were drawn. Throughout the thesis the groups are referred to using their particular group name, such as the teacher focus group, students and parents. Although not a direct participant as such, the school, the site of the study, was also a stakeholder as effective, efficient assessment of student learning is a key facet of the school's accountability processes. Communication of the results of assessment procedures to students and parents through the school's reporting format was therefore considered in relation to the fourth research question.

As the development of the portfolio proceeded, in looking to unearth and solve emerging problems from a teacher's perspective, collection and perceptive interpretation of qualitative data, supplemented by limited quantitative data, was undertaken. In an iterative study, data were collected from participant groups across the two years of the study on several occasions. That data collection is now discussed.

Participant Teacher Sample

The study centred on problems concerned with the teaching and assessment of mathematics. Therefore, the formation of the teacher focus group was of high early importance. To facilitate the future application of the study results across the school, it was seen as prospectively useful for the group to be representative of the wider teaching staff as many had displayed a high level of early interest in being part of the study. A diverse group offered the potential of yielding broad data. As a result, a group of teachers teaching across Years 4 to 7 was formed. Full details about the composition of the teacher focus group appear in Chapter Four and in Appendix 2 the explanatory letter and consent form provided to the teachers are presented for perusal.

Data Collection through Participant Teachers

Throughout the two years of the study, interactions between the teacher focus group and me, and between the members themselves, occurred with high frequency as part of normal daily school routine. Interaction varied from casual and formal to scheduled and unscheduled depending on the matter and depth of the discussion at the time. Naturally, not all professional interaction focused on the topic of this study but much did involve discussion of matters relevant to the study such as planning, advice, results of student learning and the like. Wherever practical, notes were made of relevant developmental interactions in which I was involved. A sample of the notes by way of excerpts from my study log is provided in Appendix 3.

Structured data collection sessions[1] using interviews conducted by me with individual teachers took place several times during the course of the study. Interview protocols were localised as they were developed in response to emerging feedback about the development of process portfolios within classrooms. Interviews were carried out in surroundings of teacher choice so as to ensure their comfort. Unlike the group meetings and frequent casual interactions, the structured interviews were tape recorded, with transcripts prepared for later review. The schedule of formal teacher focus group interactions with me over the course of the study is displayed in Table 3.2 overleaf.

The purpose of the initial interviews was to identify teachers’ reasons for becoming involved in the study, perceived strengths in the teaching of mathematics that they had to offer the group and ways the group might be able to assist them with their teaching. A sample of one of the first teacher interview transcripts is provided in Appendix 4. Current assessment structures were clarified, giving me some background with which to approach early weekly focus group meetings. The meetings were to help group members understand how each other’s mathematics classroom functioned. They also assisted me in my participant observer role in which I worked in classrooms with teachers developing components of the portfolio.

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[1] Many of the data collection instruments and the resultant data generated are illustrated within the appendices and referred to as used in the discussion of results through Chapters Four to Eight.

Table 3.2: **Teacher Focus Group Structured Interaction Schedule**

2004	**Instrument**	**2005**	**Instrument**
February	Interviews	**March**	Interviews
February-June	Focus group meetings (wkly)	**March - June**	Focus group meets (X2 wkly)
February-September	Classroom participant observations	**March-August**	Classroom participant observations
March	Survey questionnaires Reflections	**July-August**	Interviews
May	Interviews	**August**	Reflections
June	Reflections	**September**	Parent-Teacher-Student Interviews
September	Reflections	**October**	Survey questionnaires
November	Reflections		

The first teacher questionnaire gathered a great deal more background information on the focus group. It also served as the first formal reflection document as it asked teachers to consider much of what they were doing in their teaching of mathematics. Questions for the subsequent second interview were based on the analysis of the data collected in the questionnaires. Much of the how and why of mathematics in each of the classrooms was clarified through consideration of the collated interview transcripts. Two subsequent structured interviews provided opportunities for the participant teachers to reflect and comment upon the change to process portfolios and their personal pedagogical development.

While much reflection took place during teacher interactions, written reflections were also completed by the teacher focus group. Each was an occasion for teachers to formally share their recent personal professional journey of discovery. Late in the study three-way interviews were designed to seek even greater feedback breadth. They were created as opportunities for teachers, parents *and students* to formally reflect upon and discuss mutual expectations and student achievement.

During the first semester of the study, a high level of structured teacher focus group interaction was encouraged through weekly teacher focus group meetings. Generally, a specific topic was set so as to stimulate initial discussion. Frequently, as with all such gatherings, discussion moved to sub-topics derived from the original or to topics which members saw as particularly pressing or relevant at the time. To trace the group's development path and provide data for review, the proceedings were noted in the Teacher Focus Group Meeting Journal, the contents of which were used during subsequent data analysis discussed in the chapters that follow. The weekly meetings were discontinued after one semester as members wished to spend more time interacting on an unstructured basis in order to assist each other with planning and implementation based on what they had learned during the first semester. Meetings recommenced on a monthly basis in the third semester of the study.

Data collection was completed through a second questionnaire to the teacher focus group. The instrument asked the teachers to share their 'distance travelled' in relation to assessment and their feelings regarding the process portfolio. Analysis and illustration of the resultant data form part of the discussion of study results in Chapters Four and Five.

Survey: Teacher Questionnaire

Whilst the greater proportion of data gathered in the study was qualitative, teacher questionnaires were used on two occasions to provide both qualitative and limited quantitative data. The first questionnaire was written to collect relevant facts about the individuals who constituted the teacher focus group. The remainder of the instrument elicited a variety of professional details which included their perceptions of mathematics, program structure and feelings regarding teaching mathematics.

The first draft of the first localised instrument, which was written specifically for this study, consisted of 57 questions. The second draft carried a mixture of 36 open and closed questions. Several questions offered a range of options that could simply be ticked to make completion less onerous. Written responses were requested in seeking views and perceived problems. The instrument was then tested through eight teachers not connected with the study in any way. Test feedback was used for refinements before the teacher focus group was asked to complete the first questionnaire.

The second questionnaire was administered late in the study. Once again, it was a localised instrument developed specifically for the context of this study. Its purpose was to seek the teacher focus group's views at that time regarding the teaching, learning and assessment of mathematics. It consisted of open questions in order to attract individual responses. Its localised nature meant that it was unable to be tested formally using an unattached group. In order to complete the questionnaire a teacher needed to have undergone the developmental experience on which it focused. Therefore, I carefully reviewed the instrument and asked a briefed colleague from outside the school to review it to ensure that it would serve the desired purpose.

Programs and Planning

Another valuable source of data was teachers' planning and programs at both class and year levels. As a normal course of events within the school, all teachers meet me formally at least once a term to discuss planning, programs and resourcing, together with other teaching issues that may need consideration. The discussions offered opportunities to explore teachers' pedagogy.

Each member of the teacher focus group also shared their planning documents across the focus group to stimulate discussion, cooperation, sharing of ideas and problem exposure (see an example in Appendix 5). The regular sharing of planning illustrated the evolving forms of learning experiences and assessments being used by teachers. Apparent were the developments and changes as teachers moved toward embracing what they came to view as a multi-faceted, student-growth-centred assessment format.

Classroom Interaction and Observation

My ability to schedule my availability across the school week meant that I was frequently asked to assist with any of a number of facets of the expanding new assessment format. Amongst the requests were the exploration of ideas, the development of learning tasks, the creation of rubrics and assistance in the role of either teaching partner or participant observer. The interactions provided a great deal of relevant qualitative data.

Complementary to the direct teacher input were observations made of classroom practice in the teaching and assessment of mathematics. As an observer, I made brief notes on classroom activities (see examples in Appendix 6) and subsequently discussed them with the particular teacher. The observations provided valuable data for teacher considerations, much of which are discussed in detail in Chapter Four.

Teacher Reflections

Part of the process portfolio learning experience for students that set it apart from many other classroom activities was students being asked to commit their thoughts about their learning to paper in the form of reflections. It was seen as worthwhile for teachers to share similar experiences using a reflection process. As well as stimulating further professional growth, reflections provided additional data about teacher progress in experiencing and assimilating the changes that they may have been experiencing. At times, teacher focus group members were asked to share their reflections about their own learning, preferably in writing. Initially, not all felt comfortable writing their thoughts but all were willing to reflect in some form that was useful to the group.

Participant Student Sample

Whilst the nature of the study meant that teachers were the focus, students were the centre of attention as the ultimate aim of the work was to improve their learning. To examine progressive change over time, the student sample was drawn from the mathematics classes taught by the teacher focus group. This potentially offered data from up to 130 students ranging in age from eight to 13 years. My taking the opportunity to speak to gatherings of class parents early in the first year of the study delivered an excellent student participation rate. As far as was practical, all students who expressed willingness to participate, and who were given parental permission to do so through the consent form in Appendix 7, were included in the data collection process. Table 3.3 shows that initially the study involved 121 students in five classes across four year levels. Throughout the study, students provided data through survey instruments and interactions during classroom teaching and learning activities.

Table 3.3: **Student Participant Numbers and Ages**

Year 4	**25**	Generally turning 9 years during this year
Year 4/5	**25**	Multi-age, generally turning 9 or 10 years depending on level
Year 5	**25**	Generally turning 10 years during this year
Year 6	**23**	Generally turning 11 years during this year
Year 7	**23**	Generally turning 12 years during this year

Students, the largest group of participants directly involved in the development process and from whom a great deal of formal and informal data were collected, completed surveys and drawings based on their feelings towards mathematics. Also, their perceptions of their own abilities were sought. They took part in interviews as well as generally becoming engrossed in the evolving tasks and forms of assessment. At various times throughout the study, students were involved in all aspects of the work. They collected mathematical information, created problems and tasks based on that data, critiqued each others' problems, designed rubrics, solved problems in groups and individually, self-assessed, and created personal reflections using a variety of formats. Students were asked to provide feedback of various written formats over the course of the study. A schedule of requests made of students for formal feedback forms Table 3.4. All of the data collected were collated and considered in order to construct a clear picture of student involvement and opinion regarding all aspects of the evolving process portfolio assessment structure.

Table 3.4: **Student Feedback Schedule**

2004	Instrument	2005	Instrument
February	Consent to participate	**March**	Self-assessment
March	Survey	**April**	Problem creation and critiquing Reflection
April	Draw-A-Mathematician Test	**June**	Survey
May	Survey Interview	**September**	Parent-Student-Teacher interview
June	Written reflection	**October**	Survey
August	Rubric		
September	Rubric Class Journal Survey		
November	Survey		

In line with normal changes in class composition over two school years, the participating student body altered somewhat. However, whilst the 16 Year 7 students were lost to the study as they left the primary school after the first year, a large number of student participants remained in classes developing the process portfolio and the second year saw other teachers begin to embrace portfolio components. This meant that where practical, a large proportion of the original student participants remained available for the collection of information through various non-intrusive means.

Survey: Student Questionnaire

As students were the target of the changes being made, over the duration of the study they were involved in the completion of a wide variety of instruments designed to inform teachers about assessment developments. Responses to three brief and three longer survey instruments were used to collect information, guide planning and monitor progress of the implementation process from a student perspective.

Initial thoughts regarding questions for the first survey were presented to the teacher focus group. Discussion saw the draft format developed. Its aim was to clarify the spread of student perceptions while being straightforward for students of between eight and 13 years of age. A document of three pages carrying twelve questions resulted. Four of the questions were open, requiring students to create their own answers, four sought yes/no responses and four offered opportunities for multiple selected responses, with the option of writing their own answer or adding to the list of available choices. Enquiry centred on the point of learning mathematics, its use outside of school, feelings regarding and possible sources of help with mathematics, family attitudes and self-perception as a student of mathematics as well as their beliefs regarding the most effective aids in understanding mathematics. Questions were designed to assist teachers gather important background related to their particular classes, to gather data for the study and promote broader professional discussion regarding the teaching and assessment of mathematics.

After careful review by the teacher focus group the draft instrument was circulated to several teachers not involved in the study for comment. After further modification in response to subsequent comments, field-testing took the form of the survey being completed by a Year 5 class that had not been linked with the study up until that time. The broad parameters and purposes of the study were shared with the field-test students and their parents when they were asked to participate. I guided students through the document, moving at a pace which saw all have sufficient time to respond to each question. As the questions had been written in what teachers thought to be appropriate language, it was thought that students would have been able to complete the survey without such direction but it was considered important to facilitate the trial to ascertain possible future pacing and overall timing. Guidance was also meant to ensure that students were engaged, delivering maximum useful feedback.

As a result of field-testing a number of points emerged. Firstly, there *was* a need to guide students through the questions in order to ensure that all had sufficient time and did not feel pressured by artificial time constraints. At the same time, guidance avoided students taking exorbitant time to complete the task through comprehension difficulties. Secondly, whilst respondents were clearly told that names were voluntary (a note to that effect appeared under the line provided), virtually all took the option to name their papers. Later, that trend was also evident in the actual study students, delivering a large pool of potential interviewees. (Although instruments invited names to direct the subsequent interview process, anonymity was strictly maintained in all results reported.) Thirdly, it was found that further minor changes in wording were needed so as to ensure respondents understood what was being asked without lengthy explanation and that they did not have to constantly refer back to the question.

Under my guidance students from the five classes participating in the study completed that first student survey while seated at their desks. A similar introduction to the instrument was given to each class. No strict time frames were applied, although a timetabled allowance of thirty minutes proved sufficient for all classes.

Resultant anonymous data were collated in full text within each year group in order to inform each teacher of the perceptions held by students in their particular class. All written responses to questions 1-3, 5 - 7 and 12 were collated. Responses were then collected within suitable categories, such as education, money, and employment so as facilitate the generation of comparative graphs. The written text allowed teachers to gain clear impressions of the beliefs of their students, while the graphs simplified the identification of patterns across the year levels. In considering the emergent patterns and possible areas of future concern, the teacher focus group considered that students' responses to *all* questions were worthy of consideration, whether they were directly linked to the study or not. After all, students' perceptions across all facets of mathematics had to be important and taken into account if teachers' planning was to incorporate authentic learning experiences for their students.

Subsequent Student Surveys

To familiarise students with giving regular feedback, a brief one-page instrument was administered several weeks after the first survey. It invited students to offer comments on the teaching and learning of mathematics in their current classroom. In order to focus responses, the survey was limited to three open questions.

The first question asked students to list things that their teacher did to help them learn, the second to speculate about what they thought might help, while the third item offered an opportunity to share any other thoughts that they had regarding mathematics classes. As with all study surveys, the instrument and results are discussed in later chapters.

Draw-A-Mathematician Tests

The use of drawings to educe students' thoughts has been used effectively for some time (Gardner, 1980; Pedersen & Thomas, 1999). Students' opinions expressed through media such as drawings have been found to be reasonably accurate reflections of their attitude to the subject of mathematics (Picker & Berry, 2001). The collection of student perceptions has assisted teachers in understanding their students' thoughts in relation to mathematics and its application in the students' 'real' world.

To foster thought about mathematics and its perceived application outside of school it was decided that reference to an individual creative drawing activity would be used in the form of a conversation starter as an opening to structured student interviews. This recognised that younger students often express their ideas better in drawing than text (Chambers, 1983). Whilst in-depth analysis of the drawings was not a primary focus, the data generated assisted in identifying a number of student perceptions of mathematics that proved useful to the teacher focus group.

Students were asked to complete one of two localised versions of a Draw-A-Mathematician Test (DAMT), a concept which was developed by Picker and Berry (2001) based on the Margaret Meade's Draw-A-Scientist Test. Two versions of a DAMT were created for this study; one for Year 4 and another for Years 5 to 7. The version for the older students asked them to complement their drawing with adjectives, the addition of which was designed to add stimulus and focus to the creative process, thereby possibly adding greater depth to the portrayal.

Student Interviews

Students who had given thought-provoking responses to the first two student surveys and/or the Draw-A-Mathematician Test were identified and invited to participate in an interview. Whilst numbers remained somewhat flexible, approximately 20% of each class, some five students, was considered an effective working number, while minimising disruption to class and student routines. Numbers were varied slightly across classes to involve those students whose responses generated particularly interesting questions. As a result, a sample of 24 students drawn from across the classes of the teacher focus group was used to ensure a representative student voice across the year levels and classes involved in the study.

In seeking to clarify an overall, comprehensive image of students' perceptions about mathematics, most of the questions included in the interview protocols were derived from responses to the first student survey. In order that students did the greater part of the talking, questions were short and set in plain, non-threatening language.

As questions were devised for each particular student field-testing was inappropriate. It was a matter of refining questions if and when necessary during the interviews. Any modifications that were made were designed to ensure ease of comprehension and comfort while providing further elucidation of students' ideas.

For consistency, the interviews were all conducted by me, in locations removed from distraction but close to the students' classrooms. Although it was a teacher-student interaction, inescapable formality was kept to a minimum, creating an atmosphere which was relaxed and friendly. Students and I sat at a table so that we both had excellent views of material displayed to illustrate questions, answers and points made.

Students were made aware that with their approval the interviews were to be taped. The use of a small tape recorder meant that none of them overtly acknowledged its presence after the initial mention. Transcripts were made from the tapes to enable collation and later consideration. The time taken for each interview was kept to a minimum to maintain students' attention and enthusiasm while preserving the relaxed nature of the discussion.

It was thought important that each student felt that the interview was something of a shared, mutually-driven experience not utterly dominated by the interviewer. Interviews began with discussion of the student's thoughts about aspects of their DAMT drawing. The intention was to create a feeling in students that their perceptions were significant enough to lead such a conversation, encouraging broader responses.

Following the DAMT conversations, students were asked to expand on aspects of various statements that they had made regarding learning mathematics in the classroom, as indicated through responses on the brief second student survey. These discussions led to further conversation regarding perceptions that had been revealed through their answers to the first survey.

Subsequent to the initial data collection phase, students were introduced to a number of components and practices which emerged as the process portfolio model developed. Written reflections, rubrics and class journals were discussed at length and students began to become familiar with their nature and purpose. Consideration of the different portfolio components in this way produced much valuable data for the study.

Further Student Opinion

The third student survey questioned students as to their recent learning, difficulties that they were experiencing and their feelings regarding mathematics classes. Again, with a title designed to appear important but not onerous, *Your Opinion Counts*, it was a brief open instrument presenting little inconvenience. The fourth survey, *Your Opinion Counts 2*, again sought student opinion in an open format. Field testing was not carried out with the instruments as they were localised and therefore contextual.

Subsequent further beneficial forms of feedback for teachers and students included student self-assessment and problem critiquing. The feedback formats were designed to suit various tasks undertaken by students and encouraged them to give peers constructive criticism in relation to problem creation and solution.

Consequently, during the latter half of the second year, students were asked to complete two more substantial surveys. The survey instruments were written to gauge students' developing perceptions of the different styles and aspects of mathematics with which they were involved and their thoughts on the developing process portfolio. Both surveys used open questions in seeking responses regarding assessment and feelings towards tasks and new levels of student responsibility. The instruments were not tested by an unconnected group as once again they were localised, with answers being sought in relation to students' involvement in the work that was being done within the classes. Therefore, the instruments were carefully reviewed by the focus group to ensure question clarity. Each survey was administered to students in their own classrooms. As with all data collected, results were collated and shared with the teacher focus group for discussion of issues as they arose and to assist process portfolio component design.

Between the administration of survey instruments, students were involved in an additional new experience, teacher-parent-student interviews based on their process portfolios. Formally scheduled three-way interviews, with the student taking a leading role through presentation and discussion were a new concept for the school. Prior to the innovation, students had no formal part to play in teacher-parent interaction.

Participant Parent Sample

As part of the informed consent process, through the letter to parents circulated at the commencement of the study (see Appendix 8), parents were asked to indicate if they were willing to discuss mathematics assessment in an interview. Whilst the response on that occasion was overwhelmingly positive, the actual parent participant group of 53, approximately half of the initial responding group, was formed through parents' subsequent action, or lack thereof, in responding to the parent questionnaire. The instrument sought their views on assessment and reporting and was administered in term three of the first year of the study. Planned subsequent interviews were designed to add depth to the responses of 25 of the respondents.

Survey: Parent Questionnaire

In order to satisfy the need for a wide variety of information relevant to the study while maintaining a questionnaire of respondent-friendly length and complexity, teacher focus group collaboration formulated 14 open questions as the first draft. Parents were asked to share their insights into how they were taught mathematics at school, their perceptions as to the effectiveness of those methods, as well as the importance of mathematics, what in their opinion constituted progress and difficulty, together with an indication of the level of application of mathematical processes in everyday family life.

Unfortunately, only six (24%) of the 25 questionnaires distributed to parents through the same Year 5 class that had been used for field-testing the student survey were returned. Considering the high level of willingness demonstrated through earlier parental consent within that group and that a letter outlining the purpose of the survey had accompanied the document, the small number of responses was taken as an indication that the questionnaire possibly had significant faults which required revision.

The introduction to the instrument was altered to expand on what were advanced as potential benefits of the study in relation to students. The complexity of all questions was reconsidered. The responses to the first distribution, while small in number, were detailed and proved to be valuable influences in the revision. Several questions were made more specific, some became multi-choice, offering respondents either a memory prompt, as in personal history questions, or a scale upon which they could indicate their responses. Multi-choice was also used as a possible aid to comprehension.

The second draft of 15 questions, along with an explanatory letter addressed specifically to the parents of the new test class, was distributed to the parents of a Year 6 class of 25 students who were unfamiliar with the study. Subsequently, a much more significant response was forthcoming with 13 (52%) of the distributed trial questionnaires returned completed.

In assessing the responses from the trial groups against the information sought and questions asked, data were collated using a spreadsheet format. Responses revealed that some questions overlapped or were repetitive. Respondents’ comments, or lack of response to questions, also were taken into consideration. Accordingly, several questions were either deleted or melded in order to formulate ten questions carrying the potential to yield the desired data. A blend of question styles was used with five open questions, four that offered a range of supplied responses with scope for respondents to give additional information and one used a 1-10 rating scale.

Of the 110 questionnaires that were able to be distributed, 53 (48%) were completed and returned. Parents’ responses to the questionnaire are analysed and discussed within Chapter Seven.

Parent Interviews and Discussions

As with all busy parents, time is precious. Parents of children in the study classes had already been asked to give their time and attention to the completion of the parent survey. In seeking to further expand upon the data collected, a number of parents were then invited to share their opinions on various facets of the teaching of mathematics. To encourage parents to participate and maximise the benefits of their commitment, interviews were designed to serve a double purpose. Whilst this study was examining assessment primarily, reporting, a cornerstone in the feedback process is also an important component of that process. It is often seen as the final piece of the accountability puzzle by parents. It was deemed appropriate to ascertain parental opinion on fundamental feedback and reporting aspects as a precursor to asking about the mathematics process portfolio. Naturally, in order to be non-threatening, parents' thoughts, feelings and perceptions were sought, not professional, technical opinions.

Initially, the teacher focus group brainstormed a list of questions for the parent interview protocol. These were then discussed and considered as to relevance, strength in relation to data revelation and the questions 'fit' within a non-threatening protocol. Parent comfort level was a major consideration, along with time, and thirty minutes was seen as a reasonable expectation. Consequently, a list of thirteen questions, with six dependent sub-questions, was derived from the draft list.

A small test group of three parents was randomly selected by drawing on indications of willingness expressed previously. Through a telephone call those parents were asked to meet with me for the purpose of answering some questions on their thoughts about assessment and our current reporting system. Relevance and depth of data generated, as well as time taken and interviewee ease with questions, were assessed.

As a result, the first, most noticeable factor was the time taken; it exceeded the deemed reasonable thirty minutes. Some repetitive responses indicated that several questions were either implicit in others or were not particularly useful for the purposes of the interview. As a result, several questions were deleted, leaving ten questions as the basic interview protocol.

In seeking to apply the protocol across a representative, manageable sub-group 'cross section' of the Years 4-7 parent population, the list of parents for interview was drawn up using several guidelines. Firstly, parents who had indicated their willingness to discuss the school's reporting format at the bottom of the first explanatory letter sent home were ascertained. Then, those who had agreed to be interviewed through the return portion of a second letter outlining the purpose and nature of the discussion and asking for interested parents to select from a series of possible time slots (see Appendix 9) were noted. Variation across the time that parents had had their child/children at the school was sought. Those with extensive experience of the school's assessment and reporting and those that had only seen a semester of such, with recent experience of other systems at various schools, needed to be represented. Also, a spread of parents of students across the year levels involved in the study was seen as preferable. Fifthly, it was seen as potentially beneficial in seeking as broad a picture as possible that some of the parents had more than one child at the school, ensuring multi-point engagement with reporting at various year levels and in relation to students of varying abilities. Finally, as fathers are frequently underrepresented in educational matters, the small number of fathers that responded positively to the interview request was invited to interview. The gender mix was skewed in favour of mothers, but the mix of parents that regularly interact with the school had been observed to reflect that skew.

No attention was paid to the academic progress or standing of students in selecting parents to be interviewed. No direct reference to any student was initiated by me during the interviews. If, and when parents referred to their child and it did happen on several occasions, it was by way of illustration of a relevant point that they were making.

In order to aid consistency of approach, it was intended to schedule the interviews over the one school week. However, two parents were unavailable during that particular week. They were interviewed the following week. Unfortunately, three parents were unable to keep their appointments, reducing the number of participants to twenty two of the original twenty five, but because of the attention paid to the breadth of sample characteristics and those unavailable representing a spread across those characteristics, the number still yielded a valuable representative cross section of views.

In seeking consistency, the introduction and questioning on the interview protocol was followed with all participant parents. Variations only developed through responses to statements or questions advanced by parents during discussions. With the participant's permission each interview was tape-recorded so as to facilitate the typing of transcripts for later review.

The interviews opened with questions regarding the school's current reporting system as it was envisaged that the portfolio process was to become an important part of the accountability and reporting format of the school. The approach was taken with the intention of ensuring that parents felt comfortable through being offered early opportunity to express their views regarding something with which they had varying degrees of familiarity. It was also possible that some of the parentally perceived shortcomings of the current system could have been professed strengths of the portfolio process, leading neatly into the second part of the discussion. Questions then moved to parents viewing students' work. Interviews closed with the seeking of parents' views on process portfolios in the learning and communication of progress in mathematics.

The atmosphere of the discussions was relaxed, informal and open in comfortable surroundings within the familiar school environment. It was realised that not all parents necessarily feel particularly comfortable in teacher-parent discussions but the fact that the interviewees had accepted two invitations, the second through a personal letter and telephone call, was taken as a decidedly supportive indication.

Teacher-Parent-Student Interviews

With process portfolios forming significant parts of the assessment regime in several classrooms by the early part of the second year of the study, teacher-parent interviews that under normal circumstances may have centred on a product portfolio now focused on the process portfolio and involved teachers, parents *and* students. For the school involved in the study it was a unique approach and drew much comment across the community. Teachers who were part of such interviews were asked to note parental comments regarding views expressed in relation to the revised format and the reformed portfolio, verbatim where possible. Early interviews by me with parents had gauged perceptions of the process portfolio approach while the reality of portfolio implementation was sought in the later three-way discussions.

DATA ANALYSIS

As mentioned at the beginning of this chapter, data collection was the main focus of the chapter. Detailed analysis and discussion of the data collected using the methods discussed follows in Chapters Four through Seven. Data analysis was based on the premise that interpretation of results is a process of information matching. For instance, the responses of teachers regarding their perceptions of their classroom practice were compared to the responses given by their students and my observations. Matching was on either a qualitative or quantitative basis, or both. This effectively utilised the process of triangulation (Mathison, 1998). Whilst Guba and Lincoln (1989) believed that triangulation has too positivist an implication, as it implies phenomena that are unchanging, not transient concepts that exist only in the minds of observers, pragmatic researchers are not deterred from making valuable use of the triangulation concept.

Triangulation was used within the interpretation of the data revealed by this study in order to enhance the validity of the data and consequent interpretations. Field analysis, where information was collected during immersion, and then interpreted and clarified within the classroom context, was integral to the research framework. Post-field analysis, where the data were sorted, leading to problem delineation followed in order that the study assessed, described, documented and informed the problem from a stakeholder's perspective. It allowed a number of approaches through drawing together interpretations aimed at bringing meaning to the research in an interactive manner.

Teacher and Student Assertions

Where there were a number of references to particular issues, common problems were highlighted through verbatim teacher assertions. At times, student assertions and comments were used to reinforce teacher assertions. From those assertions the dominant problems were framed and stated. In line with the standard mathematical format used within classroom work, solutions were then formulated and supported.

Validation of the approach was undertaken constantly through feedback to the teacher focus group. Feedback was also supplied to students when appropriate during classroom interaction in my participant observer role. Due to relatively restricted interaction, only limited feedback could be supplied to parents. However, whenever suitable situations arose, as in teacher-parent interactions, parents were kept informed as to the results of the study.

Analytic Quality

According to Yin (1994), as in all social science, there are four key principles which underlie analytic quality in any study. As much evidence as possible must be sought and considered at length, the most significant aspects of the study must be identified, major rival interpretations deserve consideration, and expert knowledge needs to be brought to bear on the issues. Yin’s four principles have been applied to varying extents in this study. Significant and marked change within the teacher focus group’s teaching and assessment of mathematics was the major issue investigated. Hours of taped interviews were transcribed, many data collection instruments designed and administered and notes kept of meetings and other relevant interactions. Hours of participant classroom interactions and observations were noted. All such data were reviewed in depth as part of the problem clarification and solution processes. Due to an identified scarcity of such specific studies within the literature, rival interpretations were difficult to find, but as Chapter Two shows, expert knowledge about the potential place of the process portfolio concept as an assessment instrument of importance was considered in relation to this study.

THE NEXT CHAPTER

From the foundation established through the groundwork discussed at length in this chapter, the emphasis was clearly set on the development of the teacher focus group and its crucial function in the study. The next chapter details those developmental processes and the obstacles that were exposed through their professional enthusiasm, perceptions, discoveries and growth.

CHAPTER FOUR: FOCUS GROUP FORMATION, EARLY FIELD WORK AND PROCESS PORTFOLIO DEVELOPMENT

This and the following chapter could well be entitled 'Professional Development' for in essence that is what they describe. The entire process covered by this thesis was one of professional growth for teachers, for those directly involved and later a number who became involved in the change. The descriptions of the professional growth has been split into two parts Chapters Four and Five. As its title indicates, Chapter Four discusses the first part and illustrates the second study referent, the micro-reality in relation to assessment in the school, the foundation upon which the professional growth was based. It explores the evolution of the teacher focus group, the early fieldwork and first developments in designing and implementing components of the process portfolio model. In line with mathematical form, in describing the development of the portfolio an assertion, problem definition and solution approach is used. The second part, Chapter Five discusses specifically the professional development which underscored the development process and examines the marked enhancement of the process portfolio model which resulted from the teacher focus group's lengthy efforts. By way of general focus, Chapters Four and Five consider working hypotheses related to what was expected to be revealed during the research.

Whilst the teacher focus group has been mentioned previously, its composition, perceptions and function are further detailed. The early fieldwork centred on the teacher focus group and its evolution into a synergetic team. Although a little of the concept of the process portfolio was understood by the teacher focus group, the precise structure was unknown and open to exploration and experimentation. This chapter discusses and illustrates the early developmental work, all of which was in the field.

As I was conducting the study within my employing school, movement into the field appeared to represent no marked change from a routine that had taken place for some years. Having spent considerable time working with students and teachers across the school it was not a case of venturing into new territory. However, I soon found that when moving from predictable daily routine into jointly planning, implementing, exploring in detail and documenting major change, the complexion of the school altered somewhat, presenting something of a new face. Over the years, I have found that at times, intensive examination of a seemingly familiar territory does reveal much more than was perceived beforehand. This study proved no exception.

Working Hypotheses

Working hypotheses for the initial phase of the study and which were used constantly as a reference point as teacher professional development progressed were:

1. Teachers hold widely varying views regarding assessment. Considerable time is required to meld those views in developing and pursuing shared aims.
2. Formulating an early model of a process portfolio is an involved procedure when working with a disparate cross-sectional teacher focus group.

FOCUS GROUP DEVELOPMENT

> We typically think of assessment as an index of school success rather
> than as the cause of that success. Unfortunately, largely absent from the
> traditional classroom assessment environment is the use of assessment
> as a tool to promote greater student achievement. (Shepard, 2000, p. 4)

The catalyst for change in the assessment structure of the school involved in the study proved to be the realisation by teachers that testing only measures and generates uni-dimensional, quantitative, summative data; testing is assessment *of* learning. On the other hand, through the same early reading and discussion that brought those realisations, teachers realised that we needed to aim for qualitative, formative assessment; assessment *for* learning. We needed assessment that informed all involved in the learning process, particularly students and teachers, about the progress of learning while the learning was taking place, not only upon its conclusion.

As a result, teachers' problems in developing and implementing a new assessment structure formed the focus of this study. In investigating and tracking the change it was seen as impractical to involve all of the school's twenty class teachers. Therefore, the first task was to assemble what for the purpose of this study was named the 'teacher focus group'. Teachers who joined the focus group needed to be committed to the task. While maintaining current daily routine they were involved in exploring an unknown, challenging concept, working within an unfamiliar, perhaps threatening, assessment structure.

The study involved teachers within a school that had been using product portfolios for four years but prior to the study had not heard of the process portfolio concept. The familiar product portfolios displayed finished pieces of work only and were not considered significant contributing items in the actual teaching and learning programs. Nor were they part of the assessment structure. Discussion of the 'sanitised' nature and inherent limits of the product portfolio, as against the process model's potential to portray a 'trail' of student engagement and growing understanding, provoked a high level of teacher curiosity. The conversations saw many recognise the learning-enhancing possibilities of the alternative concept, particularly in relation to embedded assessment. A number of teachers indicated interest in being part of the study and in the interests of future transferability, it was important to form a genuine representative group.

As a result, five teachers who were teaching across Years 4 to 7 formed the teacher focus group. The characteristics of the group are shown in Table 4.1. The table reveals the cross-sectional nature of the group in relation to many characteristics of the primary school's teaching staff such as gender, age and experience.

***Table 4.1:* Characteristics of the Teacher Focus Group**

	Year level (2004)	Experience at that level (years)	Gender Staff: 58%F, 42%M TFG: 60%F, 40%M	Age bracket Staff: 20-29: 3 30-39: 6 40-49: 7 50-59: 4	Total primary mathematics teaching experience (years) Staff: 1-10: 7 11-20: 7 > 21: 6	Pre-service training in teaching mathematics (Units of mathematics studied)	Always taught maths?	Year levels trained to teach	Number of teaching positions held Staff: 1- >5	Years at this school Staff: 1- >15
A	Year 4	first year	Male	50-59	5-9	Yes (1)	Yes	P-7	>5	1-3
B	Year 4/5	first year	Female	20-29	5-9	Yes (2)	Yes	1-7	3	1-3
C	Year 5	8	Female	50-59	>30	Yes (u/k)	Yes	1-7	>5	>15
D	Year 6	2	Male	30-39	5-9	Yes (3)	Yes	P-7	3	4-6
E	Year 7	first year	Female	40-49	20-29	Yes (1)	No	1-7	>5	1-3

Table 4.1 shows that a wide range of experience and professional expertise were encapsulated within the group while the gender balance across the school was represented proportionally. Evident also was that the group's teaching experiences were based within a number of schools. The group's time within boys' schools gave its members an understanding of 'boy-specific' learning strengths and weaknesses as detailed by Hawkes (2001) and West (2002). The group was cognisant of the fact that whilst it is professionally astute to appreciate gender-based inclinations as to learning, in catering for any class all learning styles and intelligences need to be taken into account (Gardner, 1991). None of the teacher focus group was new to the school, which

indicated that members knew each other well enough to plan and share openly and constructively, activities which in themselves yielded plentiful data.

Data which revealed the full extent of the teacher focus group's attributes were collected through the first teacher interviews and questionnaires which were administered during the opening weeks of the study. Data were collated and classified to reveal the focus group's mathematics training and teaching backgrounds, teaching styles and strengths and perceptions of assessment in mathematics. Data were then considered in relation to each teacher during classroom observations and subsequent discussions on the teaching and assessment of mathematics.

Initial discussions established the broad early structure of the work and routine in regard to meeting, sharing and learning. The focus group teachers were supplied with an introductory resource kit, which included journal articles and a copy of *Thinking Allowed: Thinking Tools for the Mathematics Classroom* (Gunningham, 2003), a collection of ideas on designing learning tasks which consider factors such as multiple intelligences and orders of thinking. Use of our expanding library of assessment texts and journals, which was introduced through reviews within the kit, was encouraged. Early discussions concentrated on gaining basic understandings of each other's viewpoints, on assessment in general and process portfolios in particular. Weekly meetings ran throughout the study's first semester, until the group chose to move to less regularity in the meeting schedule. During the latter semesters, professional sharing across the group occurred mainly through teachers visiting each other's classrooms, frequent conversations and the sharing of materials, copies of which were filed as general resources available to all members of the teacher focus group.

The teacher focus group's diversity coupled to its evident enthusiasm to investigate and attempt change held considerable promise. The reality of attempting marked change in an area as crucial as assessment within a strongly traditional school was to be revealed over the following two years.

EARLY FIELDWORK

Extensive data were collected throughout the study from the three groups of participants, teachers, students and parents, through instruments such as surveys, interviews, discussions and reflections. Triangulation and analysis of the data described existing assessment formats and exposed problems in relation to current assessment formats and mooted changes. Frequent feedback to the teacher focus group ensured that the study remained grounded in classroom reality and sustained the triangulation process.

Early Teacher Focus Group Data Considered

Chapter Three discussed the development of the first teacher questionnaire and interview protocols. As part of establishing the second study referent related to the micro-reality of assessment, the first teacher focus group interviews took place immediately. The second interview followed some eight weeks later with the first questionnaire punctuating the two interviews. The three data collections were designed to trace the professional profiles of the group and their perceptions regarding the teaching and assessment of mathematics. Also gauged were their early perceptions about the nature and function of the focus group. For the purpose of the study teachers were designated A-E from Year 4 to Year 7 (see Table 4.1). To illustrate the development of the foundation upon which the study was built, discussion of the data collected begins with teachers' age groups being considered.

A spread of age groups from 20-29 to 50-59 ensured that a wide variation in professional and personal 'maturity' was brought to bear on the issues which were unearthed during the change of assessment structure. A useful spread of ages allowed possible consideration of a number of age-related factors, such as the relative ease with which various members accepted the process portfolio approach. Whilst the group was small, it showed promise in allowing a level of inference as to the willingness and capacity of older, highly experienced teachers to change from traditional assessment methods based on the mathematical 'right or wrong' dichotomy and the breadth of approaches to assessment.

Involving a spread of teachers across year levels in the change meant that students from Years 4-7 were involved in the study, offering a wide band of student input. Teachers' time teaching at their current year levels was short in some cases while the spread of teaching experience ranged from less than ten years to more than thirty. However, all had only basic training in mathematics, with none having a specific major emphasis on teaching mathematics as part of their original training. The teacher with the highest level of original training completed three units of mathematics, one tenth of that particular teaching qualification. Two teachers had taken only one such elective in original training. Later conversations revealed that early training had focused on content with little time given to pedagogy.

In regard to recent ‘up-skilling’, of concern was the fact that three of the five participants had undertaken no mathematics professional development during the last five years. Therefore, the three assumed to be rich in experience but distant from early training, had no recent additional training. One stated that there had been problems finding suitable training. Following early training, four of the five had always taught primary mathematics. The fifth had experience in Gifted and Talented, Learning Support and Visual Arts, so had the potential to offer the focus group knowledge of a range of alternative approaches to teaching. At initial and subsequent interviews all of the teacher focus group expressed a desire to learn more of recent trends in teaching and assessing mathematics in a pragmatic manner.

The Teaching of Mathematics

‘Maths for life’ was given by the teachers as the dominant reason for teaching mathematics, with the development of cognitive skills which are able to be applied across the syllabus ranked second and student self-esteem third. Evident assumptions that the cognitive aspect, as in higher-order thinking skills, are minor, as mathematics is simply a subject that has to be taught, needed to be addressed in focus group development. Similarly, the lack of in-depth understanding and inability to apply skills to a wide variety of mathematical situations that saw teachers prefer to teach “life skills” needed attention. Contrastingly, there was little evidence of an understanding of the concept of ‘learning for life’ across the group. Teachers saw it as learning maths skills that could be used in life, but didn’t see it as fostering a thirst for learning that could influence other areas of students’ lives.

Notwithstanding the group’s motivations for teaching and assessing, there was a relationship between the level of importance placed upon mathematics and claimed time commitments. Through the first questionnaire, two claimed to assign 30% of the timetable to mathematics, equivalent to 15 of a 50 period structure while two allocated 35%. Considering the breadth of the academic program over twelve key learning areas, 30% and 35% were seen as high. Only one teacher claimed an allocation of 20%, or the equivalent of one full school day per week, the expected minimum allocation within the timetable structure of the study school.

Discussion some weeks later, as part of the second round of interviews, again questioned teachers as to their timetable allocations, their reasons for the allocations and what they saw as acceptable minimum times devoted to mathematics. Teachers still claimed to devote between 20% and 35% to mathematics (see collated responses in Appendix 10). When the reality revealed through an analysis of the timetable was put to them most said that they had really thought that they were committing the proportions claimed. Those who claimed the higher percentages had not calculated but estimated, an interesting mathematical fact in itself. Actually, overall, the group was devoting very close to the expected 20%, or one school day per week. Interestingly, although it was not the reality, when calculations deducted the periods that students were taught by specialist teachers from the total available teaching time the proportions of the time remaining devoted to mathematics approached the original claims.

Factors influencing teachers' timetable weightings included, "Maths is a basic subject … the crux of a child's development" (Teacher E) and "you should do it every day" (Teacher C). Of concern were comments such as, "That's all the time that I have left" (Teacher B) and "It's just an assigned timetable load" (Teacher E) (see Appendix 10, p. 287). Overall, the minimum seen as preferable ranged across 20% to 35%, a wide variation which represented between 10 to 17.5 periods of a 50 period week. Discussions with teachers regarding pedagogical change needed to address the issue of balance across both the timetable and mathematics.

Instructional Strategies

According to responses to the first questionnaire, a broad range of instructional strategies was used, from whole class for the introduction of new topics to individual teaching for practice. Two spent 20% of mathematics time working with individuals. On one hand, the greatest proportion of teaching time was spent on whole class instruction. On the other, when it came to students applying skills, all teachers claimed to use the full range of whole class, group and individual. One highlighted concern centred on two teachers nominating between 60% and 80% of their time as being spent on whole class activities. With relatively little time left for cooperative group and individual activities, questions emerged regarding what really happened in classrooms and as to how teachers catered for individual students.

According to four of the five teachers, catering for student ability differences was strongly linked to the quantity of work that was given, not the depth. Following behaviourist pedagogy centred on imitation and repetition, a minimum quantity of problems to be completed by all students was set. In recognition of differing abilities, variations were made in relation to the quantity of work to be completed, not the quality or level of thought required. Peer tutoring and group work were used, but still within the quantity-based behaviourist parameters.

The behaviourist approach was visible through rote learning being at a level of 20% to 30% of programs. This, coupled to all teachers' high rating of the need to relate maths to the world outside of school, confirmed interpretations regarding teachers teaching 'maths for life'. They saw mathematics-for-life as being able to do quick calculations, as with money, so they focused on tables, number facts and drills. Cognitive processes, such as higher-order thought and metacognition, received only half of the emphasis of 'maths for life' and rote learning. Therefore, open to question, particularly in relation to teachers' claimed teaching strengths, were teachers' claims of the development of students' ability to think through a problem as a major teaching objective.

Teaching strengths were evenly distributed across the major topic areas and claimed levels of enjoyment were high in the cases of four teachers. However, when the negative connotations regarding difficulties relating to students who have trouble understanding were considered, it was hard to see how one of the four could claim a genuine sense of satisfaction. Teachers clearly liked structure within the teaching of mathematics. Number, operations and algorithms were the safe areas as most felt comfortable with teaching these areas. There was no mention of teacher enjoyment of mathematical challenge. All expressed some level of reservation in primary mathematics, although the only teacher with anything other than basic training claimed to enjoy teaching it. Teacher E said that it was most enjoyable when all students were "thinking along the desired lines" (see Appendix 10, p. 291) which supported the group's closed dichotomous viewpoint. That was confirmed through observations of the class as they worked out of the structured text which drove their particular program.

Not surprisingly, the topics enjoyed by the teachers within their programs correlated strongly with claimed areas of strength, with assessment showing marked deviation. Only one enjoyed assessing. This was a concern, considering the range of learning indicators that can be generated through assessment and the now-recognised need to embed assessment into programs early as a planning key (QSA, 2004a; SADETE, 2001). It may have been an indication that assessment may have been viewed as simply serving a mandated summative purpose and that it bore only loose links to learning with no enjoyment involved. Alternatively, the constructive nature and inherent value of assessment may not have been understood.

The above points were important because they generated thoughts and questions regarding possible difficulties in bringing about a change in teacher mind-set and pedagogical approaches. Time spent in exploring learning theories and current pedagogical trends was seen as an imperative in facilitating change and that professional development is discussed in Chapter Five.

Classroom Observations

In order to provide teachers with supportive feedback related to the development and implementation of suitable process-oriented tasks, observations to be undertaken by me were planned at various stages of the study. Observation schedules noted time splits between instruction and learning practice as well as forms of classroom interaction such as questioning and assessment. As teachers tended to rearrange their rooms for different activities, arrangements variations were illustrated in observation schedules to complete the interactive ‘picture’ for subsequent joint reflection. Assessment practicalities were shown, as was how teachers went about implementing concepts that were new to both them and their students. Observations were aimed to provide teachers with non-judgemental feedback as to the creation of an environment conducive to the revised approach to the teaching and assessment of mathematics.

In planning for observation sessions the particular teacher involved and I would meet to discuss learning environments, topics, formats and tasks. Key to the procedures was the agreed purposes of the observations and that in turn determined the form of notes made by me. The notes were given to and discussed with the observed teacher as a form of learning tool. Judgements as to lesson effectiveness were left to the teacher, not made by me, but discussed subsequently as part of the reflective learning process. As the observer, my prime purpose was to ascertain the blend of methodology and assessment with respect to what teachers had stated in questionnaires, interviews and conversations. My view of classroom micro-reality was then offered in discussions, cooperative planning and introduction of the portfolio model, tasks and assessment.

Structure and Purpose of Assessment

In further distinguishing the second study referent, data gathered from teachers revealed three broad bands of thought about the purpose of assessment, with respondents listing a number of purposes under each band. Given equal weighting were, to inform practice, to ascertain problem-solving abilities and to measure levels of competency. Early interviews and discussions revealed that whilst it was claimed that assessment was used to inform teaching, it was used in a summative, reviewing way, not to inform and modify teaching progressively in a true formative fashion. Summative assessment purposes dominated markedly. However, the teacher focus group showed a strong general desire to develop an assessment repertoire in which formative assessment was embedded, adding yet further impetus to the need for assessment change. Through their willingness to take part in the change tracked by this study and their constructive responses to questions asked they had indicated a desire to broaden their teaching and assessment skills.

Responses to questions about assessment formats used within the year levels were mixed. Interviews, questionnaires and observations revealed that when assessing, all teachers concentrated on whole class assessment. Table 4.2 overleaf illustrates the assessment formats utilised. In Table 4.2, it can be seen that all teachers assigned knowledge recall through testing the highest weighting. All testing was summative and norm-referenced of the form illustrated by the class test example in Appendix 11.

Ratios of written testing to oral questioning varied from 4:1 in Teacher E’s classroom to almost 3:2 in Teacher D’s. Informal oral questioning ranked second on a cumulative basis but received less than half of the emphasis of written testing. Substantial mathematical application tasks received only minor attention and then only in Teacher D’s classroom.

Table 4.2: **Assessment Formats Used by Teacher Focus Group at Start of Study**

Breakdown of Assessment Formats (nearest 10%)							
Teacher	Application Tasks/ Projects	**Questions**		**Tests**			Total
		Informal	Formal	Mentals	Number facts	Topic testing	
A	0	20	10	10	10	50	100
B	0	20	10	20	10	40	100
C	0	20	10	10	10	50	100
D	10	20	10	10	10	40	100
E	0	10	10	10	10	60	100

Sources: Teacher surveys, interviews and classroom observations

Within the formats used, an assertion based on my classroom observations that within the assessment structures very few open-ended questions were offered to students in assessment activities is supported by Table 4.3. Classroom observation showed that closed oral questions were aimed at eliciting short, closed responses.

Table 4.3: **Question and Assessment Types and Formats**

Types and formats of questions and assessments (nearest 10%)								
	Question type		**Question format**				**Assessment type**	
Teacher	Open-ended	Closed	Numerical		Word		Formative	Summative
			S/R	M/C	S/R	M/C		
A	0	100	90	0	10	0	0	100
B	20	80	60	10	30	0	20	80
C	10	90	80	10	10	0	10	90
D	10	90	90	0	10	0	10	90
E	10	90	50	0	50	0	10	90

S/R: Short response problems M/C: Multi-choice Source: Classroom observations

Within the assessment forms, word problems requiring mathematical interpretation followed by skill application received varying degrees of attention. Levels of use varied from minor, with a ratio of 1:20 word problems to numerical problems, through to very high, with a ratio of 1:1. Table 4.3 shows that by far the majority of those questions were closed seeking the one correct answer. Generally, the teachers saw mathematics as a set of knowledge and skills to be learned and recalled upon demand to provide a specific solution to a given problem. Assessment was an activity supplying summative data, not an embedded part of the actual learning process. Data such as that displayed in Tables 4.2 and 4.3 further highlighted the limited value in current assessment formats. The spotlight was clearly focused on the need for assessment to assume a dynamic, instructionally more informative role.

Monitoring the Development Process

Data derived from the first questionnaire and interviews generated a number of questions and assertions in establishing an initial ‘base-line’ of participant perceptions and understandings regarding the teaching and assessment of mathematics. During subsequent teacher focus group development, a number of issues needed to be addressed, including teachers’ problems regarding the format and validity of various assessment forms. It was clear that a great deal of pedagogical change was needed if the teacher focus group was to implement open-ended, criteria-based process portfolio assessment as a major facet of assessment. Of particular importance within that change would be teacher perceptions of balanced assessment which was of genuine use to all stakeholders. Other considerations involved relevant professional development regarding process portfolio design and implementation, the resources and support that would be required in this particular situation and how best to monitor the course of the development.

As part of the monitoring structure, it was considered prudent to ensure that the teacher focus group was kept aware of the nature of their evolving theoretical knowledge, interpretations, perceptions and professional growth. Interviews and discussion situations in particular, questionnaires a little less so, were designed to foster reflection, a practice of acknowledged importance in teacher development (Ellsworth, 2002; Friel, 1992). It was seen as beneficial to ensure that those views were shared across the group, along with the emerging areas of interest and strength peculiar to each member of the group. The sharing of many thoughts during group discussions, revealed without ascription and in a manner that strengthened group cohesion, achieved those goals. However, it should be noted that teachers frequently claimed ownership of such perceptions and comments as they shared leadership in expanding and extrapolating their developing thoughts with the group.

Additional comments offered in both questionnaires and interviews were telling. Comments such as Teacher B’s, “I feel quite lost when it comes to teaching maths”, “I find it hard to deal with the 'boxes' created by the syllabus" (see Appendix 12, p. 297) and that she thought her teaching was right but not the assessment, needed to be borne in mind when designing teacher professional development on portfolio implementation.

Teacher Focus Group Meetings

Teacher focus group meetings were held weekly throughout the first semester of the study. They generally had a major focus as a starting point and were a forum for discussion of all facets of the portfolio development process. With the permission of the group, notes were made of meetings thereby facilitating reference to previous discussion points and documentary tracking of the study.

From the outset it was clear that four members had little knowledge of what the process portfolio entailed. The fifth had an early understanding but as with the others had only used product portfolios. All indicated a desire to learn all they could about the alternative format. To that end, discussion of materials in the Teacher Starter Kit and ensuing ideas followed. It was apparent that teachers needed to read appropriate literature and group meetings needed to offer opportunities for presentations and discussions. Joint planning needed to be encouraged and guided if the culture was to change and see a relevant process portfolio structure developed and adopted successfully.

Planning needed to centre first on helping teachers shift from what was the main focus of primary mathematics according to the group, dichotomous operational number. The tasks and problems undertaken by students as part of working with process portfolios had to embrace all aspects of mathematics, so teachers needed to expand their emphases within the subject. The group acknowledged that in creating 'new' tasks the dichotomous mathematical perception presented problems for teachers and learners. Members knew that their perceptions needed to change but realised that in the practicalities of their classrooms change would not be a simple matter, nor would the creation of open-ended tasks that offered challenge to students of all abilities.

However, despite those major concerns, small but noticeable change began almost immediately in some classrooms. The second focus group meeting heard one teacher share the concepts and outcomes of a lesson taught the previous day and of 'AHA!' moments for students as they explored a question then wrote about how they reached their conclusions, their first written reflection. The writing concept was derived from previously distributed articles by Brown (1997) and Albert and Antos (2000). The meeting heard teachers talking of getting away from the old thinking regarding timeframes in mathematics work and that children need to be taught that questioning anything in maths is acceptable, necessary for genuine understanding. Already, teacher focus group members were readily expressing their evolving views. A decrease in apprehension was apparent with a counter increase in professional excitement as the very early practical stages of development and implementation began, deeply engaging the group in the process.

Subsequent meetings played parts in formulating survey instruments, discussion of results, sharing classroom experiences, as well as addressing and satisfying group professional development needs. From the initial rapid movement, the level of change taking place saw highs and lows reflecting marked variations of conceptual development across the group members. Early in the second school term of the transition, three of the five were still experiencing difficulty in visualising the ‘look’ of the process portfolio and how it would fit into their classroom teaching, learning and assessment structures. Comments during teacher focus group meetings indicated that for some, aspects of the concept and the change involved appeared overwhelming. Fruitful actions initiated by me in support of these teachers included the setting of small, incremental weekly goals by each member, an increase in the amount of time I gave to members by way of joint planning and interaction, as well as short presentations on any of a multitude of points as they arose during the semester.

Through the remainder of first semester the group began to discuss portfolio planning in greater depth, with a great deal of discussion centring on an emerging basic structure and the gaining of skills in writing and implementing open-ended tasks. Members also participated in further professional development seminars and experiences.

As a result of a group review of their first semester experiences, accomplishments and emerging needs, weekly meetings were discontinued, with future meetings held on an as-needed basis. Review, planning and goal setting conversations between group members were seen as preferable. Through formal and informal frequent interaction in and out of classrooms I traced the developmental path of the teacher focus group as together we uncovered the problems in changing to process portfolios in mathematics.

Teacher Focus Group Reflections

After reading relevant literature, it was agreed by the teacher focus group that an important part of learning for adult and child alike is developing the ability to reflect upon learning experiences. Reflection was seen as a key in constructing knowledge by working through personal zones of proximal development (Vygotsky, 1978). Through the focus group meetings teachers were asked to reflect frequently and share their thoughts. Additionally, at times for the purpose of the study, they were asked to commit their reflections to paper.

Two written reflections had been completed at the close of the first semester of the study. From those thoughts assertions were quoted, amongst which the most pressing at that stage were:

> *As with all planning and learning, there's a need to set goals within the group's portfolio development agenda*. (Teacher E: Appendix 13, p. 298)
>
> *Teachers approach teaching mathematics differently.* (Teacher A: Appendix 13, p. 299)
>
> *It is not uncommon for teachers to feel lost teaching mathematics.*
> (Teacher B: Appendix 13, p.300)
>
> *… there's a need to understand more about how others teach it and for useful professional development.* (Teacher C: Appendix 13, p.300)
>
> *It is hard to develop the process portfolio approach in maths without exposure to models to help our planning and doing*. (Teacher D: Appendix 13, p. 301)

Several of the assertions were addressed by the group immediately. It was seen that both the 'lost' feeling and the need to understand each other's pedagogical approaches could be overcome by opportunities to work with other group members in their classrooms. This was facilitated by me varying my part in timetabled classroom interactions by teaching focus group members' classes. Released teachers were then able to spend time in colleague's classrooms as participant observers.

Planning subsequent to the revelation of the teacher assertions saw a number of goals set, with particular emphasis placed upon the development of early schematic models that could be tested through the emerging components of the portfolio. The remainder of this chapter describes the development processes in relation to the problems that the schematic models were designed to solve. The problems emerged from teacher assertions made through the questionnaires, interviews and focus group discussions. As with many mathematically challenging tasks, the problems were open-ended. They required of the focus group higher order thinking similar to that which they sought to encourage in students. Thinking stimuli such as de Bono's 'Six Thinking Hats' and CoRT Thinking (de Bono, 1992 & 1994) were integrated into the development process. Through such action the focus group derived plausible solutions that satisfied each problem's current context.

First Working Hypothesis Considered

The first of the working hypotheses for this chapter stated that considerable time would be required to draw together the wide views of the teacher focus group regarding the nature and purpose of assessment. Early work with the focus group revealed that while the views were certainly wide across a disparate group of teachers, the hypothesis was not strongly supported. The wide range of ages and personal styles across the group was not reflected clearly through a similarly wide range of pedagogies. Age was not necessarily reflective of teaching methodology. A common strong thread of the implementation of behaviourist learning theory informed by summative assessment was evident through the range of data collected. This meant considerable time was spent, not on drawing the different views together but in encouraging the understanding and utilisation of social constructivist approaches to teaching and learning, with emphasis on appropriate assessment techniques.

PROCESS PORTFOLIO DEVELOPMENT

Planning the Structure of the Process Portfolio

The process portfolio was to focus on students' productive work. Unlike standardised, mass assessment it was to measure what students *could do* rather than what they could not, which is, of course, a primary principle of assessment (Mumme, 1990). Such assessment provides evidence of understanding and accomplishment. Romberg (1995, p. 161) claimed that a "portfolio offers the potential of providing more authentic information than other formats about a student's mathematical endeavours." The process portfolio is recognised as a formative evaluation tool, highly useful in providing planning information for future learning and growth (Shaklee, Barbour, Ambrose & Hansford, 1997). Counter to established traditional practices, portfolios offer freedom, are open and need not be tightly structured (De Lange, 1995).

In relation to the above, the teacher focus group had little preconception as to what constituted a best practice model of a process portfolio that would suit the school involved in the study, or similar primary schools. The central thread that emerged during a great deal of discussion in focus group meetings was simply that the portfolio had to provide evidence and 'tell the full story' as to how students moved through the various stages of completing a task or solving a problem. Group members were aware that development of the concept would require a significant commitment of time and effort, at least initially, as Romberg (1995) had warned. No rigid developmental time line was set as the teachers acknowledged that designing the portfolio was likely to be a lengthy process. However, it was seen as preferable that planning be pragmatic and that at the very least in the short term it produce components of a portfolio structure with which teachers could begin to experiment in their classrooms.

An Emergent Process Portfolio Model

As this was a study based on an aspect of mathematics and the resultant portfolio components emerged as a result of exploration of problems posed, the discussion now adopts a mathematical structure. Assertions, which were generally made by the teacher focus group, led to problems and the evolution of possible solutions. Several teacher assertions, problem clarifications and solutions are presented in terms of:

- a process portfolio model;
- syllabus elaborations;
- learning outcomes;
- assessment tasks;
- rubrics; and
- student reflections, where applicable.

The approach utilised just one of a range of sound problem solving strategies offered to students by teachers when teaching problem solving techniques. It also clearly reflected the processes which were found to lie within a functional process portfolio model.

Teacher assertion: *"There are problems trying to go away from the showcase portfolio – I'm used to it and it sits in the back of my mind, so I keep thinking of the final product, not the process."* (Teacher D: Appendix 14, p. 304)

Problem: In line with the earlier teacher assertion as to the need for models, to clarify the concept the group sought a schematic model of the process portfolio itself upon which they could focus detailed planning of the portfolio's components.

Solution: In planning a suitable process portfolio structure and its implementation, the group was mindful of many factors such as the four major purposes of assessment outlined by Shepard, Kagan and Wurtz (1998). They agreed that it was important that the structure supported learning, identified particular student needs, evaluated the program and monitored trends while providing appropriate high stakes accountability. The group also took into account what Busatto (2004) saw as pedagogically important. Busatto stressed the need for collaborative planning amongst teachers as it encourages and provides opportunities for innovative teaching. Open-ended questioning, an approach not apparent within the group's assessment practice at the time, was also acknowledged as important. Fostering student discussion during lessons to facilitate their engagement and understanding of concepts became an imperative for the teachers. In line with Busatto's (2004) thoughts on assessment in general, the list continued with the need to cater for individual student needs through consistent yet varied assessment through differentiated teaching, together with a general overall commitment to consistent approaches to mathematics.

According to Shaklee, Barbour, Ambrose and Hansford (1997), in the interests of portfolio consistency three main factors should guide portfolio design and the general guidelines are applicable across all portfolio forms. Consequently, the teacher focus group defined the portfolio's purpose as 'telling the student skill growth narrative' and resolved that task assessment criteria would be written to indicate student progress towards set goals. The group also considered the "How?", "What?", "How much?", and "How to make sense of?" questions of assessment in relation to the evidence to be collected. Barton and Collins (1997) advised that evidence could be widely varied according to the task and might include artefacts, productions and reproductions. The focus group considered many ways in which the skill growth narrative could be recorded. It was agreed that the key to the collection of evidence was that each item added new information about the movement towards the attainment of student goals.

Many of the key characteristics that Shaklee, Barbour, Ambrose, and Hansford (1997) and Ferrara (1996) applied to quality portfolios were embraced by the focus group. Performance tasks were to:

- have explicitly defined purposes and goals;
- be authentic, clearly aligned with the program;
- require multiple operations to be pinpointed;
- encourage the demonstration of different stages of mastery;
- offer students choices within tasks as to materials and response modes;
- lend a sense of integrated ownership through a clear correspondence between tasks and life experiences; and
- enhance student ownership through involving students in aspects of task creation and assessment.

Over time, the multi-purposed portfolio would comment on the mathematics program and be sensitive to and reflective of expanding student understanding and achievement.

Sensitivity needed to extend through the task and possible responses into the assessment. Feedback through assessment needed to highlight aspects of high level performance along with gaps and avenues for possible further growth. Such breadth was important as it was acknowledged that feedback shapes expectations. The teacher focus group came to realise that such broad feedback was an ideal hybrid and would require considerable time, at least initially, in planning suitable application tasks and styles of assessment for those tasks.

From the planning discussions the early portfolio model emerged, as shown in Figure 4.1 overleaf. The schematic model acknowledged that all must stem from the syllabus. From the syllabus elaborations and learning outcome statements were derived. Appropriate learning tasks followed, as did task assessment and reporting of student achievement. As a result, each student’s portfolio displayed classroom material relevant to communicating each student’s ‘learning narrative’.

Assessment rubrics were then created, based on the syllabus elaborations, learning outcomes sought and tasks. Both tasks and assessment rubrics were introduced and discussed with students simultaneously so as to create a detailed ‘picture’ of what was required. Students then completed the work. Students considered their work through using one of a growing number of task-specific guided reflection formats. Teachers recorded their assessment through the rubric. For the purpose of reporting to stakeholders, teachers ensured that their assessments aligned with the learning outcomes. The completed tasks, teacher assessments and student reflections formed the process portfolio.

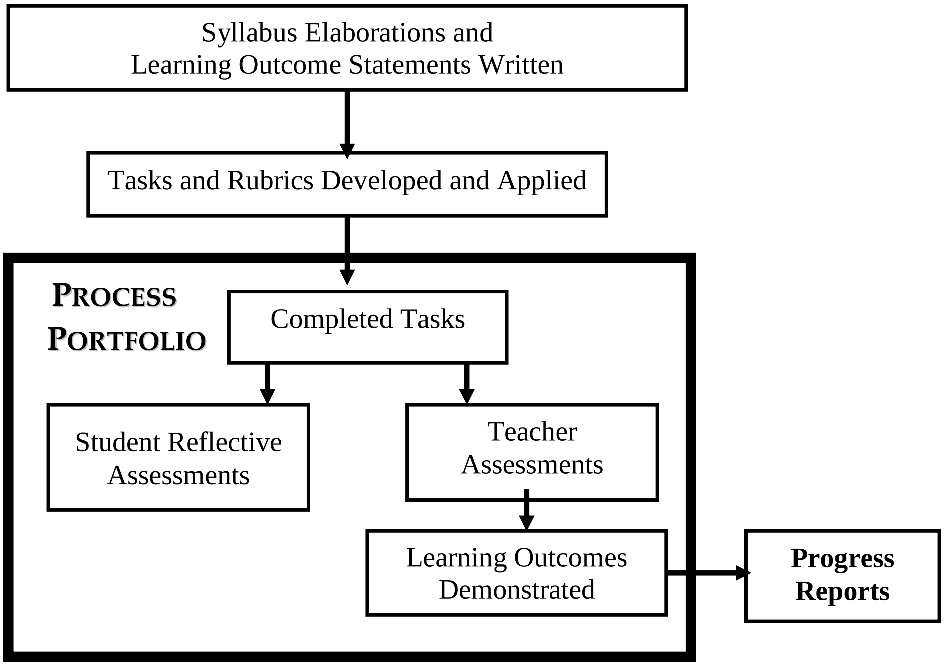


Figure 4.1: ***Early Mathematics Process Portfolio***

Detailed explanation of the components of the early process portfolio model, excluding reporting, will prove useful at this stage. As reporting was addressed in greater detail later in the developmental process, it will be discussed along with subsequent process portfolio improvements in Chapter Five.

Syllabus Elaborations

Syllabi contain a multitude of points regarding what should be taught within any given teaching and learning program. To implement the contents of such lengthy documents, teachers need to distil them into manageable, working portions. Therefore, from each of the mathematics strands in the syllabus, teacher focus group members derived succinct syllabus elaborations in relation to the concepts to be taught, see Figure 4.2.

Teacher assertion: *"I first get my content from syllabus elaborations. We all need to be working with them so that we're all moving in the same direction."*
(Teacher B: Appendix 10, p. 289)

Problem: In the outcomes-based assessment and reporting system in place in the school, all teachers needed to use similar forms of current syllabus elaborations as the basis for learning outcomes or goals. In order to establish effective programs while efficiently addressing accountability to all stakeholders, an effective and efficient number of concise elaborations and learning outcomes needed to be distilled from the syllabus.

Solution: Core content is specified in the recently released P-10 syllabus, as available from the Queensland Studies Authority (QSA, 2004a). The new syllabus aligned closely with that of the school. It provided syllabus elaborations that gave teachers broad overviews of applicable mathematical concepts across the levels. Figure 4.2 illustrates several examples of elaborations for Number, Level 3.

Syllabus Elaborations	
N 3.1 Number concepts	Understand and use patterns of whole numbers to 9999
	Understand and use patterns of common and decimal fractions
	Understand and use place value of each digit within a whole number and decimal fraction
	Apply conventions for reading, recording and rounding dollars and cents
N 3.2 Addition and subtraction	Demonstrate strategies for subtraction
	Implement strategies for addition
	Utilise addition and related subtraction facts
	Use the inverse relationship between addition and subtraction to solve problems
	Solve addition and subtraction problems (mental and computation) involving whole numbers
N 3.3 Multiplication & division	Recall or work out multiplication facts to X9
	Recall or work out division facts
	Connect multiplication and division
	Solve multiplication and division problems (mental and computation) involving whole numbers
	Represent multiplication and division problems

Learning Outcome Statements	
N3.1	Compare, order and represent whole numbers to 9 999 and common and decimal fractions, and calculate cash transactions.
N3.2	Identify and solve addition and subtraction problems involving whole numbers, selecting from a range of computation methods, strategies and known number facts.
N3.3	Identify and solve multiplication and division problems involving whole numbers selecting from a range of computation methods, strategies and known number facts.

Figure 4.2: ***Topic Cover Sheet for Number*** (based on QSA, 2004a)

The teachers resolved to examine the elaborations for each level in the syllabus. That revealed that some elaborations were implied by others and some were designed to give students early exposure to concepts and procedures. It was important to realise that elaborations implied the outcome and were therefore flexible and open to interpretation. The teacher focus group spent some time discussing the concepts and realities implied by the syllabus and then distilling elaborations prior to formulating learning outcomes. Within the emerging process portfolio model, outcomes were of high importance as they had roles in both the early and final steps in relation to teaching and learning and student achievement.

Student Learning Outcome Statements

An important function in the designing down concept is teachers establishing learning outcomes, those things that students should understand and be able to apply at the conclusion of well-designed learning activities. Those learning outcomes are derived from the newly distilled syllabus elaborations.

Teacher assertion: *"The whole point of the process is to promote learning, to get the desired outcomes. I now realise that outcomes are more than things you just measure in a test. It seems that maths tests defeat the purpose of portfolio assessment. At the end of the unit I should be able to give a full assessment of a student's capabilities from his work in his portfolio. You should not need to do an isolated test."*
(Teacher B: Appendix 14, p. 305)

Problem: Teachers needed the skills to generate an effective, efficient number of outcomes from the syllabus elaborations. The outcomes must inform all stakeholders, both formatively and summatively, while contributing to the overall 'richness' of the process portfolio package, which in turn informs the reporting process.

Solution: As O'Neil (1994) related, unfortunately, a great deal of controversy has surrounded the discussion on the use of learning outcomes as the basis for judging success levels in education. Much of the criticism has claimed that teachers had a propensity to focus on lower-order thought through behaviourist methodology and it was possible for students to get through the education system without acquiring necessary basic knowledge and skills. The teacher focus group became aware of such criticism and so set about ensuring that outcomes and assessments pursued genuine academic rigor while fostering student engagement, learning and growth across all levels.

Within the syllabus elaborations for each level, each strand required clearly identified core learning outcome statements. With the teacher focus group having delineated core learning outcomes for each of their year levels, the outcomes were placed into the table below the syllabus elaborations that led to their formulation, generating a cohesive statement of purpose (see Figure 4.2). The tabular structure became a major component in the planning of assessment and accountability within the process portfolio.

Figure 4.2 shows that for Number Level 3 one learning outcome related to knowledge and skills with numbers up to ten thousand has been distilled from the four syllabus elaborations. Once elaborations and outcomes were established, Topic Cover Sheets were prepared. For this particular process portfolio structure, Figure 4.2 is the Topic Cover Sheet for Number, Level 3. The figure illustrates the manner in which all learning outcome statements must be supported by syllabus elaborations.

Assessment Tasks

A big difference in a shift from traditional testing to assessment through the application of knowledge and skills as in the process portfolio lay in the nature and structure of the assessment tasks. Problem solving needed to receive revised emphasis, to become an integral part of *all* facets of the mathematics program. It also needed to adopt a much more open approach to problem or task creation, divergent from the traditional dichotomous structure of problems. Prior to the change, problem solving had been treated as a separate facet of the syllabus, done only at a stipulated, scheduled time. All aspects of the change presented large obstacles for the teacher focus group, all of whom had been using a traditional ‘closed’ approach to teaching and assessing mathematics until the study began.

Teacher assertions: *“We need to come up with some sort of plan or structure to follow in writing problems or tasks, just as a start.”* (Teacher D: Appendix 14, p. 304)
“Mathematics is the hardest subject to integrate into other areas. There is a danger that it could become pointless when integrated.” (Teacher B: Appendix 14, p. 302)

Problem: Initially, a schematic model to be used as a guide in developing a task or problem was needed to satisfy the group's need for a structure through which to facilitate what represented mammoth pedagogical change. Could the model assist in the generation of problems or tasks that could be integrated across many topics? Could such a model assist teachers assimilate the new assessment style more easily and remain open to further enhancement through student input later?

Solution: The teacher focus group recognised that problem-based mathematics places mathematics 'in context' for all involved. It was clear that in order to cater for differing student abilities, tasks of optimal quality would require various levels of student thought (Bloom, 1956), encourage the use of the various intelligences (Gardner, 1993) and occasionally embrace useful thought stimulators such as de Bono's thinking hats (de Bono, 1992) and CoRT Thinking (de Bono, 1994). If tasks were to genuinely cater for a wide range of student strengths and abilities they needed to provide multiple entry and exit points. The group's previously summative, closed stance with assessment utilising the one-test-suits-all method of measurement meant that developing and implementing a revised approach was a complex undertaking.

The revised tasks needed to assess a variety of cognitive processes such as understanding and representing problems, discerning mathematical relationships and organising information. They also needed to encourage the use and discovery of various solution strategies, the formulation of conjectures, evaluation of the rationality of answers, generalisation of results, and the justification of solutions (Parke et al., 2003). The use of standard terminology was important in preparing young students for later demands. That meant that Bloom's (1956) terms, such as 'synthesise' and 'evaluate' had to be used alongside the Queensland Core Skills Test 'question stems', such as 'interpret', 'recall' and 'compile' (QSA, 2005). In essence, tasks had to be written to reflect the three inter-related components of the conceptual framework of mathematics assessment, conceptual and procedural knowledge, strategic knowledge and the ability to communicate mathematically.

As a result, early planning by the teacher focus group viewed task formulation in the manner illustrated in Figure 4.3 overleaf. Teachers wrote tasks to be completed by students with the product assessed by both teachers and students. Students wrote guided reflections on their work while teachers completed the task-specific rubric. Later planning and implementation, discussed in Chapter Five, saw components, including the task, undergo marked expansion and considerable improvement as student were empowered and their influence was brought to bear on all facets of the emerging assessment process.

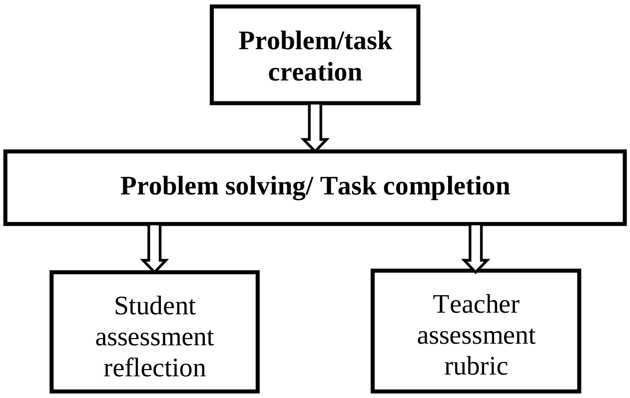


Figure 4.3: ***Problem/Task Creation and Completion***

Assessment Rubrics

If assessment is to be genuinely formative, from the outset all involved must be aware of and understand the criteria that is to be applied in judging the work. During the course of the study, expanding teacher facility with the rubric saw it emerge as a most effective device in the communication of judgement criteria.

Teacher assertion: "*While we have discussed using rubrics in assessing information gathered, we need to work out how to use the rubric in designing future teaching and learning programs that incorporate problem solving and make sure course work is covered while designing developmental learning experiences.*"
(Teacher E: Appendix 13, p. 300)

Problem: Early reading convinced the teacher focus group that because of its powerful communication role the rubric was central to teaching, learning and formative assessment within a process portfolio. The teacher focus group needed to understand the rubric and formulate a functional rubric format, or formats, with which they were prepared to work.

Solution: Within education, the term 'rubric' has come to mean a matrix, grid or table that carries assessment criteria against which the quality of students' work is judged. It is a key feature distinguishing criterion-referenced assessment from the traditional comparative norm-referenced forms (Glaser, 1963). From the beginning of a task it provides information about the judgement criteria to be applied on completion. After assessment, it provides indications as to what students can do, or have done in relation to levels of application, knowledge or skills that they demonstrate in an observable and measurable way.

As a result, the focus group agreed that in designing rubrics a number of guidelines should be followed. The language used needed to be meaningful to students. In more complex rubrics, without offering explicit clues about how to execute the task or solve the problem, expectations of students needed to be communicated clearly. At the same time, statements that were overly directive defeated the point of open-ended problems. Explanations, the quality and nature of diagrams, and labelling would help where appropriate. At the high end of performance, evidence of students' ability to explore transferability and generalisation was sought. Uppermost, teachers jointly worked to reach agreement regarding judgement criteria across the rubric; not a simple task for teachers just coming to terms with the multiple practicalities within the concepts of process portfolios and rubric assessment criteria.

Initially, in response to the design challenge, to offer variety to teachers and students two styles of rubric were developed. The first was a simple form of parallel assessment as shown in Figure 4.4 overleaf. It reinforced the links between teacher and student judgements. The simplicity was seen as a means of having teachers and students engage early and easily in the new concepts of self-assessment and guided reflection.

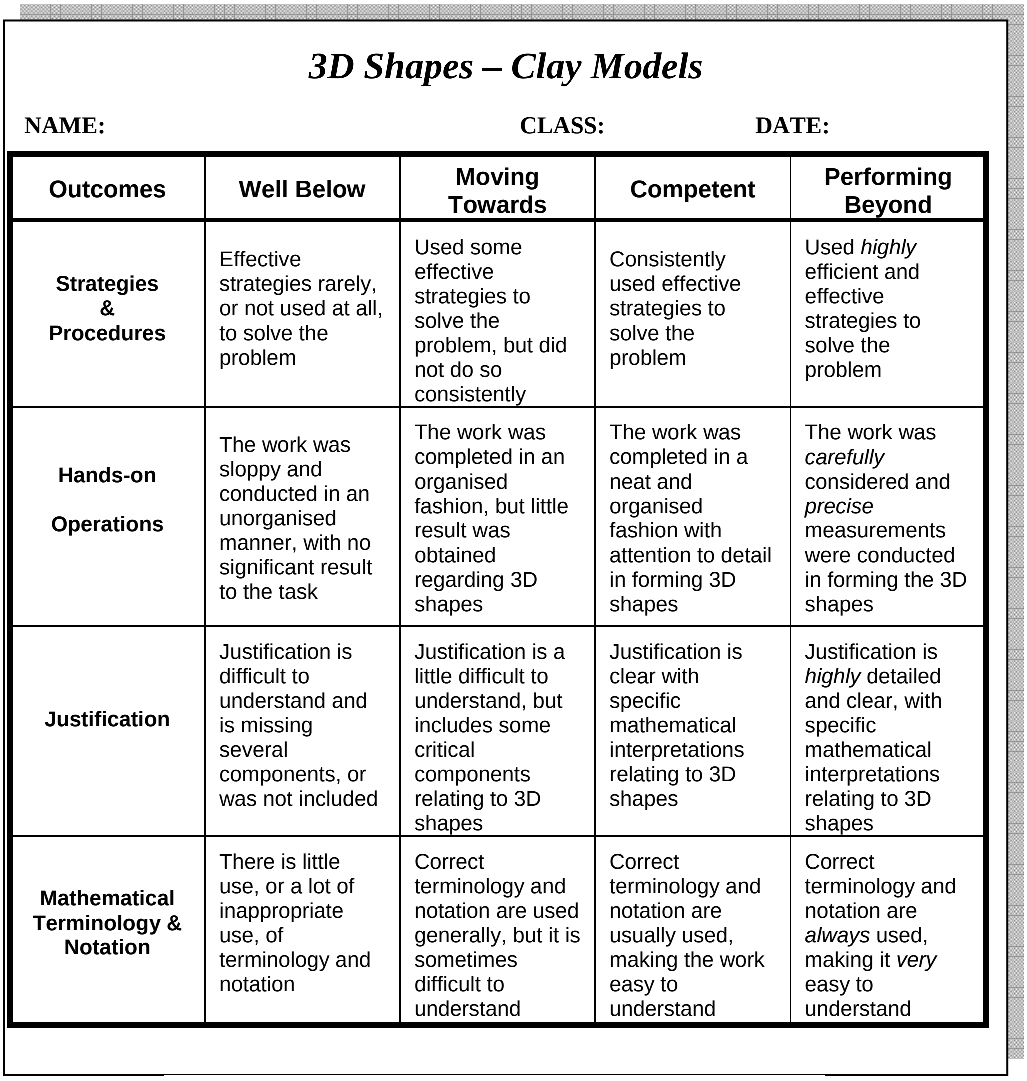
As the change progressed, teachers became more adept with the rubric assessment format. Familiarity and confidence saw the complexity of rubrics increase. This meant that the range of available rubric formats expanded, which in turn offered increased flexibility across possible forms of feedback supplied by the teacher focus group to their students.

Topic:		**Date:**		
Name	*Self-Assessment*		*Teacher-Assessment*	
______________________________	**Always**	**I must keep trying**	**Always**	**Keep trying**
Skill: Self Control				
Listens attentively				
Follows directions				
Works quietly				
Skill: Staying on task				
Is not easily distracted				
Uses time wisely				
Perseveres with task				
Skill: Solving the problem/s				
Reads the task sheet carefully				
Interprets the task/s correctly				
Follows written instructions well				
Explains outcomes well				
Checks work carefully				
Presents neat work				

Figure 4.4: ***Simple Parallel-Assessment Rubric***

As part of the expansion of the range of rubrics, a second, more involved, heavily word-based format was developed. Appropriately worded for the different levels taught, it was applied to more complex tasks. Four levels of judgement, as displayed in the example in Figure 4.5 overleaf, were taken from the school’s current reporting format. Whilst innovation was apparent and important, it was of equal importance to ensure that criteria-based rubrics used appropriate language in retaining the ‘user-friendly’ relevance of the earlier simple parallel rubric.

The criteria-referenced rubric was critical to a constructive alignment between learning and assessment through the teaching process. The word-rich style used by the teacher focus group strongly promoted learning over the view which sees assessment designed simply to evaluate and assign a grade. Because it allowed students to refer to the assessment criteria constantly, the rubric served a dual purpose; it was used during tasks in a formative manner and upon completion as part of the final assessment. Used as the teacher focus group planned, as an integral part of the complete learning experience, it promoted student engagement, making assessment look less like testing and more like teaching.



3D Shapes – Clay Models

NAME: **CLASS:** **DATE:**

Outcomes	**Well Below**	**Moving Towards**	**Competent**	**Performing Beyond**
Strategies & Procedures	Effective strategies rarely, or not used at all, to solve the problem	Used some effective strategies to solve the problem, but did not do so consistently	Consistently used effective strategies to solve the problem	Used *highly* efficient and effective strategies to solve the problem
Hands-on Operations	The work was sloppy and conducted in an unorganised manner, with no significant result to the task	The work was completed in an organised fashion, but little result was obtained regarding 3D shapes	The work was completed in a neat and organised fashion with attention to detail in forming 3D shapes	The work was *carefully* considered and *precise* measurements were conducted in forming the 3D shapes
Justification	Justification is difficult to understand and is missing several components, or was not included	Justification is a little difficult to understand, but includes some critical components relating to 3D shapes	Justification is clear with specific mathematical interpretations relating to 3D shapes	Justification is *highly* detailed and clear, with specific mathematical interpretations relating to 3D shapes
Mathematical Terminology & Notation	There is little use, or a lot of inappropriate use, of terminology and notation	Correct terminology and notation are used generally, but it is sometimes difficult to understand	Correct terminology and notation are usually used, making the work easy to understand	Correct terminology and notation are *always* used, making it *very* easy to understand

Figure 4.5: ***A Complex Rubric***

Student Reflections

Teacher assertion: *"I tried a written reflection of a group activity centred around the question of maths being fun. I was disappointed initially in the shallow responses. There's a need to teach students how to reflect and write about the process that they have followed."* (Teacher D: see Appendix 14, p. 303)

Problem: Whilst early reading of literature by researchers such as Costa and Kallick (2000) showed the teacher focus group the inherent learning power in reflection, students needed much more than a few casual words of guidance in reflecting on experiences. In order to assist teacher confidence, one or more formats needed to be devised that teachers could use to guide both themselves and their students in developing their reflective skills.

Solution: Reflection is the act of considering what one has done in relation to either one's own standards and principles or those of another. In the process portfolio structured by the teacher focus group student reflections as to the quality of their work could be made either formally or informally. Whatever form reflection took, it was meant to be personally constructive in relation to conceptual and procedural learning, that is, formative.

Rolheiser (1998) stated that assessment should be ongoing with techniques allowing both process and product to be assessed, with student input into the process regarding both their own work and that of their peers seen as essential. Student self-evaluation based on pre-communicated guidelines, as in the rubrics in Figures 4.4 and 4.5, was seen by the teacher focus group as promoting ownership of the learning and a sense of responsibility. According to Rolheiser (1998) the impact of reflection on student achievement, as in the process illustrated in Figure 4.6, generates a great deal of constructive comment, and even more so if students are guided in reflective techniques.

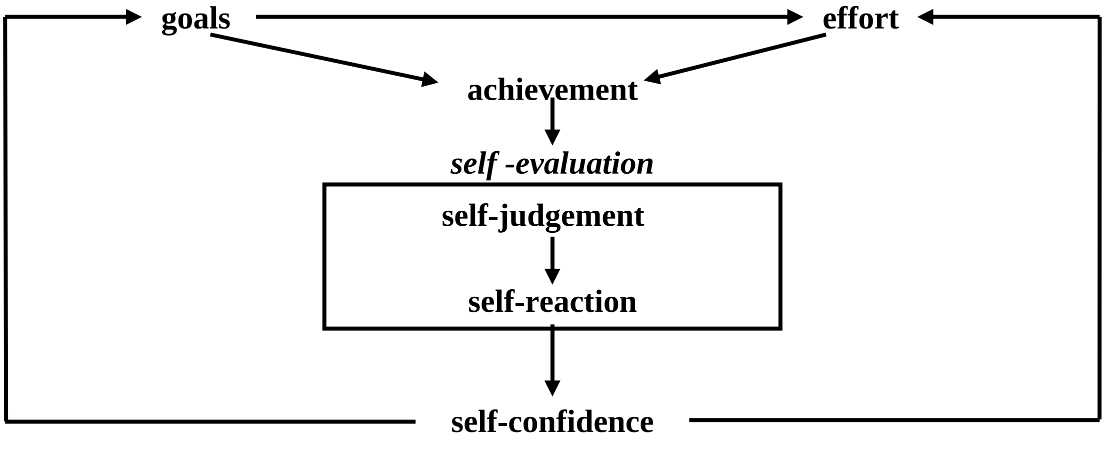
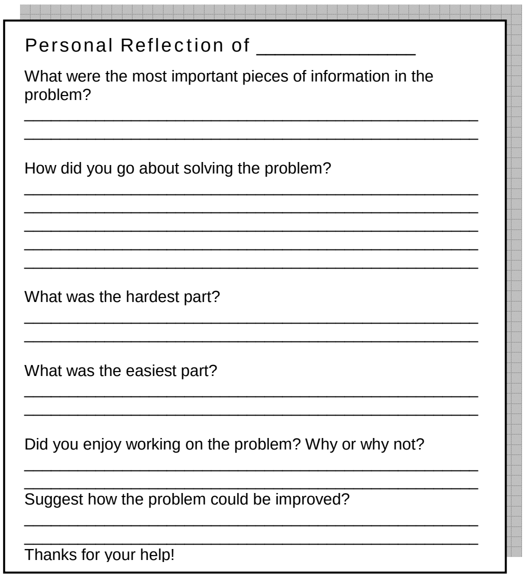


Figure 4.6: ***Reflection/Self-Evaluation's Contribution to Learning*** (Rolheiser, 1998)

The figure illustrates how goals are set to lead students toward effort and achievement. The achievement is self-evaluated which leads to the building of self-confidence and in turn sees yet higher goals set and greater effort expended. The potential learner growth cycle is clearly evident.

As a result, discussion with the teacher focus group affirmed that reflection had a great deal of potential in the learning process. Teachers had engaged in a great deal of guided reflecting upon their own learning to reach this point. With reflection having so much to offer for all concerned, the teacher focus group made it an integral part of the process portfolio through the design of a variety of instruments such those shown in Figure 4.7.



Personal Reflection of ______________

What were the most important pieces of information in the problem?

How did you go about solving the problem?

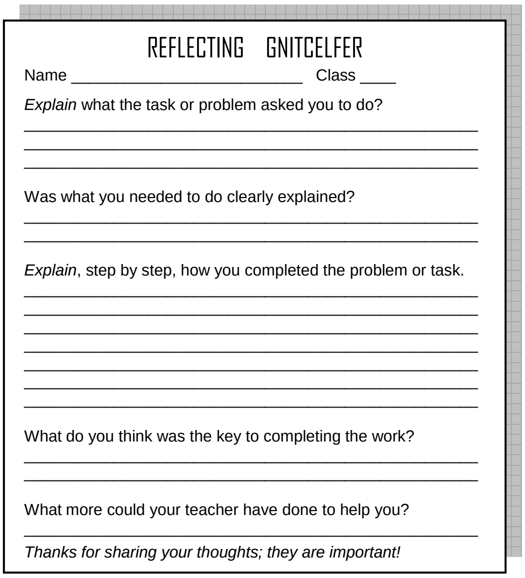
What was the hardest part?

What was the easiest part?

Did you enjoy working on the problem? Why or why not?

Suggest how the problem could be improved?

Thanks for your help!



REFLECTING GNITCELFER

Name ________________________ Class ____

Explain what the task or problem asked you to do?

Was what you needed to do clearly explained?

Explain, step by step, how you completed the problem or task.

What do you think was the key to completing the work?

What more could your teacher have done to help you?

Thanks for sharing your thoughts; they are important!

Figure 4.7: ***Reflection Guides***

In Closing the Early Portfolio: Consideration of the Second Working Hypothesis

The second hypothesis, centring on the time involved in formulating an effective process portfolio by a disparate group of teachers, was supported to a marked degree. For some time, members of the teacher focus group experienced difficulty understanding the many possible facets of the process portfolio concept. However, as can be seen from the analysis, a great deal of group discussion and experimentation saw the shape and purpose of components of the process portfolio slowly evolve. The success of the study’s integral constructivist approach was highlighted through the group sharing their understandings through the emergent schematic models for the portfolio itself and its components.

The early schematic models crystallised the teachers’ thoughts, helping the teacher focus group understand the problems that they had unearthed. The models also assisted them in the application of their emerging understandings as they created the revised assessment structure. Formulation of that structure was both assisted and hampered by the diverse nature of the group, for while it meant that many ideas were forthcoming, consensus on the place and value of some ideas often proved difficult. Overall, self-assessment of their products revealed that while the developmental process was lengthy, the teacher focus group was satisfied with the results of their early design and implementation efforts.

Shortcomings of the Literature Highlighted

Initially, the literature simply provoked much discussion amongst the teacher focus group as it highlighted the shortcomings and the uni-dimensional nature of assessment practices when the study commenced. Put simply, teachers agreed that testing was indeed at odds with the complexities of teaching (Barton, 1999). They concurred that mathematical achievement needed to be judged through more complex process tasks over time (Pandey, 1990). They acknowledged the need for change. However, having reached such conclusions, constructivist reality demanded that the group uncover and solve the problems in adopting an appropriate local assessment structure. In the local detail of that work the gaps in the available literature became even more apparent.

The first step on the teachers' learning journey saw them confront and revise their current views. Literature supplied the raw material for such action but not the detail as to how teacher change agents assimilate the revision within their zones of proximal development. Literature also failed to provide significant assistance to the teacher focus group in satisfying the prevalent tensions in moving from the generation of a summative, relatively simple test score to a language-rich, complex formative feedback structure. The Queensland syllabus now contains "rich tasks" providing some opportunity for students to learn through performance tasks. However, government benchmarking relies solely on standardised testing. Focus group teachers found no relief from such tensions in the literature; they needed and began to find their own resolution.

Resolution also was needed as to the dilemma between syllabus quantity and learning quality; yet another quandary the teachers addressed in the study's local context. Negotiation saw limited syllabus rationalisation on an experimental basis. Once convinced of the need to change, the teacher focus group also set about ensuring that student stress was reduced through major assessment focus being shifted to context-rich, embedded assessment tasks. However, it was difficult for the teachers to make the transition from closed, 'quick' dichotomous testing to contextual, open, time consuming tasks and related feedback. It only occurred after a great deal of trial and error; an excellent example of focus group synergetic success.

Black (1994) warned that transitional success in assessment change could see teachers suffer death through drowning in detail. Once again, the literature warned, but revealed little that could be used in the local context. Teachers needed to trial and develop local models that served stake-holders efficiently. That local efficiency demanded a balance between time, purpose and validity as well as relevant teacher skill development; all of which had to be determined through the actions of the teacher focus group.

THE NEXT CHAPTER

Having developed an early functional process portfolio model, the next phase involved implementing as many of its components as practical in the classrooms of those members of the teacher focus group who had not already begun to use them regularly. In the early implementers' classrooms, of which there were two, the goal was to increase the rate of development and spread each component across all of the mathematical strands. Chapter Five discusses those processes and results, beginning with a review of much of the inherent professional development, an inextricable facet of the teacher focus group's chosen course of action.

CHAPTER FIVE: PROFESSIONAL LEARNING AND APPLICATION

PROFESSIONAL DEVELOPMENT AND PEDAGOGICAL CHANGE

With the teacher focus group keen to continue along their steep learning curve, development continued through the exploration and expansion of the evolving process portfolio. This chapter discusses two facets of that work, professional development and marked portfolio enhancement. The analysis of the early questionnaire, interview and classroom observation data had shown that there was a great deal to be done in the area of expanding teachers' professional knowledge and conceptual understanding in relation to teaching mathematics. As with meaningful student learning designed to develop robust understanding, for the teacher focus group it involved drawing together theory and practice.

The drawing together was accomplished through a wide variety of interactive formats, from informal conversation through to structured presentations. Aspects and examples of such interaction are discussed as a means of highlighting their influence upon the developing process portfolio. Although by its nature the portfolio is a living document and will evolve constantly through use by creative teachers, development during the study period was substantial. Early components were enhanced whilst new concepts were initiated, making the process portfolio model multi-faceted and inherently flexible.

In developing the model, as with all human endeavours, some ideas proved highly successful, others less so. There was no shortage of worthwhile thoughts conceived and developed by the teacher focus group and this chapter discusses many of them, highlighting those adopted into what became an unexpectedly extensive and complex file of plausible portfolio permutations, bulging with practical concepts that teachers in the wider mathematics community could adapt.

In further revelation of the second and third study referents and illustrating the development of the process portfolio model, the latter part of this chapter adopts a similar approach to the previous chapter in that it shares teacher assertions, poses related problems and offers supported solutions. The solutions resulted from the combined contributions of the teacher focus group. In line with the newly adopted constructivist approach by the teachers, students were naturally drawn into the development of virtually all facets of the emerging portfolio.

Further Data Collection

Following early development of the portfolio structure, as discussed in Chapter Four, the quantity of data collected increased. As well as providing change monitoring data, the collection informed the portfolio enhancement process as the portfolio grew in size and complexity.

Teachers were involved in two further structured interviews, formal reflections and completion of another questionnaire. Classroom observations continued, parent-student-teacher interviews were trialled and focus group meetings recommenced. Simultaneously, students were asked to complete four brief surveys, took part in the parent-student-teacher interviews and became involved in enhancing all aspects of the evolving portfolio. Students wrote and critiqued tasks and assisted with the creation of rubrics while gaining a broader appreciation of the nature and purpose of assessment through self-assessment. I continued to supplement formal data collection with informal discussions, duly noted in my study log.

Data Analysis

Triangulation through immersion and consideration of the data continued, as did the teacher focus group’s creative approach to solving the problems exposed. My team teaching and frequent discussions with teachers kept the data in a clear, classroom reality perspective. Teachers had acquired the constructive habit of reflecting in-depth on their work and sharing their reflections with other members of the focus group. The intrinsic constant analysis that such high levels of inter-related activity contains ensured that the change process was constantly monitored and modified in response to issues as they arose.

Working Hypotheses

In further focusing data analysis, working hypotheses applicable to this phase of the investigation were addressed in order to underscore various practical aspects of the study. Those hypotheses centred on the nature and extent of teacher professional development that would be necessary and the rate of assessment change that would occur. The working hypotheses were defined as follows:

1. As with student learning, effective professional development will require numerous focused learning experiences so that the teacher focus group can consider, experiment and modify their thinking and practices in order to develop and assimilate new approaches within the portfolio.
2. Although the teacher focus group has struggled with the practicalities of the process portfolio concept, the group's growing enthusiasm for the revised assessment structure, coupled to its dynamic nature, will generate marked development of the evolving portfolio structure.

Formative feedback through the discussion of journal articles and presentations shared, program planning and review discussions and participant observations were the prime drivers of assessment change. Frequent interaction between teacher focus group members ensured that formative information was exchanged constantly. Two further interviews, a second questionnaire and reflections followed early data collection as teachers expanded their understandings and abilities in working with each other in changing the face of assessment.

TEACHERS TEACHING TEACHERS

> *I don't feel that I have gained an awful lot from our discussions. I may have even become a little more complacent because instead of thinking I was the only one really struggling with teaching maths and needed to get my act together, I now realise that there are many others that are just as lost. I kind of feel a little relieved that I am not the only one.* (Teacher B: Appendix 13, p. 299)
> *Being an older person … I haven't had much professional development, I'd like to give things a try but feel I don't have the experience in using the latest trends. I feel like a new kid on the block, but maybe that is the reaction you get when you are venturing towards the unknown.* (Teacher C: Appendix 13, p. 300)

The transformation of teaching practice is fundamentally an issue of enhancing teachers' knowledge and skills. In relation to process portfolios, early data indicated that the teacher focus group needed training and support as they changed assessment formats. Higher order thinking, substantive conversation and a 'real' world connectedness, key elements of authentic pedagogy demanded consideration in relation to teachers. There was a need to see teacher mathematical and pedagogical understandings expanded through careful planning and valid professional conversation. For a transformation to occur the teacher focus group needed to become both teachers and learners engaged in constructive enquiry.

To that end, early conceptions of the process portfolio, the aims of the transition and needs perceived by the teacher focus group were discussed during early focus group meetings. As the weekly meetings progressed, teachers clarified what they saw as their professional development needs in relation to the assessment through process portfolios and the changes that they faced. The list included:

- the what, why and how of process portfolios;
- learning theories and understanding;
- assessment *of* learning vs. assessment *for* learning; and
- thoughts of de Bono, Bloom and Gardner.

As part of those same discussions the teacher focus group planned ways in which they could satisfy their identified learning needs. Planned interactions included:

- journal article reviews and discussion;
- teacher focus group presentations on relevant topics;
- team planning of ‘new’ learning experiences for students;
- classroom participant observation feedback across the group; and
- group reflection upon the professional development itself.

As the enhancement of the teacher focus group’s assessment practices through assessment change and skill growth was crucial to the success of the change, professional development was on-going. It was a change introduced by me to be undertaken by the group, so explicit professional development was an early imperative. That structured explicit professional development had teachers reading a range of journal articles such those by Popham (1998), Curtis (2002) and Grootenboer (2002) as well as utilising Gunningham’s (2003) *Thinking Allowed*, a resource book distributed as part of the teacher starter kit. The professional development schedule for the first year of the study is displayed as Table 5.1 overleaf. As the table shows, focus group meetings, classroom observations and assessment knowledge and skill enhancement took place and were monitored through a variety of data collection instruments.

Table 5.1: **Teacher Focus Group Professional Development Schedule**

2004			
Month	**Mode**	**Procedure/Purpose**	**Monitoring**
February	TFG weekly meetings	Professional sharing – getting to know each other's methodologies better	First interviews Journal notes Study Log
	Teacher Starter Kit	List of reviewed resources available on loan from the collection + Gunningham's (2003)book	
	Journal articles shared	Popham: *Confessions of an assessment convert* & Curtis: *The Power of Projects*	
March	TFG weekly meetings	Professional sharing, discussion of issues as they arise and forward planning	Questionnaire Journal notes Study Log TFG Reflections
	Student questionnaire formulation	Initial drafting of first student questionnaire – incidental stimulation of personal professional review of methodologies and understandings of how students learn	
	Journal articles shared	Brady: *Tracing the evolution of portfolios*; Grootenboer: *Kids talking about learning Maths*	
April	TFG weekly meetings	Structure of process portfolios	Journal notes Study Log Observations
	Classroom partic.-obs.	Observations by TFG in other members' classrooms – sharing of ideas/team teaching	
	Reflection & rubrics	Early discussion on reflection, task criteria sheets and rubric designs begin	
May	TFG weekly meetings	Integration of maths tasks with wider curriculum	Journal notes Study Log Observations Second interviews
	PD presentations	*Understanding* and *Constructivism*	
	Classroom partic.-obs.	TRW – discussion and assistance with the development and introduction of open tasks	
	Journal articles shared	Zevenbergen et al.: *Using open-ended tasks for teaching, learning and assessment*	
June	TFG weekly meetings	Open-ended tasks reviewed – the possible nature of future tasks – portfolio structure	Journal notes Study Log Observations TFG Reflections
	Classroom partic.-obs.	Assistance with open-ended task development and utilisation	
	PD presentation	*Assessment for learning* and *Problem Solving and the Process Portfolio*	
	Journal articles shared	Hart et al.: *The Role of Reflection in Teaching* & Pogrow: *Reforming wannabe reformers*	
July	PD presentation	*Portfolio Assessment in Maths – A Skeleton* shared with whole staff as progress report	Study Log Journal notes Observations
	Classroom partic.-obs.	Review of process and procedures employed in mathematics classrooms	
	Journal articles shared	Woodward: *Portfolios: Narratives for learning*	
	TFG indiv. meetings	Individual members meet regularly with TRW to discuss issues and planning	
August	PD presentation	*Tasks and Rubrics* - discussion and further examples	Study Log Journal notes Observations
	Classroom partic.-obs.	Assessment of open-ended problems targeted through rubric design and introduction to students	
	TFG indiv. meetings	Task and rubric formulation major focus re skill development	
September	Classroom partic.-obs.	Discussion re progress and technique development with individuals	Study Log TFG Reflections Observations
	Journal articles shared	Sanchez & Ice: *Open-ended items better reveal students' mathematical thinking*	
	TFG indiv. meetings	Focus on task and rubric formulation continued	
October	PD presentation	*Journals and Real Maths* – discussion. Class journals introduced as a trial	Study Log Journal notes
	TFG indiv. meetings	Reviews of progress to date: Portfolios and students in their use of the PP – gains/losses?	
November	TFG indiv. meetings	Unresolved personal professional issues	Study Log TFG Reflections

The professional development experiences, whilst having a general focus of assessments as used in the process portfolios format, were also designed to help teachers gain renewed and expanded insights into many facets of the mathematics syllabus and pedagogy generally. As highlighted in the literature review, weaving embedded assessment into the mathematics program through such instruments as a well-designed process portfolio would ensure stimulating thought-provoking robust learning for all involved.

In relation to learning, to refresh and expand the teacher focus group’s professional knowledge and broaden emerging theoretical constructs, it was considered prudent to examine constructivist learning concepts through examples, presentations and discussions. In early data collection, the teacher focus group had acknowledged that a lack of recent training in the area needed to be addressed. They believed that knowledge of relevant learning theory would improve both their understanding and their pedagogy.

Thus, teacher learning and skill enhancement continued throughout the two years of the study, with the second year’s schedule almost as extensive as the first (see Appendix 15). The professional development was carried out in a manner which facilitated genuine understanding, that quality which the focus group was attempting to engender in students through changing their approaches to teaching and learning.

Learning and Understanding

From reading work by those such as Renzulli, Gentry and Reis (2004) the teacher focus group realised that learning rests within a continuum that leads from prescriptive and deductive learning to investigative, self-selected inductive learning. They realised that inductive learning, the solution of real problems through the application of skills, was the form of learning which they now needed to understand and focus upon. They needed to facilitate learning that fostered understanding through having learners focus on a problem, extract relevant data, categorise, critically analyse, synthesise information and then communicate the results. In the transition, the group was attempting to move from a traditional approach to teaching and learning to embrace a remarkably different pedagogy; a change of major proportions when their current practices were considered.

Through readings such as Bryant and Driscoll (1998) the teacher focus group were aware that development of their professional capacities was at the heart of changing their current practices in relation to learning and understanding. They acknowledged that central to that development was a need for them to be able to examine critically their own pedagogy, an action with which they were not familiar. That examination had begun with the teacher focus group beginning to identify their professional needs during focus group meetings. The needs list included learning theories and forms of assessment, but heading the list was an understanding of understanding itself.

In addressing that early need, a presentation on Carpenter and Lehrer's (1999) characterisation of *Understanding* as emerging in learners through a number of interrelated forms not as a static attribute was shared (see Appendix 16). The group learned that developing understanding required more than connecting new and prior knowledge. They came to understand that it required a structuring of knowledge so that new knowledge could be incorporated into existing networks rather than connected on a piece-by-piece basis. Once again, the power of reflection was recognised as the teachers realised that learners are reflective about learning when they are aware of the knowledge they have acquired and examine it in relationship to what they already know; as they themselves were doing.

Subsequent discussion revealed that the teachers had begun to appreciate that their metacognition was leading to a reorganisation of their knowledge; marked changes of established mind-sets were occurring. Furthermore, in the focus group meeting forum the teachers were revealing and strengthening new understandings by articulating their learning. Most were making the 'new' knowledge their own through the process. However, not all progressed through the mental activities at the same level or speed, an issue central to this study and discussed in greater depth at a later stage.

Importantly, from the presentation and ensuing discussion the group learned that learning does not occur through the accretion of 'pieces' of knowledge. As did they, all learners must construct personal cognitive maps of the connections across facts and concepts in constructivist style; the next concept discussed in detail by the focus group.

Constructivism

In seeking to broaden perceptions and understandings the group shared a presentation on *Learning through Constructivism* (see Appendix 17) after reading work by De Lange (1995), Blais (1998) and von Glasersfeld (1993, 1995). The presentation indicated that the focus group believed constructivism to be about learners deconstructing and reconstructing their personal interpretations of mathematical concepts. That occurs particularly effectively when they work with real world problems through a process that De Lange (1995) dubbed ‘mathematization’, interesting new jargon for the group. The group recognised that within that self-paced process, abstraction, formalisation, generalisation and connectivity occur at some time.

At that time the teacher focus group was learning and coming to the realisation that as individuals they were in fact learning as per the constructivist theory that they were discussing, not the ‘rote imitation’ that they had required previously of their students. Opportunities for them to reflect on their own learning with colleagues had revealed the true nature of their learning *to them*. This was by far one of the biggest revelations during the course of the study for it was foundational in the establishment of a revised teaching, learning and assessment structure in their classrooms.

Assessment

> *I’d like to think that the system we devise will be put into practice by everyone,*
> *if that’s possible, and not just put into the too-hard basket.*
> (Teacher C: see Appendix 13, p. 301)

Once some shared understanding existed about constructivist learning, the teacher focus group members prepared to review their assessment procedures. Early data had shown that traditional assessment methods dominated the existing practices of the teacher focus group. After reading and discussion, group members acknowledged that their current methods were founded on outdated beliefs and that in order to increase learning the existing practice of increasing student anxiety and competition by comparing students should be altered. Assessment was to be used much more constructively in their classroom practices.

The micro-reality of classroom practice, the third referent of the study, was beginning to emerge more clearly. The focus group agreed to endorse the claims of Stiggins

(2001) and Chappuis and Stiggins (2002) by attempting to involve students deeply in their own learning by emphasising progress and achievement instead of possible failure. It was agreed that involving students in assessment processes could motivate rather than merely measure. Again, to assist clarity, the group collated its findings through a PowerPoint presentation that would be beneficial to the wider staff later (see *Assessment for Learning* in Appendix 18).

Through discussion and trial of suitable assessments, the teacher focus group developed an understanding of assessment *for* learning, using assessment information to modify learning activities and incorporate formative feedback. They found that formative assessment involved ascertaining what is known by students at the outset and continually adjusting instruction according to ongoing assessment results. It included analysing which students required more practice, conferring as to their strengths and weaknesses, facilitating constructive interaction, such as peer tutoring, and finally and importantly reflecting on their own teaching practices. While they had been involved in some aspects of such activities before, the complete concept was new to the group and it was the ‘package’ that members found difficult to implement initially.

Questions of Quality

The teacher focus group became aware of major differences between alternative assessments and the traditional formats that they were using. They argued that any change had to address questions regarding its impact on their current practice in relation to efficiency and effectiveness. Change had to lead to assessments that accurately reflected students’ abilities. They realised that in order for assessment to support learning it had to be meaningful to students through both content and context.

Teacher D summed up much of the focus group’s emerging beliefs when he said, “I now realise that it’s better to give my students tasks that they see as worthwhile, in context if you like, having meaning. That way they see a point to the work and I get to assess them effectively. We all feel that the work is worth doing.”
(see Appendix 19, p. 312)

Although the entire teacher focus group had embraced the study enthusiastically, hesitancy as to the extent of commitment became noticeable in two of the five teachers as their knowledge base and depth of involvement expanded. They questioned the time involved in creating worthwhile tasks and in turn generating formative feedback and interpreting the quality of student products. These issues began to dominate discussions. Three members were reassured by comments that teachers who have been involved in such assessment change found that it required a refocusing, not redoubling of effort as instruction and assessment were unified and that time spent on the revision does not detract from teaching. However, once the euphoria of early involvement had decreased, two were experiencing noticeable difficulty coming to terms with the new demands. The results of those pressures are discussed later in this chapter.

In reforming assessment to generate the 'new' data the teacher focus group agreed that a lasting shift to quality alternative assessment would emanate only from an investment of effort over time. That time would need to be invested in ongoing professional development in all facets of teaching and learning linked to improved pedagogy and assessment of high quality.

Teacher Reflection

> *I've found reflection gives me great insights into the learning experience.*
> *I think communication about the learning experience is based on reflection.*
> *Getting my students to be part of the reflection process has been very*
> *valuable for me and them.* (Teacher E: Appendix 19, p. 313)

As part of this study, reflection resembled a double-edged sword. The teacher focus group discovered that reflection was beneficial for both teacher and student learning. They saw metacognition in themselves and their students as a powerful learning tool which led to meaningful explanation of reasoning. As with their students, teachers found that while they often produced reasonable answers, explaining the precise procedure taken to reach the conclusion to an audience of peers was not always easy. They began to appreciate why students often had difficulty explaining and supporting solutions.

Teacher Focus Group Learning and Understanding

In line with Smith's (2001) findings, when the teachers reflected on their practices with colleagues in the way in which the focus group was moving, a great deal of robust learning took place. Reflection offered an opportunity for both learner and teacher to critically assess the learners' understanding in detail and to determine directions for further learning. As can be gauged from the above discussion, through their commitment to change the teacher focus group came to appreciate the value of becoming learners, exploring and reflecting upon their emerging understandings.

CONTINUING IMPROVEMENT OF THE PROCESS PORTFOLIO MODEL

As a result of ongoing problem exposure and subsequent teacher learning through solution generation, the process portfolio model expanded appreciably in complexity and possible points of application. The true success of the teacher focus group's work became apparent through the emergent unique, multi-faceted, flexible process portfolio model and resultant student engagement and learning. The increasingly complex components of the portfolio are examined through discussion of problems exposed during teacher focus group discussion and the subsequent design and development of plausible solutions.

The Process Portfolio MkII

Teacher assertions regarding the process portfolio model that was developing were many and varied. The second teacher survey questionnaire collected teacher assertions using de Bono's (1994) PMI concept. Of the results of the process which refer directly to the process portfolio particularly noteworthy points are displayed in Table 5.2, with the collated responses displayed in Appendix 20.

Table 5.2 **Selected Responses to the Teacher PMI Questionnaire**

Teachers' Perceptions of the Qualities of Process Portfolios		
PLUS	**MINUS**	**INTERESTING**
Empowers everyone involved, is inclusive, learning style friendly, provides immediate feedback through the rubric, has the potential to increase student understanding of mathematics *and* the learning process	Hard on time management, more like a culture so takes time to establish – it needs to grow on you, you need to foresee the overall benefits of this approach to provide the 'drive' to work through changes to pedagogy	Great conversation pieces with parents, like a job interview – presenting your portfolio, allows for a more interactive student/teacher relationship, providing opportunities for students to 'say' how the learning is for them – is invaluable feedback for teachers

As the change progressed, teacher focus group comments regarding the process portfolio became overwhelmingly positive. The strongest support related to the capacity of the portfolio to empower students through its inclusivity, its learner-friendly formative feedback potential and the noticeable lift in lasting student mathematical understanding. The level of engagement through wide stakeholder interaction at a deep level was seen as invaluable. Even the negative comments indicated in Table 5.2 were constructive as it was seen that the overall benefits markedly exceeded the difficulties. Of note was that once again the issue of time for change to take place came into play.

Over the period of the change, the structure of the process portfolio itself significantly changed. In looking for answers to questions of student engagement and ownership, effectiveness and efficiency, as well as comprehensive assessment and time management, the teacher focus group expanded both the number of components within the structure and the permutations within components. Developments resulted from discussion following presentations such as *Problem Solving and the Process Portfolio* and *Tasks and Rubrics* (see Appendices 21 & 22). Consequently, a more conceptually sophisticated model was conceived by the teacher focus group. The model is illustrated in Figure 5.1.

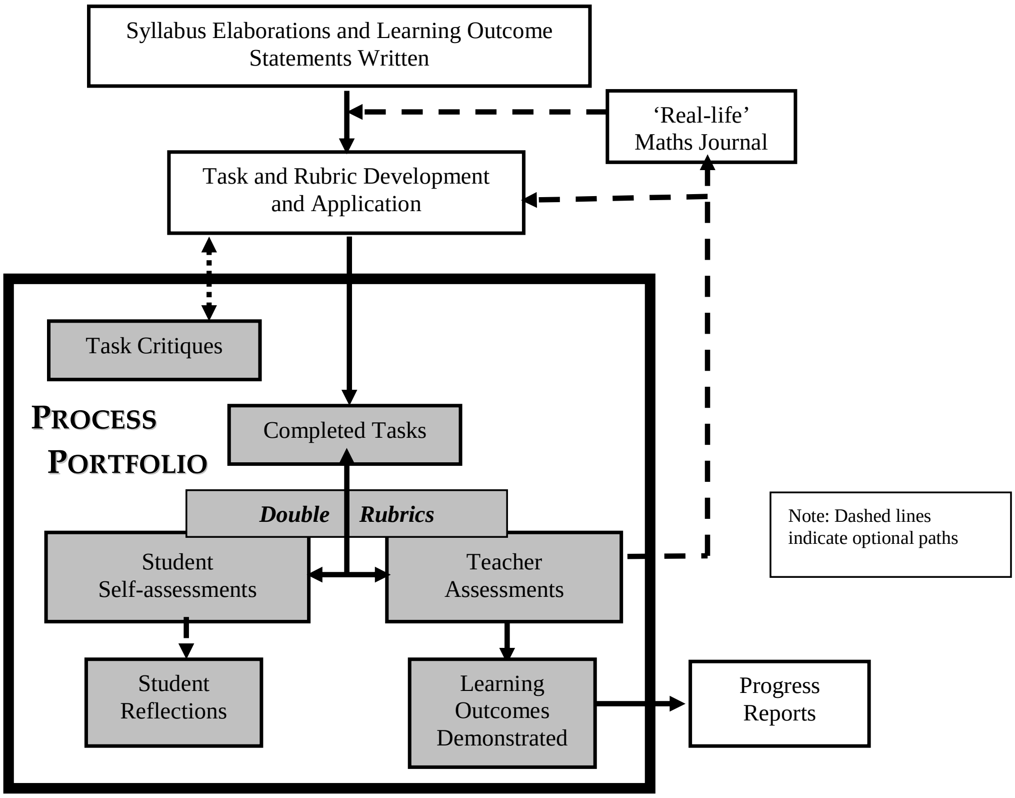


Figure 5.1: ***The Process Portfolio Model***

The resultant model, in contrast to the initial model (see Figure 4.1, p. 108) showed that the teacher focus group had grasped that effective process portfolios:

- offer marked flexibility in task and assessment formats ;
- provide an empowering sequential learning structure with assessment embedded;
- facilitate meaningful student involvement in almost all constituent components;
- encourage deep student engagement through that involvement; and
- display a comprehensive student learning narrative.

More interest in the work of the focus group became evident when I was invited to make presentations about the group's achievements to the school's P-12 staff as well as education students at Bond University (see Appendix 23). Significant interest was shown by both audiences in relation to the developmental path that the group had followed and the reasons why the portfolio and its components had been expanded.

Component expansions were aimed at ensuring student engagement in the entire process from data collection, task and problem generation through to assessment and reflection. The improvements included the addition of a class journal option, peer task development and critiquing, true formative feedback through ongoing two-way assessment and what became a powerful teaching tool, the double rubric.

In explaining and illustrating the development of the process portfolio model, a similar format to Chapter Four, using assertions, problems and solutions is taken in this chapter. The assertions identify realisations teachers made about:

- the complex meanings in the language of mathematics;
- the difficulty of changing to a problem solving approach to teaching mathematics without easily understood models;
- the value of rubrics in providing assessment feedback;
- the benefits of students self-assessing before the teacher assesses;
- the power of learners reflecting; and
- the necessity of syllabus elaborations and clear learning outcome statements.

The 'Real-life' Mathematics Journal

Teachers were concerned about students acquiring ready facility with the language of mathematics. To remove some of the perceived mystique, they considered ways in which students could be involved in using the language more frequently and more readily.

Teacher assertion: "*Mathematics uses ordinary language in unusual ways. Writing is used successfully to develop English skills, so it could be useful in teaching mathematical vocabulary. Students need to see mathematics as part of every aspect of their lives. They'd benefit from involvement in problem and task writing.*"
(Teacher B: see Appendix 24, p. 322)

Student assertion: *Some of the words are a bit tricky because they can mean a couple of different things. You need to get used to that.* (see Appendix 25, p. 326)

Problem: Bringing teachers and students to a realisation that mathematics permeates all facets of their daily lives needed to be achieved in a constructivist manner as simply telling students achieves only limited understanding. A medium was needed that would use and extend students existing abilities to consider mathematics as an integral part of *their* lives.

Solution: As the portfolio model became more complex its flexibility increased, offering teachers a wide number of permutations as to which portfolio components could be used in any given assessment task. As a result, multiple possible starting points were identified by teachers, the 'Real-life Journal' initiative being one. From a common starting point the journal, a student driven component, developed to become an important part of mathematics and to serve a number of purposes within different classrooms. Students shared the mathematics in their lives through writing, reading and discussing their journal entries. Problems and tasks based on student entries were also generated by teachers and students.

Through the evident high level of student commitment to the journal, teachers became aware that mathematical language was becoming more relevant and meaningful to their students. Teachers shared further reading on the use of writing in the teaching of mathematics in the form of articles by Vacca and Vacca (1986) and Scott, Williams and

Hyslip (1992). Through their expanding knowledge and experience with students using the language in their writing in learning mathematics, the teacher focus group moved towards a revised view of the core teaching program. In the revised concept, English, for so long viewed as the hub of learning, shares the central role with mathematics. In the view of the group, both serve functions central to life, form crucial parts of the essential hub of learning. The group illustrated the concept as shown in Figure 5.2.

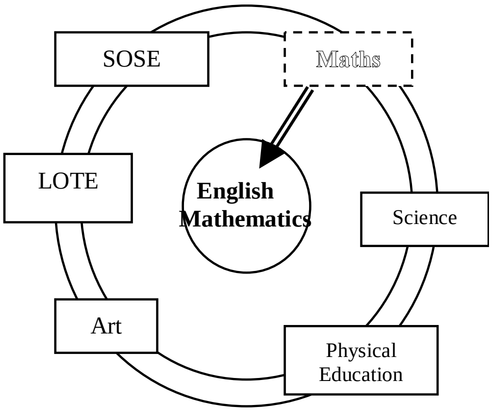


Figure 5.2: ***Mathematics and English as the Hub of Learning***

As a result of discussions which considered Albert and Antos's (2000) irrefutable statement that mathematics permeates every situation, each class began a class 'Real-life' Mathematics Journal. In line with Burns' (2004) thoughts, two classes had already begun using personal *reflective* journals to engage students in self-monitoring of the procedures they were using in problem solving. The new concept engaged students in viewing mathematics as part of their everyday lives. English had seen journals used for years, so it was sound for students to share their 'mathematical lives' through a journal.

The 'real-life' everyday nature of mathematics was reaffirmed through introductory discussions with students and an explanatory page at the front of the journal. They were simply asked to write 'diary' entries, stories, or illustrate thoughts and normal daily occurrences. They were not asked to pose problems or isolate the mathematics from the situation about which they wrote. However, in all classes it took time to steer students away from the inclination to write and solve problems. Whilst completing such a process may have been useful for the student involved, it allowed only passive involvement of others. When asked as to the 'automatic' reaction to create problems, the general response was that they were writing about mathematics and mathematics *is* problems. Through persistent modelling and discussion students became adept at writing entries which simply shared aspects of their lives without necessarily drawing attention to the mathematics involved. Interestingly, one of the most useful early models was written by a Year 4 boy. That piece was incorporated into a revised journal introduction (see Appendix 26).

As students became more aware of being surrounded by and immersed in mathematics they appeared to lose the need to highlight the mathematics inherent in entries. Entries covered myriad facets of life, from cooking to animals to parties. Using such mathematically rich contextually 'real' material, problems and tasks were formulated by teachers and students, critiqued and solved by individuals and groups.

As with all portfolio components, flexibility was seen as essential to allow teachers to vary the approach depending on a particular purpose and as a means of increasing student engagement and motivation. Figure 5.3 illustrates possible uses of the journal within the process portfolio model developed through the study. The figure illustrates that the journal can fulfil a remarkably flexible function within the portfolio structure. Whilst the common starting point in the use of the journal is students making entries, from there the possible productive paths are many and varied.

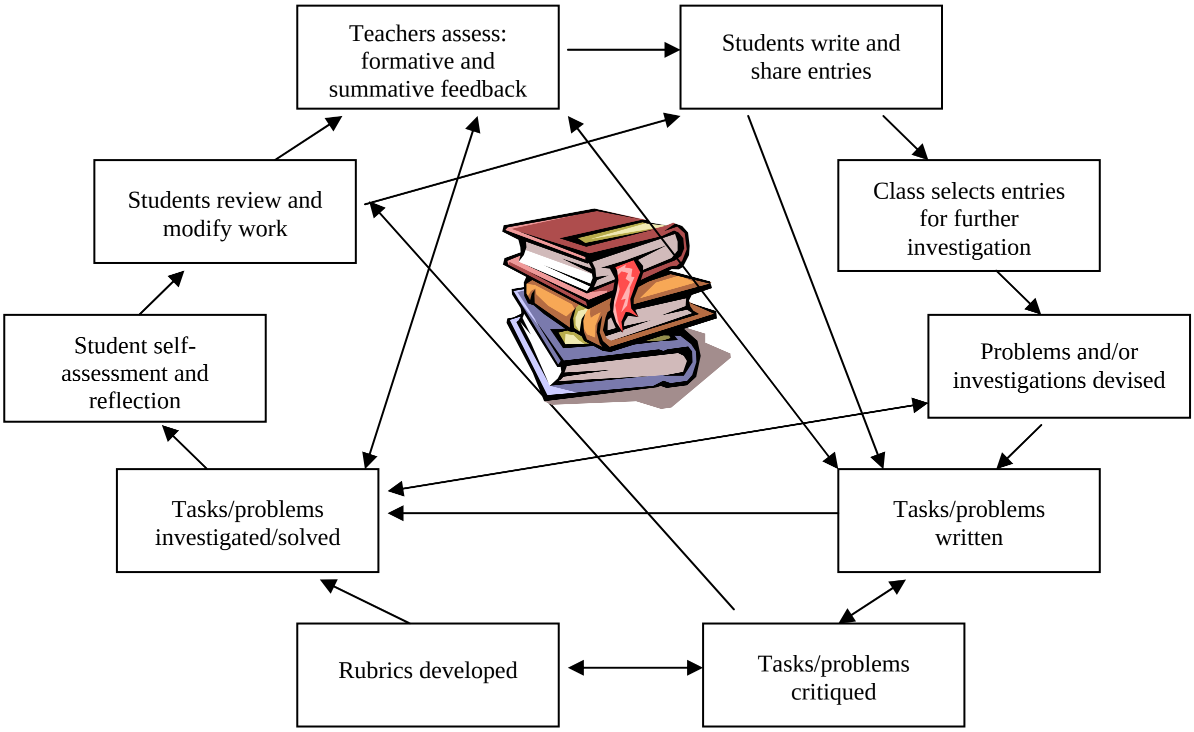


Figure 5.3: ***The 'Real-life' Maths Journal: Possible Paths of Implementation***

CREATING, CRITIQUING AND ASSESSING TASKS FOR STUDENT LEARNING

Assessment Tasks

The meaningful application of mathematics in the performance of mathematically based tasks, traditionally termed problem solving, is the central purpose of students working in the process portfolio structure. However, the teacher focus group found that the transition to genuine student engagement in problem-centred, performance-based learning was not necessarily straightforward. They needed to find the best form of assessment tasks for use in the process portfolio and the optimum level of student involvement.

Teacher assertions: *"It is hard to develop the problem solving approach specifically in maths without exposure to models to help inform planning and doing."*
(Teacher D: see Appendix 13, p. 301)
"Children need to be taught that questioning anything in maths is acceptable, necessary for genuine understanding." (Teacher C: see Appendix 24, p.321)
"Children solve problems best when they are in a context that they can relate to."
(Teacher D: see Appendix 24, p. 321)
"There are various interpretations of problems possible. I think they need to be taught to substantiate their interpretation, understanding and solution."
(Teacher E: see Appendix 24, p. 321)

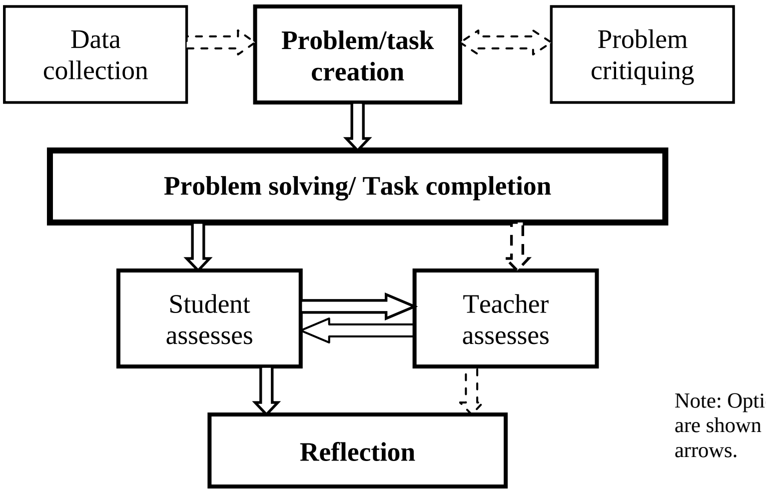
Problem: Early teacher experience had shown that a structure or model was required that guided those formulating tasks while allowing a level of freedom. The model needed to offer opportunity to engage both students and teachers from initial data collection through task creation and on to eventual task completion. Tasks needed to encourage fluency and ease in mathematical communication through the use of specialised terms and symbols, to provide opportunities for students to really connect with the language of mathematics.

Solution: The teacher focus group was aware of Dietel, Herman and Knuth's (1991) finding that the acquisition of knowledge and skills does not make one into a competent problem solver. The disposition to use, linked to the knowledge of when and how to apply the skills and strategies, is required. Armed also with Renzulli, Gentry and Reis's

(2004) declaration that real life problems genuinely engage learners, the group devised and implemented a flexible structure for the formulation and use of problems and tasks.

During the formulation, from their initial attempts at assessment change the teacher focus group bore in mind that tasks needed to be seen by students as meaningful, real-life, have a plausible personal frame of reference for *them*, a real audience and a lack of prescribed strategies for solution. To the focus group, the creation of tasks based on students' journal entries potentially satisfied those criteria. Coupled to such strengths was the potential for fruitful group work in formulating and overcoming problems or discovering ways to complete tasks. The teacher focus group endorsed student group work as it facilitated learning by scaffolding effective, sometimes complicated strategies while providing mutually constructive feedback.

Focus group work saw the task creation structure within the process portfolio undergo marked revision as the entire procedure became much more student-centred and driven. Students became involved in data generation and collection. The teachers were encouraged to take students into the 'real world' on mathematical fact-finding excursions as students became an important part of the problem creation process. Students began to critique each others' tasks and self-assess their own work on completion. The process was capped by reflection, with either student or student and teacher reflecting upon what had transpired. As with all flexible structures, a number of variations were possible around the central core visible within the structure illustrated in Figure 5.4. As one teacher said, "If it comes from them and you introduce it to the class; if a 10 year old boy has written it then most of the boys will be interested" (see Appendix 19, p. 310).



Note: Optional paths are shown by broken arrows.

Figure 5.4: ***Problem/Task creation and completion***

Unlike the earlier simpler structure (see Figure 4.3, p. 113) where the problem solving/task completion was given dominance, each horizontal line within the more complex structure assumed major, if not equal importance. Whilst offering marked flexibility and choice, indicated by the dashed arrows in the illustration, significant learning experiences were possible across each line but not necessarily always building the complete structure. An example of the results of the entire process carried out by a Year 6 class where they visited a theme park to collect data, spent considerable time in class creating and critiquing problems, solving problems and assessing resultant efforts. They reflected upon their work and finally ‘published’ a book, example pages of which form Appendix 27.

Students Critiquing Peers’ Tasks

The teacher focus group found that deep student engagement accompanied student involvement in task formulation. However, students needed to be guided in what constituted a worthwhile challenging task. It was found that students constructively critiquing tasks written by peers offered that guidance in a meaningful context.

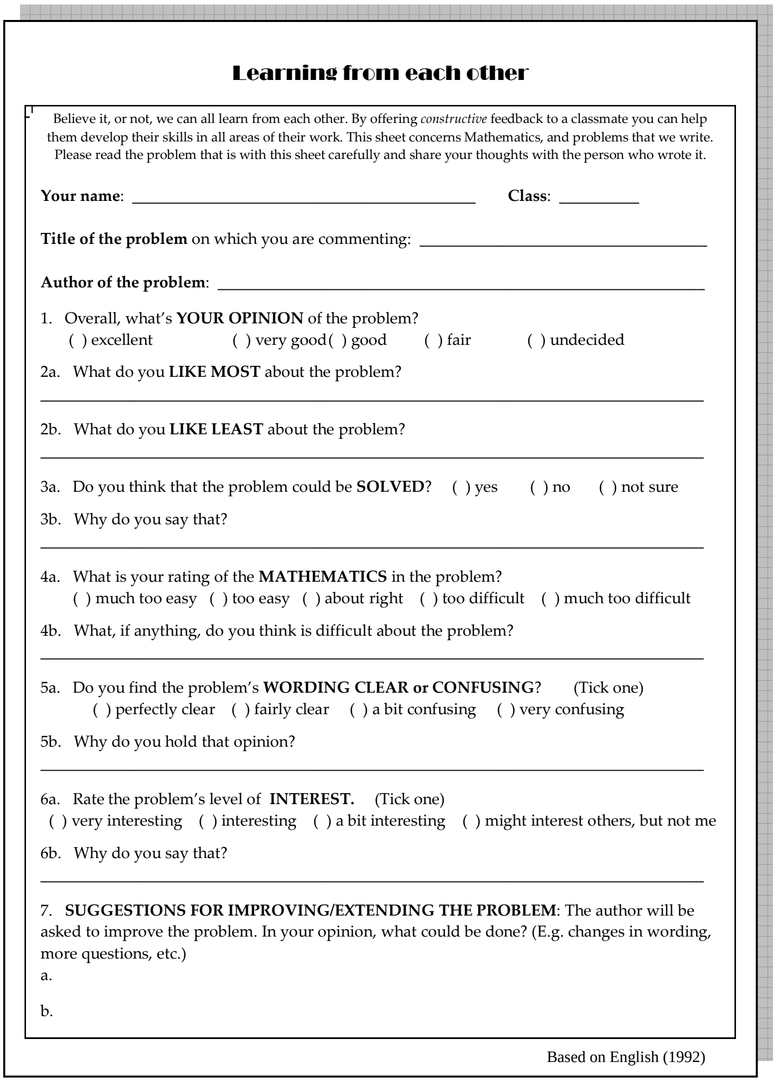
Teacher assertion: A teacher who was not a member of the original teacher focus group but became involved in aspects of the work later, asserted that students needed to be directly involved in writing problems. The teacher stated that in order to develop those skills students must be able to appreciate the qualities of sound problem structure.

Problem: Constructivist principles dictate that students understand the importance of problems and tasks being logically structured, using terminology appropriate to eliciting plausible outcomes. If students were to gain maximum benefit from their involvement they needed to participate in all aspects of problem formulation, including the analysis and improvement of wording through guided critiquing of tasks written by others, including the teacher.

Solution: Using a rudimentary format by English (1992) as a basis, a critique format suitable for student use (see Figure 5.5 overleaf) was developed. As indicated in Figure 5.4 it became part of the flexible task creation process. It led students in their consideration of peer-written problems by seeking a number of opinions as to wording, inherent interest and perceived level of difficulty. Finally, it asked them to provide constructive criticism that could be used by the author to improve the problem.

Student and teacher feedback gained whilst working in classes using the structure indicated that students enjoyed the opportunity to comment on peers' work. Comments such as, "I personally didn't understand a few questions", "Make it more interesting and a little harder" and "I could read it clearly and it was easy" (see Appendix 28) were used by students to improve their problems, which were often tasks based on 'Real-Life' Mathematics Journal entries.

Asking students to analyse the work of peers in depth meant that teachers had to ensure that students understood what constituted sound task or problem structure. Students needed to be aware of the necessity to use appropriate clear wording and supply sufficient data in a logical format. In order to pass judgement they had to ensure that it was meaningful and made sense; a steep learning curve for students who had never been so involved before.



Learning from each other

Believe it, or not, we can all learn from each other. By offering *constructive* feedback to a classmate you can help them develop their skills in all areas of their work. This sheet concerns Mathematics, and problems that we write. Please read the problem that is with this sheet carefully and share your thoughts with the person who wrote it.

Your name: ________________________ **Class**: __________

Title of the problem on which you are commenting: ________________________

Author of the problem: ________________________

1. Overall, what's **YOUR OPINION** of the problem?
( ) excellent ( ) very good( ) good ( ) fair ( ) undecided

2a. What do you **LIKE MOST** about the problem?
____

2b. What do you **LIKE LEAST** about the problem?
____

3a. Do you think that the problem could be **SOLVED**? ( ) yes ( ) no ( ) not sure

3b. Why do you say that?
____

4a. What is your rating of the **MATHEMATICS** in the problem?
( ) much too easy ( ) too easy ( ) about right ( ) too difficult ( ) much too difficult

4b. What, if anything, do you think is difficult about the problem?
____

5a. Do you find the problem's **WORDING CLEAR or CONFUSING**? (Tick one)
( ) perfectly clear ( ) fairly clear ( ) a bit confusing ( ) very confusing

5b. Why do you hold that opinion?
____

6a. Rate the problem's level of **INTEREST.** (Tick one)
( ) very interesting ( ) interesting ( ) a bit interesting ( ) might interest others, but not me

6b. Why do you say that?
____

7. **SUGGESTIONS FOR IMPROVING/EXTENDING THE PROBLEM**: The author will be asked to improve the problem. In your opinion, what could be done? (E.g. changes in wording, more questions, etc.)
a.

b.

Based on English (1992)

Figure 5.5: *'Learning from each other' – A Student Critique Guide*

Teachers found the critique format useful in developing students' data collection and selection skills, an appreciation of the problem writing process and the ability to select key words in solving problems. From having to provide a lot of guidance early, the teachers found that generally the demand for help decreased as students began to feel comfortable writing and working with problems. The resultant high level of involvement across all facets of the process proved to be "a great way to keep them involved and feeling like they own the maths" (Teacher D: see Appendix 24, p. 324).

Students supported the process. One commented, "It was fun critiquing other peoples work and finding out others mistakes." Another said, "Editing is essential to help the other author and to help you as well" (see Appendix 29, p. 330). Observations included, "It took a long time to find the correct wording for the problems. [Those] with the most problems were the deductive reasoning ones" (see Appendix 29, p. 331).

Assessment Rubrics

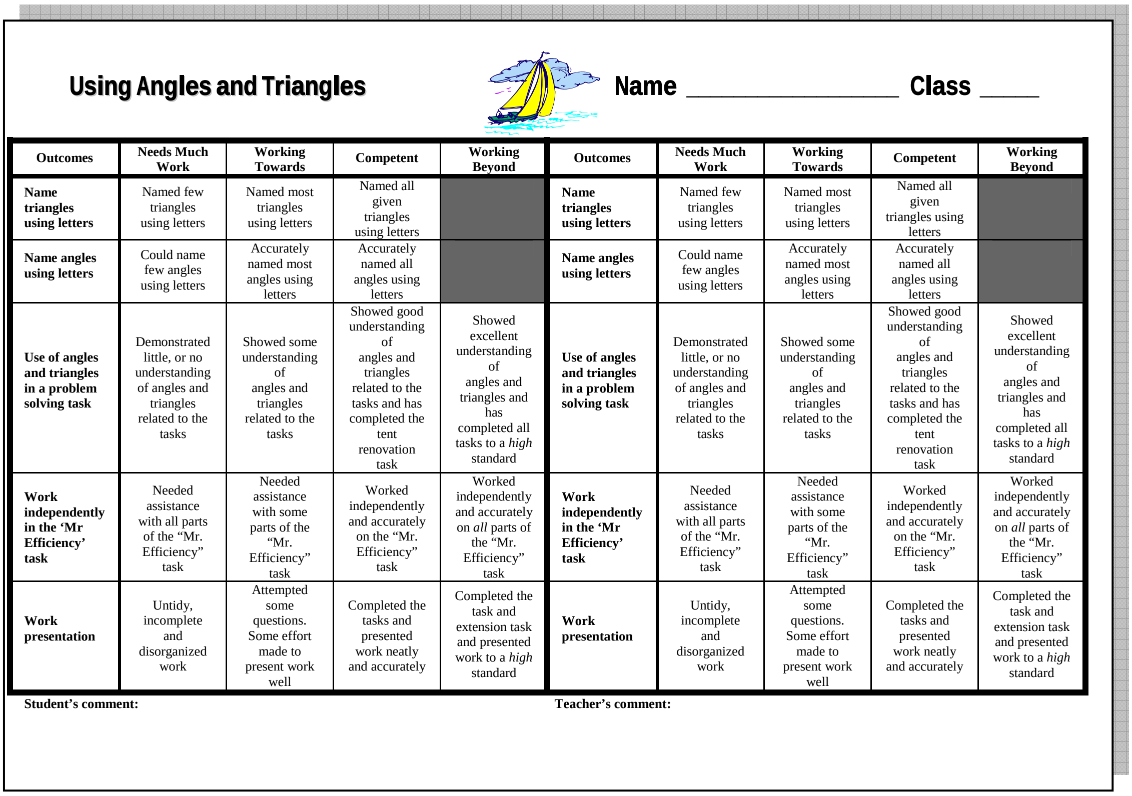
Traditional summative assessment supplies students with very limited feedback through a score or grade and perhaps a short comment. Embedded, formative, criteria-based assessment has the capacity to supply a grade but also assists students increase the quality of their performance by offering a great deal of guidance through word-based feedback.

Teacher assertions: "*We need to work out how to use the rubric in designing future teaching and learning programs that incorporate problem solving."* (Teacher E: see Appendix 13, p. 300) *"I'm a firm believer in their* [rubric's] *value in English and now am thinking that they could be really useful in maths, if can we get them right."*
(Teacher E: see Appendix 30, p. 334)
"That is my next task to learn with the children, to say, Well – if it [the rubric] *is generated by them it is going to mean a lot more for them to be more reflective."*
(Teacher C: see Appendix 31, p. 336)

Problem: There is a need to shift from the dominant focus which sees the teacher as the sole constructor and contractor of assessment. Students have long simply completed teacher-written tasks and tests and submitted the work for assessment with little true 'ownership'. If students are to genuinely engage in all aspects of problem solving they must see themselves as significant contributors to both the task and the assessment process. Therefore, students should be involved in the design and writing of assessment instruments which assist formative self-assessment during and after task completion. Such need to become the catalyst to deep learner reflection and understanding.

Solution: As the process portfolio developed, the influence on student learning of two components, the task sheet and the rubric became critical to the entire learning process. The task sheet and rubric were used in tandem as the task introductory tools. Teachers saw students gain broader pictures of expectations regarding the true nature and breadth of tasks as the strong shift of emphasis from product to process became more apparent.

As a result, the teacher focus group's approach to rubric development was enthusiastic. Facilitation of the broadening of their understanding of the nature, form and purpose of rubrics led to the teachers guiding their classes in the design of rubrics. That process led to their students acquiring sound self-evaluation skills using a growing range of rubric formats. That range extended from a simple generic form to a task-specific complex rubric. The double rubric, as illustrated in Figure 5.6, was developed as both a task-specific teaching tool and a student-teacher generated reflective assessment instrument. The double format was incorporated to bring to reality the concept of student empowerment through *parallel* formative student and teacher assessment.



Using Angles and Triangles **Name** ________________ **Class** _____

Outcomes	Needs Much Work	Working Towards	Competent	Working Beyond	Outcomes	Needs Much Work	Working Towards	Competent	Working Beyond
Name triangles using letters	Named few triangles using letters	Named most triangles using letters	Named all given triangles using letters	▨	**Name triangles using letters**	Named few triangles using letters	Named most triangles using letters	Named all given triangles using letters	▨
Name angles using letters	Could name few angles using letters	Accurately named most angles using letters	Accurately named all angles using letters	▨	**Name angles using letters**	Could name few angles using letters	Accurately named most angles using letters	Accurately named all angles using letters	▨
Use of angles and triangles in a problem solving task	Demonstrated little, or no understanding of angles and triangles related to the tasks	Showed some understanding of angles and triangles related to the tasks	Showed good understanding of angles and triangles related to the tasks and has completed the tent renovation task	Showed excellent understanding of angles and triangles and has completed all tasks to a *high* standard	**Use of angles and triangles in a problem solving task**	Demonstrated little, or no understanding of angles and triangles related to the tasks	Showed some understanding of angles and triangles related to the tasks	Showed good understanding of angles and triangles related to the tasks and has completed the tent renovation task	Showed excellent understanding of angles and triangles and has completed all tasks to a *high* standard
Work independently in the 'Mr Efficiency' task	Needed assistance with all parts of the "Mr. Efficiency" task	Needed assistance with some parts of the "Mr. Efficiency" task	Worked independently and accurately on the "Mr. Efficiency" task	Worked independently and accurately on *all* parts of the "Mr. Efficiency" task	**Work independently in the 'Mr Efficiency' task**	Needed assistance with all parts of the "Mr. Efficiency" task	Needed assistance with some parts of the "Mr. Efficiency" task	Worked independently and accurately on the "Mr. Efficiency" task	Worked independently and accurately on *all* parts of the "Mr. Efficiency" task
Work presentation	Untidy, incomplete and disorganized work	Attempted some questions. Some effort made to present work well	Completed the tasks and presented work neatly and accurately	Completed the task and extension task and presented work to a *high* standard	**Work presentation**	Untidy, incomplete and disorganized work	Attempted some questions. Some effort made to present work well	Completed the tasks and presented work neatly and accurately	Completed the task and extension task and presented work to a *high* standard

Student's comment: **Teacher's comment:**

Figure 5.6: ***The Double Rubric***

With the double rubric distributed and discussed as an integral part of task introduction, meaningful assessment had become embedded, supporting the calls of the likes of Hiebert and Carpenter (1992) and Burke (1992). Teacher B stated that, "Rather than bits and pieces, they [students] actually have the whole road map; they know where they are going. … when we started to write our own rubric there was a lot more motivation because of the ownership factor" (see Appendix 31, p. 335).

The implementation of the double rubric uncovered other problems, the heavy reliance on language in informative formative feedback being one. In moving from basic format to the more complex, the focus group teachers realised that there were possible pitfalls and potential benefits. As well as opportunities to further immerse students in the language of mathematics, assessment terminology was now exposed. Task introductory sessions became multi-faceted, even more so when their students became involved in creating rubrics. "Even though setting it up is more difficult the end product is far easier [for students to use]*"* claimed Teacher B (see Appendix 31, p. 335). According to Teacher B, students' attitudes towards mathematics changed.

> *I suppose the biggest thing that I saw was the change that maths was not as intimidating, especially with a group of strugglers. Maths at the beginning of the year was very much too hard; I hate maths, I don't want to do it, I am no good at it, I have to do it because I am at school, the sooner this class is over the better; that changed a lot.* (see Appendix 31, p. 335)

Student Reflective Learning

Through personal experiences during the change process, the teacher focus group had become aware of the learning power of reflection as described by Glaser (1988) and Shepard (1992). Teachers acknowledged that student reflections offered opportunities for students to deepen their appreciation for the process of learning and understanding while giving teachers increased feedback on each student's progress.

Teacher assertions: *"This is the only way to go about it, if you don't discuss it, you don't know. …Even again after group discussions and presentations you get more out of them. If they have to write it down again, I think it is because they are boys, they don't like writing and you get 'that'll do'."* (Teacher B: see Appendix 31, p. 335)
"They put their own interpretation on it; they look for the easy way out in lots of ways." (Teacher C: see Appendix 31, p. 336)

"For me I found that reading their written responses has given me so much more information about them. Another example perhaps if they were to tell me orally how they were doing I find they are much more able to explain it verbally than written responses. I can then have something concrete on their understanding." (Teacher D: see Appendix 31, p. 336)

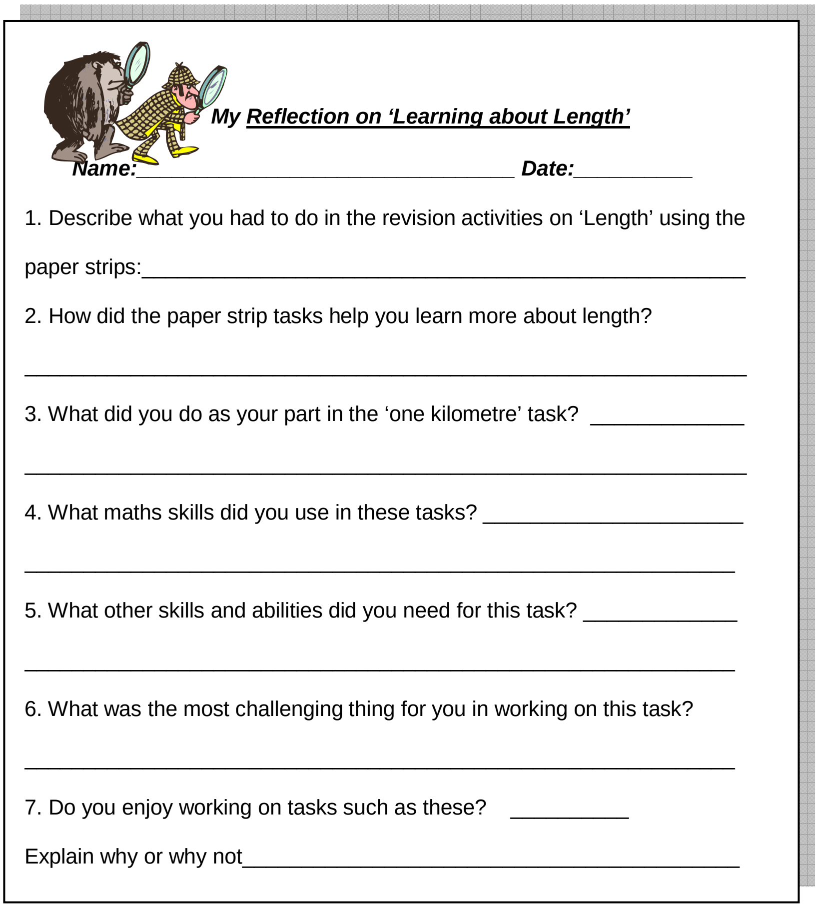
Problem: A test can measure a student's level of information recall and to some extent the ability to apply that knowledge. However, when moving into the higher orders of thinking, such as synthesis and evaluation, as the teacher focus group was now doing in relation to the portfolio and in turn expecting from students to a high degree, accurate assessment of understanding was open to question. Can a learner's true level of understanding be measured without having the learner recount in some form the path taken to produce the product, in other words the problem solving process applied? Can a teacher assess, or understand, a student's real level of understanding without the student reflecting in some form?

Solution: Since realising the value of reflection, in line with Rolheiser's (1998) basic model (see Figure 4.6, p. 117) and beginning to utilise the process, reflection had proven to be an invaluable part of learning and assessment. The teacher focus group had early problems understanding the need for students to formally reflect upon their work. However, acceptance followed the realisation that, at times, student reflections showed that even those who reached a correct solution did not really understand the concept with which they had been working. As the National Council of Teachers of Mathematics (2000) had claimed, teachers realised that students' reflective writing was supporting the organisation and consolidation of their thinking. In clearly expressing their ideas students had to use precise language, which in turn assisted them analyse and evaluate the thinking of others.

As a result, in attempting to cater for all abilities within those higher orders of thought, the teacher focus group broadened the reflective approach to include demonstrations and verbal explanations. Reflections of various forms yielded valuable information about students' interests and understandings. In turn, the teachers were then well equipped to implement effective learning programs, modify existing situations and create new rich learning environments which fostered conceptual and procedural understandings.

From the outset, a major stimulus for the teacher focus group's efforts to come to terms with process portfolios was to foster robust conceptual and procedural understandings. The group had been open to self-examination through reflection in increasing depth and now saw broad extension into all facets of students' work as a logical progression that would further assist them gain insights into their students' thinking. Shared experiences supported such an extension. Teacher B stated, "A student did a test for me and he didn't perform very well at all. Then he answered orally. At lunch break I actually wrote a paragraph about how he went orally as he was fine." (see Appendix 31, p. 335)

Consequently, reflective formats expanded considerably during the study. The focus group developed a resource base of reflection guides, including the simple parallel rubric and task-specific guides (see Figure 5.7). This encouraged variation in reflection styles across situations as beneficial and appropriate.



My Reflection on 'Learning about Length'

***Name:*________________________________ *Date:*__________**

1. Describe what you had to do in the revision activities on 'Length' using the paper strips:____

2. How did the paper strip tasks help you learn more about length?

____

3. What did you do as your part in the 'one kilometre' task? _____________

____

4. What maths skills did you use in these tasks? ______________________

____

5. What other skills and abilities did you need for this task? _____________

____

6. What was the most challenging thing for you in working on this task?

____

7. Do you enjoy working on tasks such as these? __________

Explain why or why not____

Figure 5.7*: A Task-specific Reflection Guide*

Acknowledged reflection was still a new experience for teachers and students alike. A great deal of teacher reflection took place during focus group meetings. Initially, students needed a lot of teacher guidance with all forms of reflection, from rubric-based self-assessment through to more time-consuming lengthy written reflections. Student comments of a reflective nature often took unforeseen turns. They enjoyed reflecting on their work and that of others. One student thought that it was a lot of fun solving other people’s problems and looking at it from their perspective. Another contributed, “It was way better than doing text books … working with Richard was very fun because he could always pick out something that was wrong” (see Appendix 29, p. 331).

ASSESSMENT AND ACCOUNTABILITY STRUCTURE CHANGES

Syllabus Elaborations and Outcome Statements

Structure within a learning program ensures the scaffolding of knowledge and skills. In mathematics, that structure is based on the mathematics syllabus. From the syllabus, learning outcomes are drawn through syllabus elaborations. In turn, assessment against the outcomes leads into school accountability structures, such as reporting. Therefore, planned clear learning outcome statements are vital at both ends of a learning program.

Teacher assertion: *“Well, I have to set something up. I would like to keep it consistent with the rubric or report card, have it in the same assessment pieces, just transfer it onto my own data base.”* (Teacher D: see Appendix 31, p. 336)

Problem: Teachers must work within accountability parameters which begin within the syllabus and finish with reporting to stakeholders. Depending on the administrative structure in a school, within the school’s established parameters teachers have various levels of freedom to establish teaching and learning programs together with accountability frameworks, including assessments and the recording thereof.

At the study school, teachers are allowed a great deal of freedom in relation to assessing students and recording the results, although major assessment items must be applied across year levels. Outcomes-based reports inform school administration and parents regarding student progress and achievement. At this exploratory stage, process portfolio tasks had not been classified as major reporting items. However, with regard to future portfolio reporting possibilities, the teacher focus group was keen to develop assessment rubrics which naturally ‘flowed’ through elaborations into outcomes to tasks and assessments and then into reporting formats.

Solution: As a result, suitable elaborations and linked outcomes were generated for each strand at each syllabus level by the teacher focus group. An example for Number Level 3 is shown in Figure 5.8.

	Elaborations	Well below	Working towards	Competent	Working beyond
N 3.1 Number concepts	Understand and use patterns of whole numbers to 9999			✓	
	Understand and use patterns of common and decimal fractions			✓	
	Understand and use place value of each digit within a whole number and decimal fraction			✓	
	Apply conventions for reading, recording and rounding dollars and cents		✓		▨
	Outcomes				
N3.1	Compare, order and represent whole numbers to 9 999 and common and decimal fractions, and calculate cash transactions.			✓	

Figure 5.8: ***Elaborations and Outcomes (Assessment Results Collated)***

Learning experiences were then designed with assessment performed through instruments such as the double rubric. In a modification to the earlier rubrics designed to enhance the 'flow' to reports, the overall learning outcome for the task was added to the bottom of the rubric as shown in Figure 5.9.

Understanding Fractions

Name ______________________________ **Date / /**

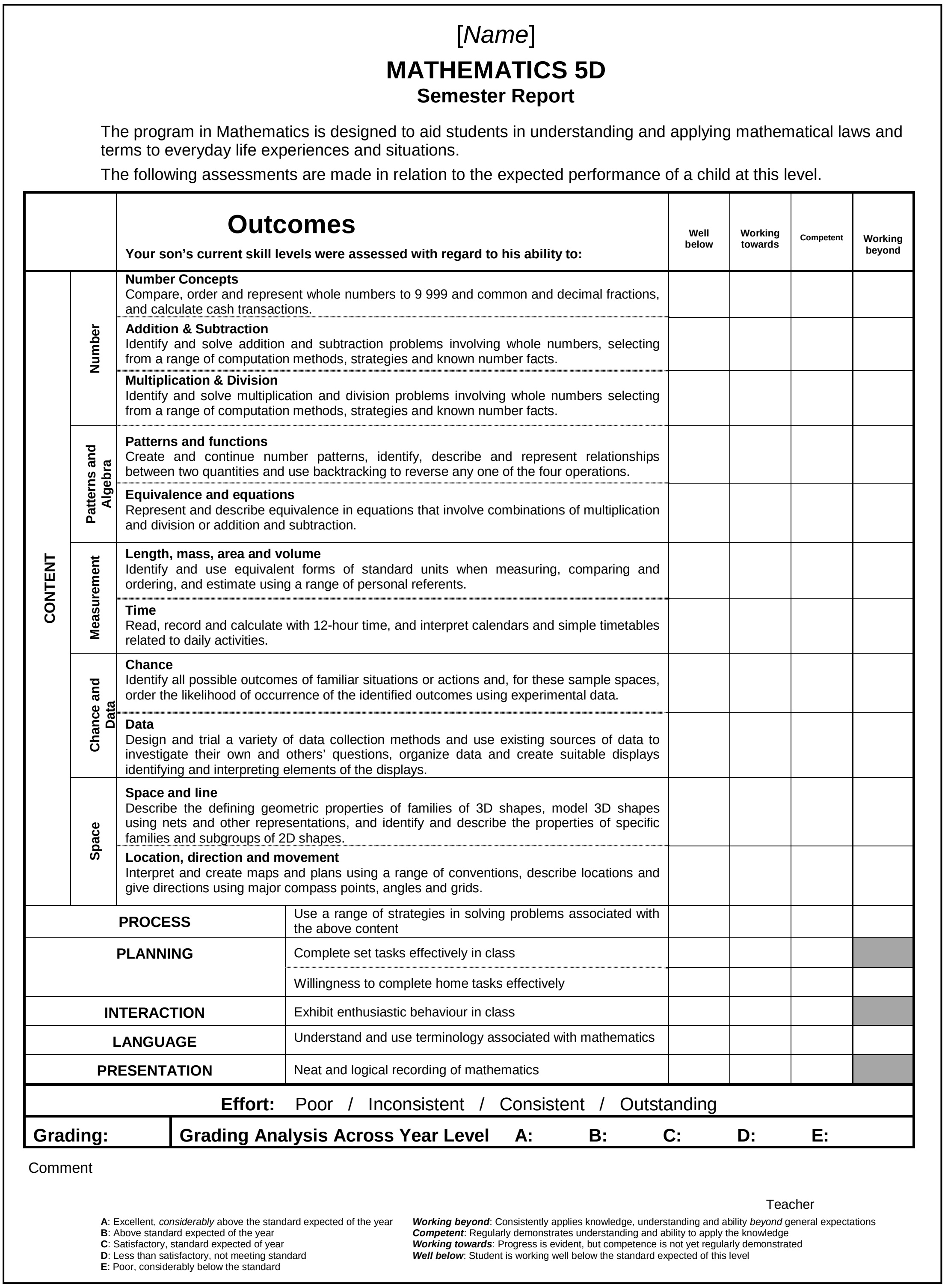
Outcomes	Needs Much Work	Working Towards	Competent	Working Beyond
Show common fraction equal to one whole	Limited or no understanding of fractions equal to 'one whole'	Some understanding of fractions equal to 'one whole'	Understands fractions equal to 'one whole'	Understands fractions equal to more than one
Illustrate fractions in a diagram	Cannot illustrate fractions through creating a diagram	Can illustrate some fractions through creating a diagram	Illustrates given fractions by creating clear diagrams	▨
Place fractions on a number line	Places very few fractions on a number line correctly	Places some fractions on a number line correctly	Accurately places fractions on a number line consistently	▨
Add fractions with common denominators	Unable to add given fractions accurately	Adds some given fractions accurately	Consistently adds given fractions accurately	Adds larger given fractions accurately
Subtract fractions with common denominators	Unable to subtract given fractions accurately	Subtracts some given fractions accurately	Consistently subtracts given fractions accurately	Subtracts larger given fractions accurately
Problem writing	Unable to create problems using fractions	Can create problems of limited scope using fractions	Creates problems using fractions consistently	Creates very interesting, challenging appropriate problems using fractions
Working shown	Shows no working	Shows some working	Working is shown and easy to follow	Working is complete, very detailed and clear
Neat and logical work	Work is untidy and incomplete	Mostly completed; some effort with neatness shown	Tasks are complete and neatly presented	Fully completed with a very high standard of layout
Reporting Outcome **Understanding addition and subtraction of fractions**				
Comment				

Figure 5.9: ***Rubric with Reporting Learning Outcome Statement***

With rubrics now displaying reporting learning outcomes, the next step was to establish an effective, simple link to the report form. Through work by the group, which saw non-focus group teachers invited to examine prototypes for comment, the report form was reformatted. The successful reformatting meant that each result in relation to any particular outcome could now simply be transferred directly from a teacher's records to the report in what became a simple, efficient operation.

A significant efficient operation initiated in regard to accountability was the linking of the devised feedback and reporting format to a suitable computer program. Investigation found a commercially available computer program that could be adapted to store the linked elaboration and outcome groupings to facilitate the transfer to reports. The biggest advance devised through the computer program adaptation was enabling teachers to electronically record and store complete student assessments against both syllabus elaborations and learning outcome statements as shown in Figure 5.8. A digital link between that record and the report form (see Figure 5.10 overleaf) saw the assessment results automatically transferred into the electronically stored report form. When the progress report was required, the teachers simply opened the stored report form within the computer program. Already displayed on the document were all assessment results in the form of ticks adjacent to the appropriate outcome statements. The teachers then simply added a word-based comment at the bottom and the completed report was printed for distribution.

The simplicity of data handling proved a major 'selling point' with the wider staff. Although only a small number of other staff had become involved in aspects of the developmental work, many knew of and showed keen interest in it. Prior to the study, the school's system had not facilitated any form of linked storage of assessment results. The lack of such a system meant a great deal of work for teachers at the end of each reporting period. As they had to refer back to and electronically transfer students' results for the semester into what were blank report forms. As it represented an appreciable economy of time, particularly in the case of mathematics, the new reporting system concept was well supported. The revised reporting format provided another platform for future professional development of all staff after the study was completed.



[*Name*]

MATHEMATICS 5D

Semester Report

The program in Mathematics is designed to aid students in understanding and applying mathematical laws and terms to everyday life experiences and situations.

The following assessments are made in relation to the expected performance of a child at this level.

		Outcomes **Your son's current skill levels were assessed with regard to his ability to:**	**Well below**	**Working towards**	**Competent**	**Working beyond**
CONTENT	**Number**	**Number Concepts** Compare, order and represent whole numbers to 9 999 and common and decimal fractions, and calculate cash transactions.				
		Addition & Subtraction Identify and solve addition and subtraction problems involving whole numbers, selecting from a range of computation methods, strategies and known number facts.				
		Multiplication & Division Identify and solve multiplication and division problems involving whole numbers selecting from a range of computation methods, strategies and known number facts.				
	Patterns and Algebra	**Patterns and functions** Create and continue number patterns, identify, describe and represent relationships between two quantities and use backtracking to reverse any one of the four operations.				
		Equivalence and equations Represent and describe equivalence in equations that involve combinations of multiplication and division or addition and subtraction.				
	Measurement	**Length, mass, area and volume** Identify and use equivalent forms of standard units when measuring, comparing and ordering, and estimate using a range of personal referents.				
		Time Read, record and calculate with 12-hour time, and interpret calendars and simple timetables related to daily activities.				
	Chance and Data	**Chance** Identify all possible outcomes of familiar situations or actions and, for these sample spaces, order the likelihood of occurrence of the identified outcomes using experimental data.				
		Data Design and trial a variety of data collection methods and use existing sources of data to investigate their own and others' questions, organize data and create suitable displays identifying and interpreting elements of the displays.				
	Space	**Space and line** Describe the defining geometric properties of families of 3D shapes, model 3D shapes using nets and other representations, and identify and describe the properties of specific families and subgroups of 2D shapes.				
		Location, direction and movement Interpret and create maps and plans using a range of conventions, describe locations and give directions using major compass points, angles and grids.				
PROCESS		Use a range of strategies in solving problems associated with the above content				
PLANNING		Complete set tasks effectively in class				▨
		Willingness to complete home tasks effectively				
INTERACTION		Exhibit enthusiastic behaviour in class				▨
LANGUAGE		Understand and use terminology associated with mathematics				
PRESENTATION		Neat and logical recording of mathematics				▨

Effort: Poor / Inconsistent / Consistent / Outstanding

Grading: **Grading Analysis Across Year Level** **A:** **B:** **C:** **D:** **E:**

Comment

Teacher

A: Excellent, *considerably* above the standard expected of the year
B: Above standard expected of the year
C: Satisfactory, standard expected of year
D: Less than satisfactory, not meeting standard
E: Poor, considerably below the standard

Working beyond: Consistently applies knowledge, understanding and ability *beyond* general expectations
Competent: Regularly demonstrates understanding and ability to apply the knowledge
Working towards: Progress is evident, but competence is not yet regularly demonstrated
Well below: Student is working well below the standard expected of this level

Figure 5.10: ***The Mathematics Report***

Third Teacher Survey: The Extent of Change

Near the conclusion of the study the types and forms of assessment currently being used by the teacher focus group were compared with what had been the case at the beginning of the transition (see Tables 4.2 and 4.3, p. 99). Data were gathered through the final teacher survey and classroom observations. The revised figures, with the extent of change stated in brackets, gave an indication of the extent to which teachers had embraced and implemented assessment change. Examination of each teacher's figures indicated both individual and overall patterns of interest.

As Teacher A had withdrawn from the study (discussed in the section which follows) no change was noted in relation to his assessments. Of the others, Teacher C exhibited the least change (see Table 5.3). In fact, the level of change was appreciably lower than the remaining three teachers and was considered disappointing by the teacher concerned. She had made efforts to change but found over 30 years of traditional methodology extremely difficult to override even though she was motivated and supported by her colleagues. The changes she claimed were the introduction of limited authentic performance tasks and the move from single response numerical problems to an increase in the level of word questions, a promising move towards one thrust in the process portfolio concept. Latent potential lay in a comment that she made regarding being prepared to change even though she saw herself as a traditional teacher.

Table 5.3: **Assessment Formats Used by Teacher Focus Group after Change**

Breakdown of Assessment Formats							
Teacher	Application Tasks/ Projects	**Questions**		**Tests**			Total
		Informal	Formal	Mentals	Number facts	Topic testing	
A	0	20	10	10	10	50	100
B	***50*** (+50)	***10*** (-10)	10	***10*** (-10)	10	***10*** (-30)	100
C	***10*** (+10)	20	0 (-10)	10	10	50	100
D	***60*** (+50)	***10*** (-10)	***0*** (-10)	10	10	***10***(-30)	100
E	***30*** (+30)	10	***0*** **(-10)**	10	10	***40***(-20)	100

N.B. Bold italics indicate change. Figures in brackets indicate extent of change. Sources: Final teacher survey and observations

When it came to application tasks, Teachers B, D and E showed substantial increases of between 30% and 50% in the use of such tasks. Teacher D had begun the transition almost immediately the study began and worked at increasing the levels of understanding of both himself and his students. To move from very minor use within what was clearly a behaviourist classroom to over half the assessment being centred on application tasks was notable. The increasing level of enthusiasm for the revised approach was readily evident throughout that classroom over the entire period of the study. Teachers D and E reduced the earlier emphasis on informal questioning appreciably, preferring to use the application tasks as they were able to be designed to cater for a wide variety of learning styles and abilities. Teachers B and D decreased their reliance on topic diagnostic testing markedly, while for Teachers C and E that remained unchanged. Teacher E's lack of change was attributed to the Year 7 program being influenced by Year 8 texts and expectations within the school's P-12 structure.

The types of questions used altered markedly, particularly in the cases of Teachers B and D. Open-ended questions replaced closed questions (see Table 5.4). While closed problems were often still used to begin task sheets, many now finished with open questions encouraging synthesis, analysis and creativity. The increase in the use of mathematical language by the teachers blended with the expanding use of such expression in student critiques and reflections. Importantly, in three out of the four classes summative assessment decreased appreciably with the emphasis shifting to formative assessment. This reflected teachers' recognition of the importance of formative assessment in learning. Overall, the changes indicated a growth in the appreciation of the focus group as to the importance of assessment as a learning tool.

Table 5.4: **Question and Assessment Types and Formats after Change**

Types and formats of questions and assessments (in 5% groupings)								
	Question type		**Question format**				**Assessment type**	
Teacher	Open-ended	Closed	Numerical		Word		Formative	Summative
			S/R	M/C	S/R	M/C		
A	0	100	90	0	10	0	0	100
B	***60*** (+40)	***40*** (-40)	***50*** (-10)	***0*** (-10)	***50*** (+20)	0	***80*** (+60)	***20*** (-60)
C	***20*** (+10)	***80*** (-10)	***60*** (-20)	10	***20*** (+10)	***10*** (+10)	10	90
D	***40*** (+30)	***60*** (-30)	***60*** (-30)	0	***40*** (+30)	0	***60*** (+50)	***40*** (-50)
E	***20*** (+10)	***80*** (-10)	***40*** (-10)	0	***60*** (+10)	0	***40*** (+30)	***60*** (-30)

N.B. Bold italics indicate change. Figures in brackets indicate extent of change. S/R: Short response problems; M/C: Multi-choice questions Source: Classroom observations

As part of this final formal reflection, focus group members' comments regarding the biggest change within their classrooms ranged from personal feelings to thoughts on the process portfolio approach and student involvement in all facets of assessment. Comments indicated a wide range of change over a small group. Teacher perceptions of assessment and accountability had changed. The focus group had come to the realisation that others shared similar issues when it came to assessment change. Teacher B spoke of the diminished need to generate substantial test results in support of student progress reports because of the wealth of material displayed in the process portfolio. Teacher C had made few changes, but nevertheless felt that students setting their own goals in some areas of mathematics and her increased use of options through multi-choice questions in testing and increased use of open-ended questions were at least changes. At this stage, whilst such changes were minor and not necessarily strongly supporting the process portfolio philosophy, they indicated a willingness to change and possibilities upon which change agents could continue to work.

Change was also recognised by Teacher D as he emphasised what students were now able to contribute and achieve through the revised assessment process. A genuinely positive approach was accorded by the new structure. He offered marked support of the constructive and supportive nature of the rubric. Teacher E acknowledged assessment improvement through the process approach. She found working collaboratively with students to build a field of knowledge through authentic tasks strongly beneficial. She saw student participation in assessment through self-assessment and reflection as crucial.

Just as students were offered opportunities to comment on the change through de Bono’s (1994) Plus-Minus-Interesting format (discussed in Chapter 6), teacher focus group members were asked to pass final formal reflective comments using a similar format. Minus points were relatively few, but will need future consideration at the study school. They included issues regarding storage problems owing to the portfolios’ bulk, the chance of loss if it was allowed to go home, the time needed to resource and establish the culture and then to share foresight of its potential benefits with other staff. Indeed, time proved a perennial issue with the teacher focus group, as in time to customise tasks and rubrics if the mathematics was to be authentic. Teachers D and E warned that the fact that change is developmental and uncomfortable for some would need to be borne in mind in any wider school transition to process portfolios.

On the plus and interesting sides of the ledger a number of strong descriptors summed up teachers’ attitudes. The process portfolio model developed was seen as inclusive, holistic, empowering everybody involved, creative and fostering excitement and engagement. It encouraged communication, was student-focussed, learning style friendly, flexible, invoked a sense of pride and accomplishment while identifying student strengths and weaknesses in a positive manner. Importantly, teachers saw it as increasing student awareness of mathematics *and* the learning process through encouraging ownership. It increased self-esteem through a “greater awareness of their capacities through opportunities to explore their own progress” (see Appendix 20, p. 316), and fostered an interactive classroom climate based on social constructivist pedagogy; all hefty praise indeed.

Additionally, the realism of students being able to present and discuss their work with parents drew focus group support under ‘Interesting’, as did students’ growing ability to self-assess and adapt to the revised structure of mathematics activities. Opportunities for student comment on how they learnt were seen as invaluable feedback for teachers. The teachers said that students enjoyed reading over assessments and reflections, a learning experience in itself, and parents gained from reading their children’s insights into their learning. According to Teacher E, the portfolio was seen as providing “tangible evidence of the capacities of students at that point in time … in a wide range of areas other than just mathematics” (see Appendix 20, p. 316).

BARRIERS TO CHANGE

The complexity of the education process and the relationships within that process ensure that change is rarely a straightforward matter. All stakeholders have vested interests to protect, but the initial key to any successful change is teacher receptivity. By undertaking the assessment transition the teacher focus group had indicated their willingness to become change agents. As previously discussed, in focus group meetings and data collection members exposed and examined their attitudes towards change, the practicalities of change and its associated uncertainties, the personal cost involved and the available support mechanisms within the study school. Experience revealed that all influence the rate of change uptake.

From the outset, the focus group had advanced ‘how-to’ possibilities and focused on real classroom contexts. Feedback as to the positive results of their efforts was a major factor in maintaining their commitment to assessment change. Data collection revealed that the teacher focus group believed that the needs and issues being addressed were important and were being met through their mutually supportive interactions. The tangible success that the group experienced overall was a markedly noticeable incentive during the transition.

Teachers and Change

The change monitored by this study was not without its barriers, but most were overcome through cooperative planning and effort. Generally, fears and anxieties within the teachers were resolved through time being taken in early focus group meetings to ensure that the reasons for change, the philosophical basis for the effort and the nature of the problem and practicality of the development program were understood. Whilst some early apprehension was evident in all members of the teacher focus group, generally it dissipated as the work progressed through mutual group support and growing confidence as evidenced through interview and survey results revealed within various parts of this thesis. How-to possibilities were plentiful, needs and issues were rapidly addressed, tangible successes were shared and positive feedback was frequently given across the group. Although discussion about minor problems is mentioned throughout this thesis, two teacher-raised issues need discussion at this point, beginning with the major matter of time.

Time to develop and evaluate the very large change involved was mentioned regularly as the major early obstacle to investigating and bringing about the desired transition. Primary class teachers have heavy responsibilities across at least all of the core subjects and overall responsibility for the progress and pastoral care of their students. A committed primary teacher is generally ‘time poor’. However, data showed that members of the teacher focus group supported each other through sharing ideas, planning and a wide range of teaching materials, to the point where the time concern received decreasing mention. The portfolio became embedded within the teacher focus group’s psyche and teaching programs.

The transition was hampered by a second problem. As the first year of the study progressed, Teacher A expressed strong concerns about his ability to take part in the development. Discussions revealed that as he was new to the year level he believed that his unfamiliarity with the syllabus would hamper any attempt at innovation. He found that regardless of what he wanted to do, he could do little more than cope with the basic requirements of the Year 4 syllabus and was hesitant to leave his ‘pedagogical comfort zone’. After much discussion, assurance and support, he agreed to maintain the change attempt. I spent increased time each week in cooperative planning, both team and demonstration teaching as well as observing the mathematics classroom and offering constructive feedback. However, whilst some progress was made with isolated components of the portfolio concept, after further discussion the teacher left the study during its first year.

His withdrawal from the study was marked by a lengthy ‘exit’ debrief which was noted in the Study Log, extracts of which form Appendix 32. Whilst he believed that there was a definite need to examine possible change in mathematics teaching and assessment practices, his traditional approach to education was proving a major obstacle. He felt more comfortable working with familiar approaches, at least during his initial year at his new teaching year level. Teacher C had expressed similar concerns in relation to change, but persisted with the revised approach with abundant support from Teacher B. However, Teacher A felt more comfortable being ‘out the front’ of the class ‘in charge’. He expressed feelings of inadequacy in comparison to younger teachers who appeared willing to “have a go at anything new with only limited background knowledge” (see Appendix 32). He admired but was unable to adopt such an approach.

As part of the discussion, Teacher A also raised the issue of time, time to learn the old, the new and assimilate change. He stated that he did still want to be part of any subsequent wider school transition. He recommended that when any transition took place that staff be given plenty of time to assimilate, that various models and exemplars be offered and that teachers be mentored by year level peers if possible.

Students and Change

In line with Fullan (1991), the teacher focus group was aware that successful student participation in the transition was determined by the nature of what students were required to do. The teacher focus group ensured that their students participated by making sure that they understood, acquired the appropriate new skills, such as constructive critiquing and were motivated to engage with the revised approach to learning and assessment. Through careful planning the teachers ensured that heightened student engagement was integral to the change process.

However, several negatives were expressed by students, such as, “Sometimes you get too much work to do in a small amount of time”, “Not enough maths time” (Appendix 33, p. 338), “You can get happy about your assessment but you can get upset about the teachers marks” (Appendix 33, p. 339) and “You can’t lie to mum” [when she can see the learning narrative] (Appendix 33, p. 341). However, the final student survey (PMI) which drew such remarks and is discussed in detail in Chapter 6, revealed that all students had positives to say regarding the change. Overall, student barriers were minor but with teachers cognisant of student attitudes the barriers attracted constructive attention during teachers’ subsequent planning.

School Community and Change

As the change reported in this study was major in that it effected the entire mathematics teaching, learning and assessment program across a number of classes, it would have failed had the school community not provided encouragement and support. Parents were involved in the change as deeply as practical and as a result resistance was non-existent. Parental involvement is discussed in depth in Chapter 7. While there were some early doubts expressed by parents, those doubts dissipated once parents had opportunities to see their child work within the evolving process portfolio structure. Overall, the section of the school community that was involved in this study was overwhelmingly supportive of the change as parents gained very clear impressions as to the progress of their child through the detailed portfolio displays communicating their learning and achievements.

WIDER STAFF INVOLVEMENT

Teacher Assertion: *“I think at the beginning of the year we should have shared the idea of the process portfolio with the whole staff; I have found that to do the process portfolio with one group that is really three different classes to be difficult.”*
(Teacher C: see Appendix 13, p. 301)

The above assertion was made by Teacher C who struggled with both the concept and reality of the process portfolio throughout the study. It was based on difficulties experienced through the use of grouping for mathematics across one particular year level. However, in the second year of the study a second member of the focus group, Teacher E, became part of that year level grouping and managed the movement to the process portfolio effectively while offering continuing support to Teacher C. Teacher E had grappled with and assimilated assessment change quite readily and had begun to influence change amongst the wider staff with discussion and the sharing of portfolio components, particularly tasks which contained embedded assessment options.

In changing from an assessment base which would be classified as strongly traditional and conventional, caution as to the pace and breadth of change was sensible. Therefore, the use of a small focus group was considered appropriate, as against complete upheaval of the entire teaching and learning program. It was a matter of personal professional judgement based on lengthy experience within the school’s structure and the study school’s embedded politics, forever a factor.

However, to keep the wider staff informed and involved to a manageable extent, professional development was not restricted to the teacher focus group. In sharing developments, presentations were made to the staff and wider audiences on a number of occasions. The incidental growth in the number of teachers who became involved in the study in some way generated heightened interest across the staff and increased levels of useful feedback from all staff.

As a result of the high level of professional interaction across the teacher focus group, the actual number of teachers involved in the concept’s development grew to include others looking to adopt the process portfolio. They began with particular components that held appeal for them, in accordance with Hord et al.’s (1987) ideas about change dissemination and implementation. Of course, their interest was appreciated and actively fostered by the teacher focus group as the group had demonstrated the value of synergy and were happy to expand the teacher base. In fact, all teachers within the school were touched by the study in some way as journal articles were shared, the focus group’s ‘discoveries’ were discussed at staff briefings and meetings and general use accountability documents, such as the mathematics report, were modified.

Invitations for the wider staff to visit teacher focus group classrooms and participate at an individual level within their class programs followed indications of interest from the wider staff, further spreading the influence of the study. Another incidental benefit was seen through the new ‘participants’ adding yet greater depth to facets such as task and rubric writing and beginning to examine the possibility of taking the double rubric into other subject areas. Inclusion of other teachers, with them starting their adoption at points of the model that they found of strong personal interest was possible as the process portfolio model facilitated was extremely flexible. Initially, partial implementation of the model succeeded, as the teacher focus group had found. The casual expansion of the group was encouraged as it had the potential to broaden discussion and generate yet further ideas as to the possible form variations of the expanding assessment base could take.

Whilst the spread was quite unstructured, the school being relatively small with only fourteen classes within Years 3 to 7, which was where the interest lay at the time, meant that oversight of, and indeed interaction with pockets of expansion were not difficult to maintain. Indeed, the informal spread was seen to add natural depth to later considerations regarding the transferability of the assessment format across the wider school.

Such possibilities were highlighted by one Year 6 class which adopted the Real-life Journal and modified the teacher focus group approach. Instead of students being assigned the journal to make an entry, the book remained accessible to students throughout the day. Students took the book whenever they had ideas for entries or wished to add notes to 'their' page with a view to 'building' towards a later entry. The class also had shared topic pages, such as the *The New Turtles* (see Appendix 34). After discussing a common theme, all members of the class added thoughts and questions to the common page, or their page as they occurred. Those entries often led to subsequent mathematical investigations.

The Process Portfolio Package – Working Hypotheses Considered

For the greater part, the working hypotheses, as broad as they were, held true. In relation to the first, numerous focused learning experiences were necessary in order for the teacher focus group to come to terms with the process portfolio concept and develop a suitable model. In regard to the second, the group's early struggles with the process portfolio concept were overcome and the model developed markedly in complexity and flexibility.

However, as in any constructivist learning, teachers' experiences and current methodologies influenced the starting points and depth of much of the learning. The need for ongoing professional development remains if the teacher focus group is to be facilitated in further development of the assessment structure. Professional development must also address the needs of the wider staff if and when they embrace the process portfolio model that resulted from the teacher focus group's work in this study. The success of the revised learning and assessment structure demanded that the process portfolio became an embedded part of the teaching program. Whilst a great deal was achieved and successful approaches developed, much remained to be done in not only applying the process portfolio in mathematics, but also in moving the general approach into previously overlooked areas such as Science and the Study of Society and Environment (SOSE).

THE NEXT CHAPTER

Whilst the teachers were the focus of this study, to be effective education must genuinely involve and engage a number of stakeholders. That 'TEAM' within the key stakeholder relationships is illustrated by the 'triangle of interdependence' shown in Figure 5.11.

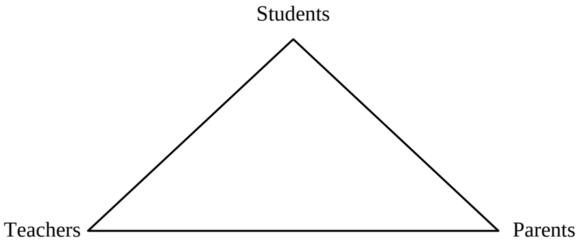


Figure 5.11: ***Partners in Education***

For students, the focal vertex of schooling, to realise their true potential, experience lasting success, they must be strongly supported within the 'Education TEAM' by teachers and parents. The next chapter discusses the vital part that students played in the development of the process portfolio. The mutual dependence of the three members of the team is highlighted by the realisation that if one member fails to accept their crucial role only two members remain, leaving only a straight line, nothing resembling a triangle, a mathematical figure of great structural strength.

CHAPTER SIX: STUDENTS - THE REAL FOCUS

With the previous two chapters focusing on teachers' points of view and input, this chapter gives voice to the ultimate focus of the study's development work, the students. One major outcome sought from the teacher effort and learning reported by this study was to have students strongly engage with all facets of the mathematics program through a well-designed process portfolio. Over two years the focus group teachers spent considerable time designing and trialling process portfolio components and planning and implementing learning experiences. Keys to the development processes were student beliefs about the nature and purpose of mathematics, feelings towards learning mathematics, participation in that learning and its assessment, and feedback about their learning and achievement.

Working Hypothesis

The working hypothesis for this facet of the study was:

> As some two thirds of the students involved had expressed an early liking for mathematics, students would accept the changes to assessment readily. The difficulty for teachers would be in maintaining the expected early student enthusiasm across the breadth of the changes made.

STUDENT INPUT: A CHRONOLOGICAL REVIEW

Over two years, students in the teacher focus group's classes were heavily involved in many facets of the work as part of their normal mathematics classes. Process portfolio tasks were many and varied. Journal entries, problem writing and critiquing, problem solving, rubric creation, self-assessing and reflecting upon their efforts encouraged student involvement in all facets of the development. The number of students involved in the change expanded as other teachers in the school began to accept the portfolio challenge. Their students became involved as those teachers experimented with facets of the approach. The increased feedback from the extra teachers added further diversity to each of the evolving portfolio components.

During the developmental work, those students who were part of the study were asked to complete surveys and interviews so that the teacher focus group remained informed of their students' perceptions and progress within the emerging teaching, learning and assessment structure. Student contributions are discussed on a chronological basis in examining their part in the development of the process portfolio model which resulted from this study.

The extensive data generated by the first three instruments completed by students were used to formulate the student interviews which were designed to provide the teacher focus group with ample information with which to determine the shape of the process portfolio model. The first revelations formed a major learning experience for teachers, as students had never before been asked to share their thoughts and opinions in such a comprehensive, structured manner. Early data, whether directly linked to portfolios or not, generated high levels of discussion within the teacher focus group.

The First Student Survey

The first student survey was deliberately broad. Although this study centred on process portfolios, in the early stages of the academic year the focus group teachers saw it as an opportunity to gain an overall picture of their classes' perceptions of, and inclinations towards, mathematics. Such information would have a bearing on all aspects of the teachers' approaches to teaching and learning as well as assessment. As the examination of the process portfolio concept by the focus group was embryonic, a wide initial picture of student insight was seen as beneficial.

Therefore, the main threads in the survey included reasons for learning mathematics, where mathematics is used, feelings regarding mathematics, seeking help in learning mathematics, family attitudes about mathematics and their self-perceptions as learners of mathematics. Composition of the student sample of 121 Years 4 to 7 students and the development and administration of the first survey instrument were discussed in Chapter Three. The first survey's resultant data were reviewed with the teacher focus group. The data are displayed in Figures 6.1 to 6.12 and discussed accordingly.

Students' perceptions related to the reasons for learning mathematics are illustrated in Figure 6.1 overleaf. Year 4 responses indicated a line of thought which differed markedly from most other groups. Learning mathematics "made you smarter" according to the majority of the younger students. Unlike other groups, they placed general life skills low in their reasons for learning mathematics. The multi-age 4/5 group ranked mathematics highly as making one 'educated'. With this group, general life skills became more prominent in the eyes of the students, a pattern that was maintained across the upper year levels. As with all but the Year 4 group, mathematical skills were rated appreciably below general life skills, implying that students saw no connection between the two. This offered teachers opportunities to establish the connections through process portfolio tasks.

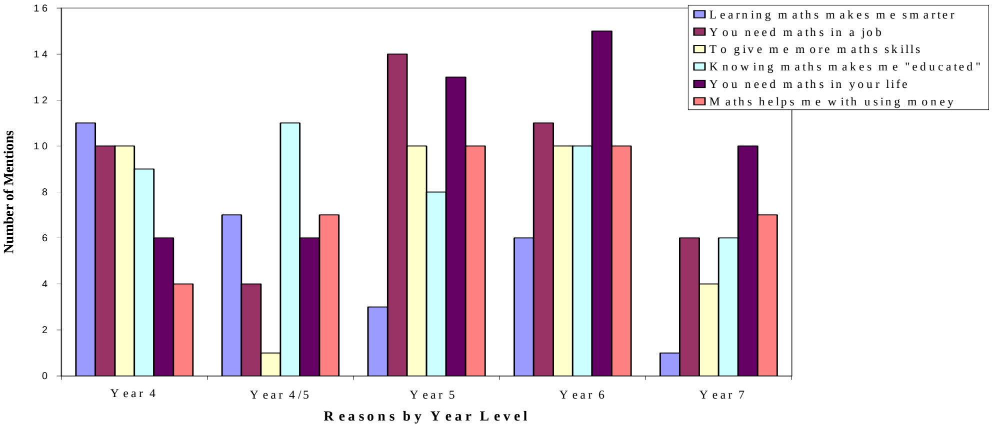


Figure 6.1: ***Why are you learning mathematics?***

Year 5 students highly ranked ‘real’ world mathematics through a link to employment and general life skills. Educational reasons for learning mathematics then followed. Both Years 6 and 7 students also ranked general life skills, employment and money most highly. Interestingly, that high ranking supported similar reasons for teaching mathematics which had been expressed by the teacher focus group. Maths skills, being ‘educated’ and making one smarter were ranked lowly by Year 6 and 7 students, as well as by the middle-primary students.

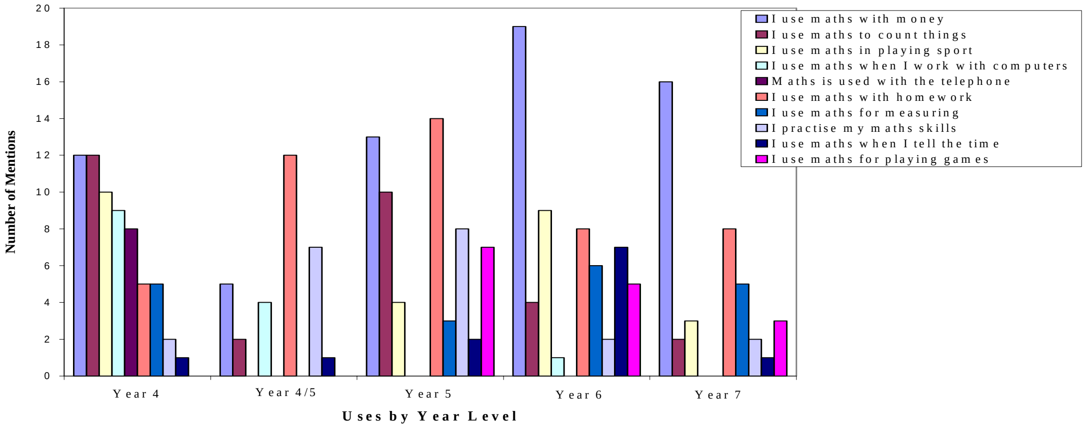


Figure 6.2: ***What do you use mathematics for outside of school?***

In the use of mathematics outside of school, again the youngest students differed appreciably from the older ones. As Figure 6.2 shows, according to the Year 4 students, money, particularly pocket money, counting and sports topped the list of uses outside of school. Homework gained appreciable importance with the mid-primary students, outranking the ‘real’ world applications which began with the use of money. A comment by one student claimed that outside of school the only relevance of mathematics was “to work with calculators, do homework, or emergency sums in your head” (see Appendix 35, p.344).

Upper primary students placed the manipulation of money well above other applications of mathematics. Teachers noted this result with the comment that such strongly held opinions can be used to great effect when planning teaching programs. Year 7 students revealed an emerging interest in and awareness of motor vehicles when they mentioned costs and power in relation to cars. Portfolio tasks capitalised on such inclinations while attempting to broaden students’ views about the application of mathematics outside of school.

Without exception, across classes, employment and money were the most highly ranked applications of mathematics after leaving school (see Figure 6.3), with the use of mathematics skills at university a distant third. Everyday activities such as measuring, counting and sport followed but were seen as minor uses by students. As with the previous question on using mathematics outside of school, older students drew attention to their emerging awareness of independence through vehicles and their beliefs that mathematics applied to driving.

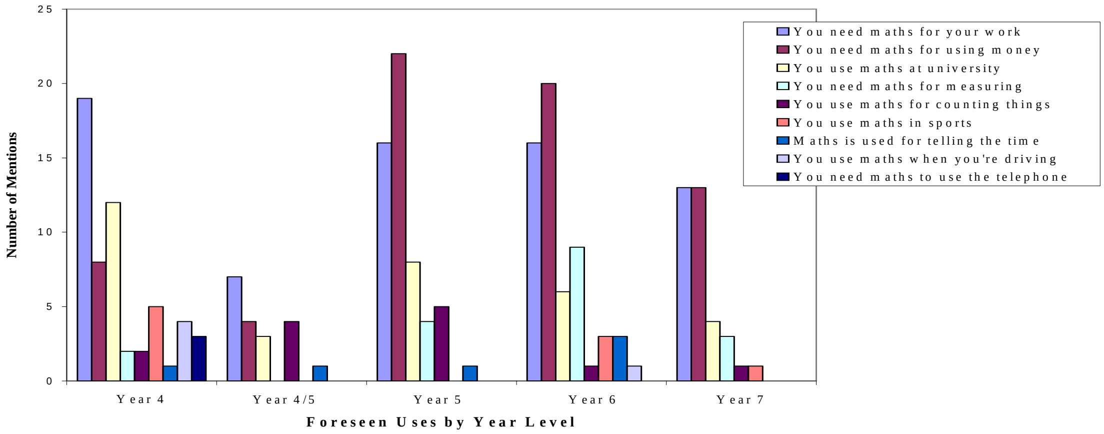


Figure 6.3: ***Use of Mathematics after Leaving School***

Year 4 students’ feelings about mathematics differed markedly from other students, with 21 of 25 indicating a liking for the subject (see Figure 6.4 overleaf). The level of support dropped appreciably to 17 out of 25 within each of the Year 4/5 and Year 5 groups. The popularity of mathematics then improved slightly with 17 of the 23 Year 6 students and 16 of the 23 Year 7 students saying that they liked the subject.

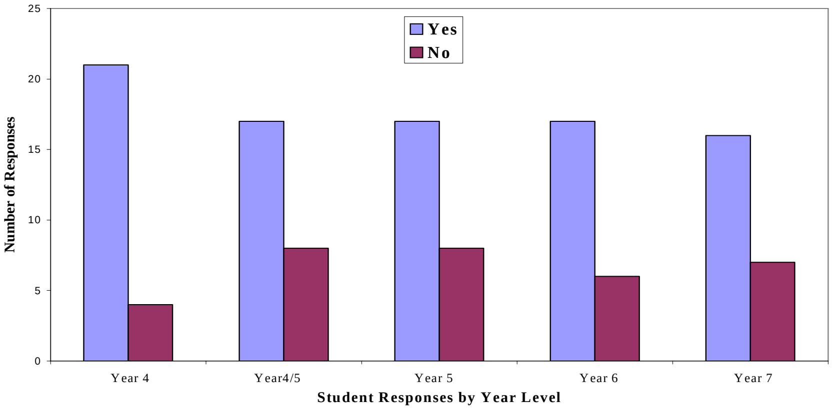


Figure 6.4: ***Do you like learning mathematics?***

The subsequent question offered opportunity for multiple responses in asking those students who liked mathematics to state their reasons. It generated a wide range of pointers, a summary of which is shown in Figure 6.5. ‘Challenging’, ‘exciting’ and ‘a good start to life’ dominated Year 4’s reasons, while Year 4/5 students attributed their positivity to Teacher B’s approach to teaching mathematics. Classroom observations showed that Teacher B used a high level of student hands-on activities in her teaching.

Figure 6.5 illustrates the considerable variation in reasons across the year levels. Middle primary students strongly linked their liking of mathematics to the excitement and fun of hands-on learning, a relatively new, but strengthening facet of the school’s program to cater for visual-spatial learners. After a marked drop in responses tied to mathematics giving ‘a good start to life’ in the Year 4/5 group, it regained importance through an increased level of response amongst the middle and upper primary students. Interestingly, the positive influence of ‘difficulty and challenge’ was significantly reduced amongst older students.

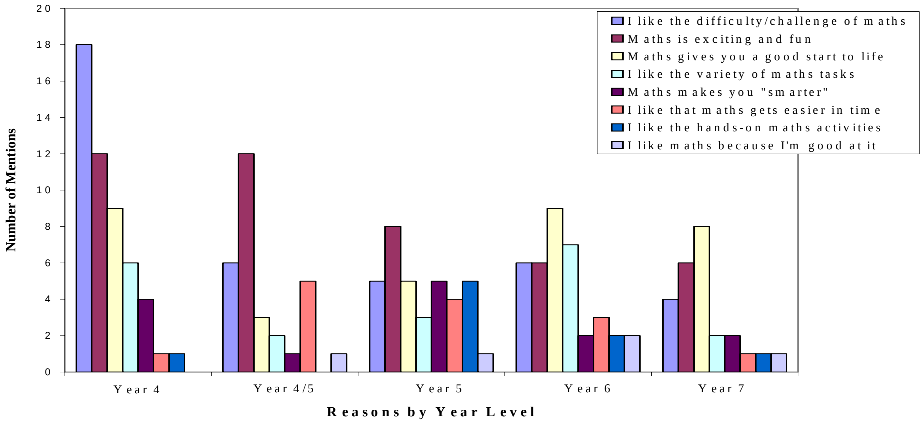


Figure 6.5: ***Students’ Reasons for Liking Mathematics***

Several students, undecided as to their feelings, gave indications of feeling lost. Typical of the group were responses such as, “I just can’t do it and I get emotional” (see Appendix 36). They found difficulty in having the presence of mind to continue by looking for tasks that *can* be completed. Others simply wanted more opportunities to practise skills.

Several points arose from the reasons for student disliking mathematics (see Figure 6.6). Difficulties in understanding mathematical concepts and processes dominated students’ responses. Year 5 opinions related to difficulty, frustration, confusion and poor personal perceptions in relation to mathematics needed attention from the Year 5 teacher in future planning. The ascendancy of ‘boring’ linked to ‘difficult’ in the Year 4/5 group countered the positivity connected to the teacher which had been expressed by those Year 4/5 students who liked mathematics, identifying planning issues for her to consider.

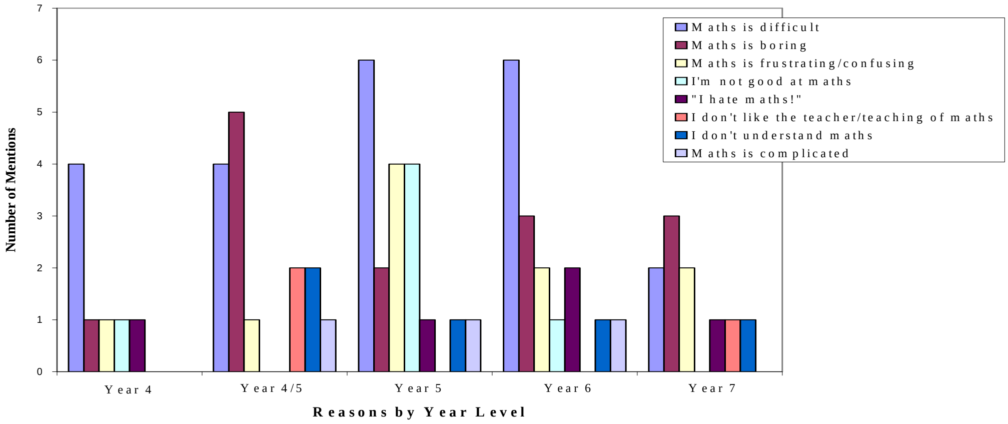


Figure 6.6: ***Students’ Reasons for Disliking Mathematics***

Several issues arising from the student responses were of interest to the teacher focus group. Four of the 25 Year 4 students expressed a dislike of mathematics and gave an average of two reasons each for their feelings. The number of students that disliked mathematics in each of Years 4/5 and 5 doubled to eight with those students again offering two reasons each. Of concern were the high levels of ‘frustration’ and ‘poor personal perception’ evident within the Year 5 class. In Year 6, where 6 of the 23 students disliked mathematics, the number of reasons given per student increased. However, in Year 7 where 7 of the 23 expressed a dislike, students offered only one reason each. In planning, teachers needed to explore and consider whether this meant a dismissal of mathematics by some of the older students or a begrudging acceptance of its presence but a lack of desire to consider the reasons for their feelings.

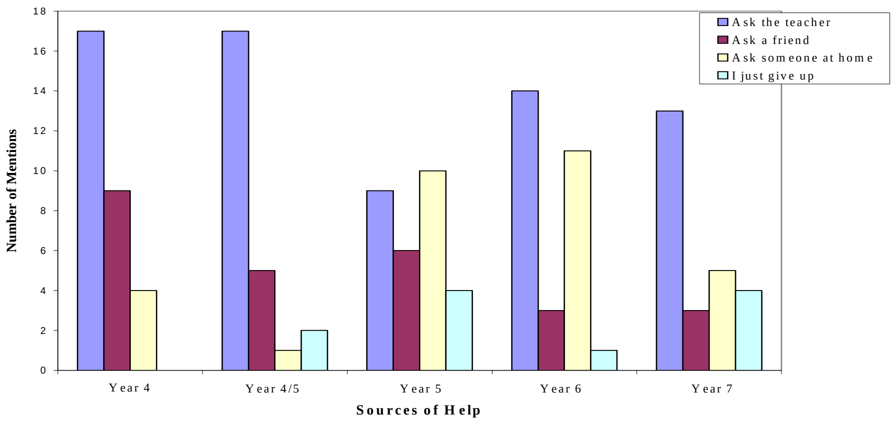


Figure 6.7: ***Students' Preferred Sources of Assistance***

Readily apparent from Figure 6.7 is that students used teachers as their main source of help at school during mathematics lessons. Home help clearly ranked second, although it rated more highly than help from the teacher in Year 5. Help from friends received notable mention by Years 4 and 5 students. The number of students who responded that they gave up was reasonably evenly spread across the classes, although encouraging lows were indicated in Years 4, 4/5 and 6. The Years 5 and 7 levels of student surrender attracted teacher focus group attention and comment regarding possible pedagogical changes to address this attitude in planning the process portfolio approach. However, it should be noted that data from this and other student surveys laid scant blame on teachers as to students' negative attitudes to mathematics.

Teachers believed that the students expressing the preference for help at home, most noticeable in Years 5 and 6, were talking of homework. This increased the teacher focus group's awareness of the need to ensure that students felt confident to seek help from them. It also raised issues for them in regard to parents being well informed about the classroom mathematics program. The focus group agreed that positive attitudes towards mathematics on the part of those at home were important and needed to be nurtured through communication.

Responses to questions about parents' and siblings' feelings towards mathematics saw Year 4 students claim that a majority of mothers (18 of 24) liked mathematics with only 12 of their fathers sharing similar feelings (see Figures 6.8 and 6.9 overleaf). In the mid- primary, where mathematics is more complex, the number of mothers who liked mathematics fell sharply to 25 of 50 while the number of fathers increased to 28. The number of fathers liking mathematics was 29 of 50 in upper primary but the number of mothers fell further to 19. Of interest was that the increase in fathers liking mathematics was accompanied by an increase in levels of help sought at home by students (see Figure 6.7).

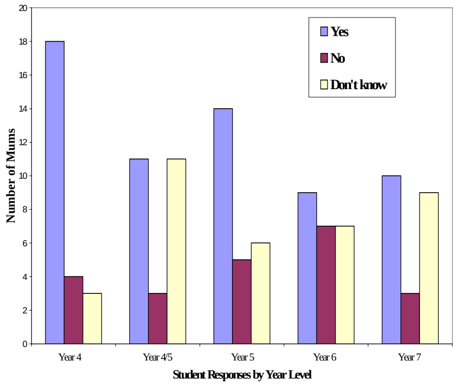


Figure 6.8: ***Does Mum like mathematics?***

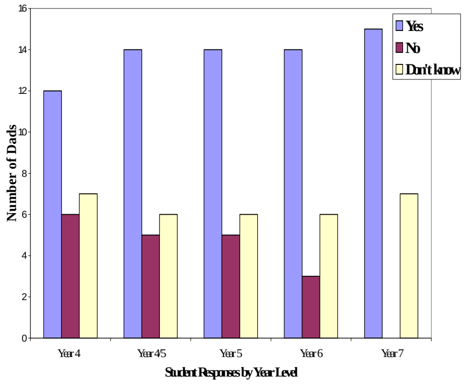


Figure 6.9: ***Does Dad like mathematics?***

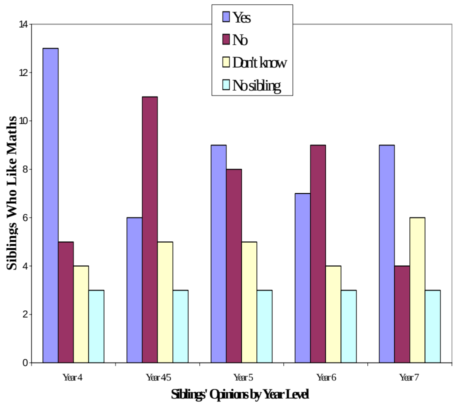


Figure 6.10: ***Do siblings like mathematics?***

Students' perceptions of their siblings' positive influence on their liking of mathematics dropped markedly between Year 4 and Year 6 and 7 students, with a strong negative factor in the mid-primary classes (see Figure 6.10). It appeared that mathematics was not a broadly discussed subject at home as 6 of the 23 Year 7 students were unaware of their siblings' feelings regarding mathematics. Students' responses had made the teacher focus group more aware of opportunities to harness and perhaps increase the levels of home interest in mathematics. The design of process portfolio tasks based on real life situations had the potential to encourage all members of students' families to support students' learning.

As to students' self-perceptions regarding their persistence in mathematics, Figure 6.11 shows that student responses revealed that less than half of each of Years 4 and 4/5, each of 25 students, believed that they were independent workers. In both classes approximately a quarter of the students actually found the work easy most of the time.

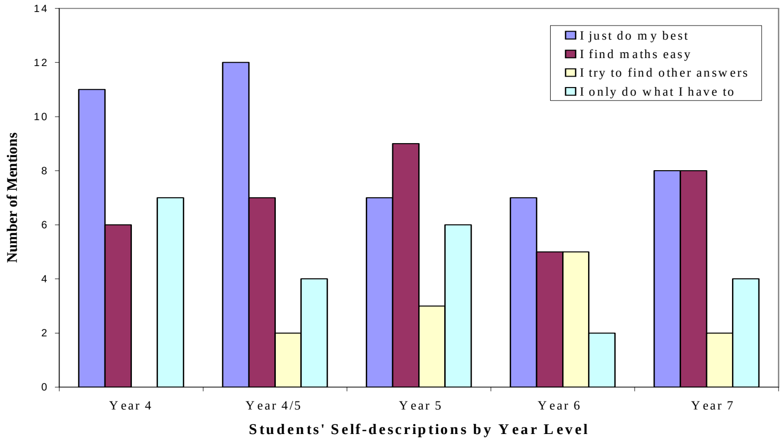


Figure 6.11: ***Students' Self-descriptions of their Mathematical Persistence***

In relation to persisting and looking for alternative answers to problems, the Year 4/5 class contained only two students who sought to do so. The groups seeking alternative answers in Years 5 and 6 were 3 of 25 and 5 of 23 respectively, but in Year 7 those seeking alternatives shrank to 2 of 25. In seeking solutions to problems, the fact that 7 of the 25 Year 4 students did only what was required in order to complete mathematics questions was not seen as a reason for concern by the Year 4 teacher. Responses from those students indicated that they had no idea that alternative answers were possible in mathematical problems.

Across the five classes, which only varied in sample size by a maximum of two, the teacher focus group noted fluctuations in relation to the numbers of students who did their best. In Year 5 a small increase on the number of Year 4/5 students who sought alternative answers from two to three was offset by the increase to six of students who met only minimum requirements in working with mathematics. Proportionally, Year 6 with 7 of 23 students 'doing my best' indicated an improvement on Year 5 students' level of commitment. Year 6 students diminished the inclination to call the work easy and increased the number seeking alternative answers while keeping the proportion that did the minimum well down at 5 of 23. Unfortunately, Year 7 decreased the proportion of seekers of other solutions to two of the 23 students, a regression of concern for the teacher focus group. The focus group realised that there was a clear demand for process portfolio tasks that increased students' levels of independence and encouraged them to persist in seeking alternative answers.

In following the persistence theme, the final survey question asked students to share their perceptions of what best helps them learn mathematics. Figure 6.12 overleaf illustrates the resultant strong level of student support for ‘teacher talk’ and demonstration on the board. Those forms of assistance dominated all forms of help across all year levels in the minds of students. Hands-on mathematics activities also attracted significant student approval. Year 6 students made particular mention of using mathematical equipment in their quest to understand new concepts and procedures in mathematics. Once again, task design and teaching methods needed to take account of the strong student inclination to rely on the teacher as *the* source of knowledge. Tasks needed to counter the inclination by encouraging students’ levels of self-reliance and willingness to explore mathematical possibilities in grappling with problems.

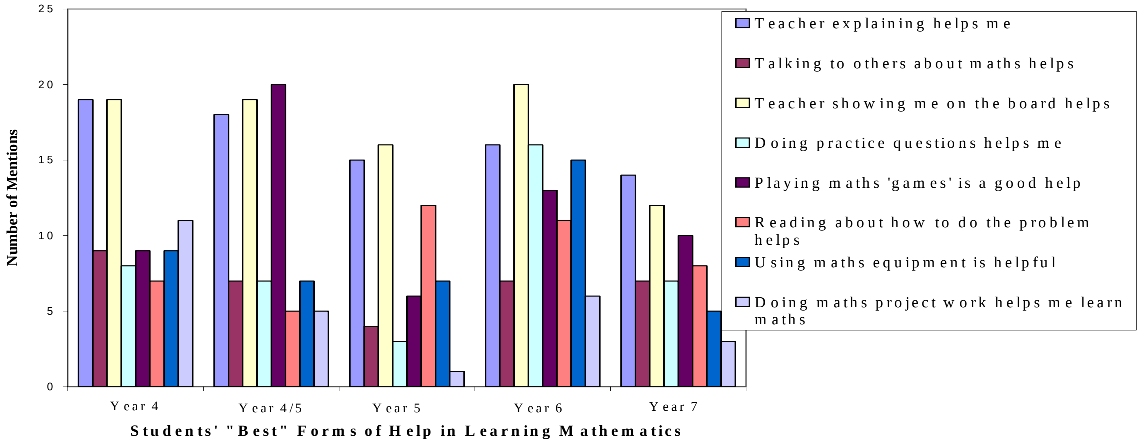


Figure 6.12: *Students’ Perceptions of What Best Helps Them Learn Mathematics.*

The Student Interviews

Following the analysis of the results of the first student survey, student interviews were planned. The interviews were based on data generated by the first student survey supplemented by student perceptions drawn from their completing a local version of the Draw–A-Mathematician Test (DAMT) and a brief second student survey. Subsequent discussion of the results of the two surveys, the DAMT and the interviews was designed to complete the student ‘image’ of the nature of learning mathematics in the study school and their perceptions of the purpose of mathematics outside school, in their ‘real’ world.

Student Interview Sample and Protocol

The student sample of 24 was drawn from the 121 students involved in the study and reasonably evenly from across all five teacher focus group classes. Selection was based on the level of interest sparked within the teacher focus group by the students’ responses to the surveys and the DAMT. Individual interview protocols were written for each student interviewee and were based on the students’ responses to those instruments. Discussion of interview results begins with a review of students’ perceptions as revealed by the DAMT.

Draw-A-Mathematician Tests

Students’ drawings were considered in line with the set of basic indicators advanced by Kahle (1989) who noted that an interesting facet of student responses was the level of stereotypicality across year levels. Stereotypicality, as shown through students’ perceptions of mathematicians as being male, bespectacled and balding, had been discussed by Picker and Berry (2000). However, as with many data generated in the course of this study, the teacher focus group was unaware of the published patterns and a great deal of discussion was stimulated by responses by their students to the DAMTs. Across the 81 drawings, 79 depicted males, with 38 of the mathematicians being teachers. One student indicated that mathematicians’ level of commitment and eccentricity meant that they could and would teach anywhere. This may have been a compliment to teachers, enhanced by the fact that students generally said mathematicians have good concentration, are hard workers and enjoy involved difficult tasks. There was a perception amongst students that mathematicians never give up as they seek perfection amongst the codes and patterns of numbers. According to one Year 4 student, teachers also seek perfection in mathematics. Examples of students’ DAMT illustrations and thoughts are provided as Appendix 37.

A large number of students stated that mathematicians are ‘smart’, as indeed one would need to be in order to ‘know everything’. One Year 4 student’s mathematician even had a smart dog. Nuno (1998) found that students commonly applied the ‘smart’ descriptor to those who understand mathematics. During interview when questioned as to the descriptor, one student attached the meaning, “It helps your brain think more and you know more. You can learn more maths signs”, while another said, “I understand smart as being alert and switched on and knows what is happening” (see Appendix 38, p. 348). Possibly contrary to the earlier compliment to teachers, yet complementary to other student comment, was that several students supported the idea that mathematicians are ‘boring’ most of the time and are generally always inside, isolated from the real world. One expanded his opinion with “Because with maths most people would consider it to be the most boring subject. If a subject is harder, you don’t enjoy it as much. I know a lot of people who are better at English than mathematics” (see

Appendix 38, p. 349). Some respite was offered by another who saw the teaching mathematician coming to the aid of those under mathematically-induced stress, with “Very useful, always helping victims of homework and stuff” (see Appendix 37).

Symbols of research and knowledge were plentiful in the students’ drawings, as were stereotypical symbols of wisdom and intelligence, such as eye glasses. When questioned in the interviews, students who drew glasses on their figures said that glasses were necessary to correct the poor eyesight that resulted from reading too much; ironically, a concern which stereotypically is not a tendency related to boys (Hawkes, 2001). The overall feelings shared by students during their interviews were positive towards mathematicians, but very few expressed a desire to become one.

Opening the study interviews with an approach centring on students’ perceptions of mathematicians proved productive, as students reacted positively to the opportunity to discuss and explain their depiction of personal interpretations of a real world profession. Generally, they found it difficult to explain from where the stereotypical aspects of their depictions were derived; most simply believed that mathematicians would have predictable visible and behavioural characteristics. The teacher focus group realised that there were many issues to be addressed from the stereotypical perceptions. The perceptions were seen as clear support for the focus group’s view that students held narrow views of the nature and purpose of mathematics. Yet unlike the strong negativity found by Bessoondyal and Gribble (2004) amongst Mauritian students, overall these students were found to exhibit a positive attitude towards mathematics. However, there remained broad scope to improve students’ images about mathematics and mathematicians. Teachers saw the responses as yet another motivating factor in their drive to broaden mathematical conceptual understandings through working with expansive real world mathematics in problem solving tasks.

The Second Student Survey

The second group of questions in the student interview protocols was based on student responses to the second student survey which was completed by 102 of the 121 students involved in the study. The survey was a one page instrument which despite, or perhaps because of its simplicity, generated much broadly useful data for the teacher focus group. During the course of the study, three brief student surveys such as this complemented the more extensive questionnaires, interviews and discussions.

In response to questions which asked for students' opinions about what their teacher did and could have done to help them learn mathematics, students commented positively on the level of 'Teacher Talk', as they had done in the first survey. However, the teacher action drawing the highest level of support, mentioned by 49 students, was persistence in explanations of concepts and processes (see Table 6.1 overleaf). In teacher explanations, earlier data analysis was reinforced as chalk and white board demonstrations attracted four times the level of praise from students, 48:13, as that of the second ranked, "Shows me other examples with different sums" (see Appendix 39). Whilst teaching has acquired a wide range of available media, including computers and data-show projectors, the high level of student support (48) for the often maligned 'chalk and talk' was noteworthy. Students clearly indicated their appreciation for such a sequential display assembled by the teacher 'on-the-spot' and related to their direct situation. Most highly appreciated in the 'Nature of Tasks' were teachers making the work "fun" and offering hands-on activity. The latter affirmed Hawkes' (2001) generalisation regarding boys being kinaesthetic learners.

Students asked for a wide variety of improvements to lessons, with 30 students making the most prevalent request, for increased challenge in mathematics tasks. Nineteen students wanted more mathematics games and 12 sought more number fact speed tests, timed tests which sought increased speed of recall based on students achieving 'personal bests'. Discussion showed that students saw hands-on activities as 'games' and linked rapid recall of fundamental number facts to time taken to complete tasks.

Time taken to complete mathematics work was in turn linked to a major student concern, getting 'bogged down' in a task. The perceived speed with which students completed work was directly related to student levels of comfort with particular styles of problem. For example, students who believed that they had rapid recall of multiplication tables appeared confident when working with problems based on multiplication. Surprisingly, it could be claimed that two of the three modifications requested by students involved an increase in pressure situations, not a decrease.

Table 6.1: **Second Student Survey Results**

Student Survey

Number of respondents: 102

Things teacher does that help me understand Maths

	TEACHER TALK					NATURE OF TASK									DEMONSTRATION				ENVIRONMENT		
	Persists	Encourages	Simplifies	Seeks ideas	Spks clearly	Makes fun	Hands-on	Challenges	Variety	Freq. Mental	Games	H/work	Own levl	Group wk	Board	Multiple ex	Videos	Diagrams	Time to fin	Quiets class	Peer tutor
Year 4	4	5	4				1				1			1	11	2			1		1
Year 4/5	7	4	3			3	1			2	3				11		6	1			
Year 5	14	6	5					3					1		13	1		1	1		
Year 6	9	5	2	3		3	4		4	2		2	1		10	4	1	2	1		
Year 7	15	7	4		1	1		1							3	6			1	1	
Totals	49	27	18	3	1	7	6	4	4	4	4	2	2	1	48	13	7	4	4	1	1

Things I would like to see happen in Maths classes to improve my learning

	MORE please!																				
	Challenge	Games	Speed tests	Hands-on	Fun	Expl.	Work	Board	Help	Videos	Diags	Computers	Ind. Work	H/work	Mental	Group wk	Quiet	OHT/P	1-on-1	Calcul'rs	Variety
Year 4	2	3	1	3		4		1	1							1		1			
Year 4/5	6	4	4		1	2				2			2					1			
Year 5	9	4	2	1	3	1	3	1	1		1			1			2				
Year 6	3	1	2	4	2		2	4	1	2	2	2	1		2	1					1
Year 7	10	7	3	3	2	1	2		2			1		1					1	1	
Totals	30	19	12	8	8	8	7	6	5	4	3	3	3	2	2	2	2	2	1	1	1

	MORE please!					and LESS …					
	Oral work	Riddles	Revn	Boys expl	Text bk	Variety	Distractn	H/work	Talk	Work	Bkwork
Year 4					1						
Year 4/5											
Year 5				1		3	1	2			
Year 6	1	1	1					1	2		
Year 7							2			1	1
Totals	1	1	1	1	1	3	3	3	2	1	1

Teacher persistence in explanations and class concentration were reaffirmed by students as of high importance as they assisted students in coping with tasks within a time frame that they saw as reasonable. Students suggested that class concentration would improve through group work which involved peer tutoring. In the development of the process portfolio, the teacher focus group ensured that tasks involved peer interaction through all stages of their completion.

Following the interviews, the collated expanded data base was shared with the teacher focus group. The extensive student opinion regarding mathematics and its teaching was beneficial to the teachers and carried broad connotations for their pedagogies and the structure of the process portfolios. Of note was the fact that the diverse information generated through those early instruments proved of considerable interest to the wider staff, with whom it was shared at a subsequent staff meeting as it had marked applicability across mathematics teaching in general. That interest generated discussion and practical responses in classrooms. Extracts of those responses are discussed later in this chapter.

TEACHERS' PLANNING BASED ON STUDENTS' RESPONSES

Having collected and collated a significant quantity of data from students, the teacher focus group needed to consider the feedback in planning the nature and structure of the process portfolio. Focus group teachers were of the opinion that planning needed to take student opinion into account if the change of assessment emphasis was to realise authentic and lasting gains. Increasing student involvement in all aspects of mathematics, from task development to assessment, had been a strong motivator in these teachers becoming part of the study. They saw the revised approach as a means of enhancing students' perceptions of mathematics and students' self-perceptions as mathematicians.

Students' Attitudes to Mathematics

The overall student positivity regarding mathematics and their self-perceptions as workers in the subject pleasantly surprised the teacher focus group. Data were expected to support teachers' perceptions of student negativity towards the subject which had been revealed by findings of DAMT and DAST studies generally (Bessoondyal & Gribble, 2004; Mays, 2003; Picker & Berry, 2002). The focus group was supportive of assessment change as recorded by this study because of their interest in improving mathematics and their beliefs that a sound understanding of concepts and processes is vital. The evident student positivity regarding mathematics added extra encouraging impetus for the group.

Of interest to the teacher focus group in regard to students liking mathematics was that the proportions of classes that expressed a liking decreased from Year 4 to Year 7. The total number of reasons that Year 4 offered for their positivity was more than double that of the older students. This study did not have the scope to examine the school years prior to Year 4, the area from which much of the indicated positivity appeared to emanate. However, the teacher focus group believed that they would benefit from an awareness of the pedagogy used in the junior years. Presentations by teachers of Years 1 and 2 at subsequent staff meetings ensured that middle and upper primary teachers gained an awareness of junior primary pedagogies.

By giving reasons for disliking mathematics, students offered their teachers significant opportunities to plan programs that addressed their negative perceptions. Year 4 students indicated a passionate dislike for the need to use a range of different thinking skills across mathematical activities. One student exemplified the issue by writing:

> I don’t like learning mathematics because it teases your brain. It
> makes me concentrate too hard. I don’t like mathematics also because
> it is frustrating and makes my mind work overtime. I do not like maths.
> (see Appendix 35, p. 344)

In reasons for students’ dislike, the dominance of ‘boring’, with a likely link to ‘difficulty’ was of major concern to the Year 4/5 teacher. It was early in the year, so the attitude was considered to be residual from students’ previous years’ mathematical experiences. Year 5 students showed a strong dislike of ‘difficulty’ and linked it to frustration, confusion and diminishing self-perception. An awareness of what they needed to learn to succeed but that they saw as difficult to learn, was evident through several comments. For example, one student said, “it is so complicated and hard once you do one thing you need to do another thing to do another thing” (see Appendix 36).

Teachers of the older students needed to address the possible links between ‘difficulty’ and ‘boring’ in all of the learning activities they planned. They had to consider whether or not it was an indication that having endured mathematics to this point, older students were simply giving up when faced with challenge and a claim of ‘boring’ masked that surrender. Carefully considered action was required when planning future activities. Once again, the teacher focus group believed that the process portfolio would offer broader scope in regard to this concern. An additional unease was attached to the decrease in Year 7 students’ reasons for disliking mathematics. Had they simply become resigned to the fact that although they did not like it, mathematics is an inescapable part of school?

In comparing and contrasting student feelings regarding mathematics, passion was evident on both sides of the argument with little middle ground taken by students. Those who found that mathematics is a good start to life felt positive about learning mathematics, while those who disliked it made no apparent connection between mathematics and life. Poor personal perceptions in working with mathematics were noticeable in those students who disliked mathematics. Those who disliked the subject repeatedly stated that it was “boring”, while those who liked it said that the variety of tasks kept their interest. Encouragingly, the issue appeared not to be rooted in the personalities and styles of particular teachers, because comments regarding teachers and teaching styles were minimal.

Of concern to the focus group were students’ responses that indicated that in all classes less than half of the students did their best yet claimed to like mathematics. Students’ claims of a lack of challenge in mathematics tasks evoked a similar response from the focus group. This raised concerns over students’ perceptions as to the nature of problems posed to them. The teachers concurred that the general style of current tasks was closed. It was agreed that tasks needed to offer students suitable levels of openness and challenge if a greater proportion of students were to be encouraged to seek and test alternative solutions to problems.

‘Real’ Applications of Mathematics

Survey and interview data showed that general life skills were rated most highly by students. Written responses about the purpose of learning mathematics linked the skills strongly with employment and money. One student summed it up by reasoning:
“Because later on in life you will have to use maths and its also educational and you also could get the wrong change at a supermarket you could lose money and not know

about it and go bankrupt” (see Appendix 36). The decreased perception of the power of mathematics to make them ‘educated’ and ‘smarter’, contrasting with the increase in support for mathematics giving ‘life skills’, drew comment from the focus group. All agreed that class activities should incorporate elements of both purposes in order to foster a balanced student view.

While students’ strong connection between mathematics and money was evident, one aspect of disconnection from that real world view was exposed through their rating homework as the second most prevalent use of mathematics outside of school. However, that could have been a reflection of a ‘disconnected’ perception of many ‘things school’ or that they saw homework as part of the real world. One student stated a solitary purpose for mathematics with a succinct comment: “I use it for homework” (see Appendix 36). Only the youngest students ranked homework below the top three purposes for learning mathematics. The students’ perceptions of isolated purposes were clear invitation to teachers to introduce tasks that demonstrated the ‘connections’ between mathematics and the world outside of school. Such demands augured well for the process portfolio’s planned strong emphasis on expansive ‘real world’ tasks.

Year 6 students exhibited a wider range of ‘real’ applications of mathematics than other students which probably reflected the dominant emphasis on practical mathematics in that classroom. Year 7’s teacher, Teacher E, made particular note of her students’ real world interest in motor vehicles and the multitude of possibilities available through travel to ensure that transport problems received early emphasis in planning. However, students in the younger years indicated little about the use of mathematics aside from future employment, but that was not seen as a strong concern. Through the tasks set, their teachers would continue to concentrate on mathematics activities which centred on students’ more immediate lives.

Students and Help with Learning Mathematics

Clearly, when it came to help in understanding mathematical concepts, students found teacher ‘chalk-and-talk’ useful. However, the possibility of shifting some of the focus away from the adult teacher, to have students more self-reliant during exploration of topics and tasks, with the intention of having more peer ‘teachers’ sharing their skills, was discussed. It was agreed by the teacher focus group that the demonstration and explanations so keenly appreciated by students need not emanate from a teacher-centric position. Where possible, the teachers agreed that demonstration media used by teachers and students would be varied to a greater extent to assist the shift in focus from teacher as the font of all knowledge to cooperative, collaborative class learning.

In relation to cooperative learning at home, student responses to questioning about family attitudes to mathematics indicated that in the early years of education their parents generally felt comfortable helping them discover numbers and shapes, to explore mathematics. The responses supported what Sutton (2004) had found in relation to home and homework. At home, students expose their parents to the mathematics that they are learning at school through homework. However, indications were that at some stage of their learning mathematics many students have been asked to complete tasks with which their parents feel unable to help. Parents have then referred their children back to the teacher, creating the impression in students that help is no longer available at home. As a result, the teacher focus group agreed that mathematics tasks taken home by students needed to challenge the child while informing ‘home’ and encouraging family involvement through a renewed sense of mathematical purpose. The group’s planned process portfolio approach, which involved students in creating mathematical tasks, not just applying rules blindly to problems, was to lead the reform.

Hands-on activities, so useful in teaching kinaesthetic learners (Hawkes, 2001) were discussed as a viable learning alternative within the planned reform. That students tended to class as ‘games’ any activity in which they manipulated objects in finding solutions was seen as positive. In line with the hands-on option, an increase in the use of mathematics equipment was seen as desirable. From manipulative number lines to measurement equipment to 3D models of paper, card and the like, mathematical equipment, including student produced materials, would be included in teacher planning to a much greater extent in future. This led to discussion and teacher action in relation to changing some classroom layouts in looking to creating spaces in learning environments that encouraged students to use mathematics equipment.

Whilst many areas of concern were unearthed, discussions about the possible forms of the process portfolio had assured the teacher focus group that with planning, coupled to joint activity by students and teachers, the concerns could be addressed. It was clear that a major part of planning should centre on mathematics in the students’ real world.

Student input had influenced the group's direction appreciably and served to increase the emerging group synergy.

FROM BACKGROUND INFORMATION: LEARNING EXPERIENCES

Planning and implementation of revised process portfolio components were ongoing throughout the study. Whilst teacher focus group professional development was part of the process, this section discusses several typical examples of process portfolio-based student learning and concludes with evolving student opinion through student surveys.

The 'Real-life' Mathematics Journal

The class journal produced a wide array of material that was utilised in various ways by teachers and students. Four student journal entries, differing in style and topic, from narrative to recipe, are used to illustrate discussion at this point. Activities derived from student entries are shared by way of demonstrating possibilities available through the journal option within the resultant process portfolio model.

Cliff's[1] journal entry told his Year 5 classmates about a party that he had attended the previous weekend at a Laser Skirmish Park. The entry was made soon after the class journal concept was introduced. As a result, the teacher initiated the consequent activity with students involved in creating subsequent activities. An A3 copy of Cliff's double page narrative was distributed to each student and all were asked to highlight any mathematical words that they found. After a period of individual work it was seen that the first word that any student had highlighted was "two" on the ninth line. Many others had waited until the mention of money some lines later. Discussion about what constitutes a mathematical word ensued. Students realised that the story's first word "Last" was a mathematical word. The complexion of the activity then changed dramatically as students found many such words.

Following the introductory activity, further discussion about the mathematical possibilities within the entry produced a number of ideas for possible entry-based tasks. As it was early days, the teacher undertook to design a task sheet for the following day using the students' ideas. The resultant task, 'Blaster Laser Skirmish' (see Appendix 40) asked students to establish a new business following specific guidelines. It began

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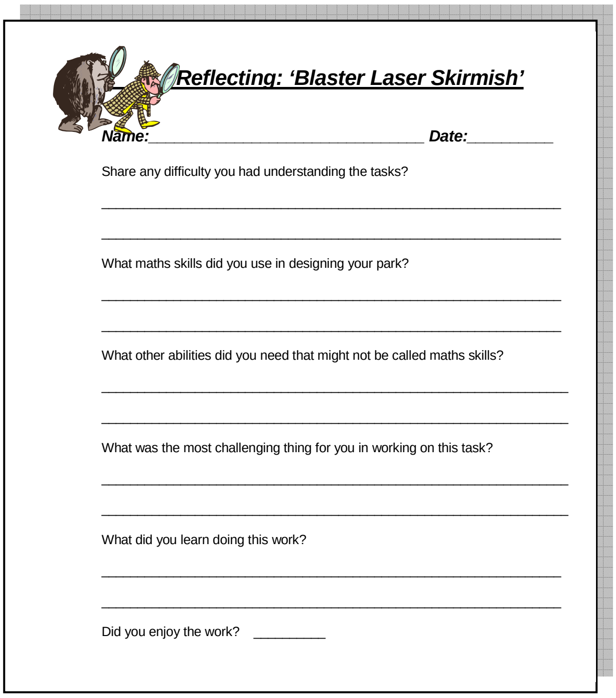
[1] Student names are pseudonyms

with a closed budgeting question and finished with open questions to allow students creative expression in context.

Consequently, students' portfolios displayed complete 'stories' of their development of the task, from notes made of ideas to finished budgets, sketches, advertising scripts and posters. Several students had designed presentations which included 3D models of the park and others shared PowerPoint presentations. All were asked to reflect on the task using the task-specific guide shown in Figure 6.13. Incidentally, some parents took advantage of the scheduled sharing time and visited the classroom to observe the students in action. Feedback from these parents to teachers was very supportive. Parents spoke of their motivation to observe their children as a result of the high level of commitment evident at home through discussion of ideas for the task.



Reflecting: 'Blaster Laser Skirmish'

Name:**______________________________** ***Date:*****__________**

Share any difficulty you had understanding the tasks?

____

____

What maths skills did you use in designing your park?

____

____

What other abilities did you need that might not be called maths skills?

____

____

What was the most challenging thing for you in working on this task?

____

____

What did you learn doing this work?

____

____

Did you enjoy the work? _________

Figure 6.13: ***Blaster Laser Skirmish - Reflection Guide***

From discussions about Robert's journal entry on his trip to New Zealand the teacher discovered that few students had a true concept of distance, particularly a kilometre. The class decided to construct a scrap paper strip kilometre to be unrolled on the school oval. Discussion of method even covered the width of the strips, bearing in mind the need to conserve paper while retaining strength. Students' reflections saw many positive learning experiences emerge, from learning to use a trundle wheel to having to be a patient, supportive member of a team. However, practical work did not always draw positive comment. In completing his guided reflection, one student stated that he did not enjoy the activity as he already “knew everything about this length and this task didn’t help me” (see Appendix 41).

Teachers’ understandings about how to accommodate all students’ needs and levels of understanding in class activities based on the journal grew when the Year 6 class began ‘The New Turtles’ project. The journal entry began as the idea of one student but through a ‘mind-map’ style entry quickly became a series of class investigations. Three baby turtles had recently joined the classroom from distant Adelaide. Students were fascinated by all facets of the topic, transport from source to their classroom, turtle growth rates, through to how often their head is withdrawn. Project teams were established. The teams set research questions in order to discover how far the animals had travelled, why they were delayed, how long it would take for them to grow from their present 25mm diameter to full size, and so on. Each team devised their own method of reporting so wall charts, PowerPoint presentations, paper and pencil calculations and notes were all shared during the extended investigations.

In another example of the use of journal entries for task creation, the Year 6 class wrote a series of problems related to spaghetti following a journal entry on cooking dinner at camp that used what they called ‘thought balloons’ (see Appendix 42). In seeking to further their problem writing skills, students then critiqued each other’s problems with a great deal of frank, constructive comment. The resultant critique, using the *Learning From Each Other* format, assisted students improve their problems before sharing them with their peers for solution. After class presentations and resultant discussion, materials were filed in students’ process portfolios for later discussion with parents.

Other Tasks Evolve

A wide variety of tasks were created through the joint efforts of teachers and students. The tasks were based on combinations of student interests and input blended with the need for the teacher to satisfy syllabus requirements. From text book controlled mathematics classes there was a shift to a blend of syllabus-based text exercises and tasks that had been specifically written for and by different classes and groups.

As a result, students were asked to complete a wide variety of tasks such as *Welcome To The Maths Resort!* and *Gone Fishin’* (see Appendix 43). As the study progressed, it was evident from the level of student effort put into task completion and constructive feedback that they gave to each other that the revised approach to mathematical activity was having marked effect across ability groups and year levels.

A Student Mathematics Conference

During the second year of the study, one year level ran what was considered a bold experiment. Year 5, which by then contained two of the focus group teachers, held a mathematics conference over two consecutive days. It meant that the timetable, which normally scheduled six specialist teachers across each week, was altered to allow students an uninterrupted prolonged period of mathematics immersion. The conference schedule (see Appendix 44) shows that the structure centred on a series of rotational workshops. Each teacher had to prepare only two sequential repeated workshops, much like an adult professional development conference. Anecdotal feedback from student participants proved very supportive (see Appendix 45).

Subsequent debriefing discussions showed that both teachers and students believed that they had gained a lot from the experience. Students expressed appreciation for the lack of interruption to their thought processes, their ability to work in groups for extended periods, of being treated in a ‘mature’ manner and having opportunities to produce substantial results of interest within a compacted time frame. Predictably, in line with earlier data, students generally expressed strong support for the practical, real-world basis of the tasks set in the workshops. Teachers mainly commented on the high level of engagement apparent across the groups, the notable quality of student planning and cooperation as well as the results produced and shared over what had been a substantial investment of time in what for the study school had been a novel activity.

Over the two years of the study, the activities involved in the teaching and learning of mathematics underwent a number of noticeable changes. There was a shift from teacher-centricity and marked student passivity in learning to a far greater sharing of the ‘load’ throughout the entire process. Students and teachers were all involved from information collection and input, through task creation and completion to assessment and reflection upon the learning experience. My classroom participant observer interactions, joint planning involvement and artefacts collected, together with frequent invitations to visit classrooms and observe student presentations and discussions indicated that major change was being implemented. Changes in emphases were altering the context within which mathematics was being taught and learned, with movement away from dependence on lower orders of thought, skills and drills, to the higher orders of investigation, synthesis, evaluation and creation.

Subsequent Student Surveys

Whilst feedback was gained from students' work, assessments, reflections and discussions about tasks set throughout the study, there were four further formal surveys conducted. Two were single page instruments entitled *Your Opinion Counts and Your Opinion Counts 2.* The first of these carried several general mathematics questions in order to inform teachers' planning, while the second was more study-specific. Collection of further general information of use to teachers was seen as important. Through expanding their understanding of students' needs and feelings, the surveys directly assisted them in general program planning and in creating tasks suitable for the process portfolio. The last two instruments were longer questionnaires seeking more extensive student thought in relation to the activities that had been designed specifically for the process portfolios.

Student Survey: 'Your Opinion Counts'

Several months into the study, 72 students across Years 4 to 7 used *Your Opinion Counts* (see Appendix 46) to comment on what they had learned in the month just past, topics that were causing difficulty, with what they would appreciate help, how they were feeling in mathematics class at that time and to share their greatest current concerns. The data (see Table 6.2 overleaf) were used to inform teacher focus group mathematics planning.

When asked to nominate the two most important things learned in mathematics in the previous month, 17 students nominated *BODMAS* and 17 nominated *Division*. Clearly, those students placed mathematical procedure high on their priority lists in mathematics. Only five students listed *Problem Solving* as one of the two most important things learned in the previous month. A similar number saw *word problems* as difficult and asked for help, although none listed them as their greatest current concern. Interestingly, several students acknowledged a growing awareness of mathematics being 'everywhere' as one of their important recent recognitions. To the question regarding how they felt in class, of the total 217 responses made by the 72 students, 156 were positive. The nature of the negative responses attracted attention in subsequent teacher planning discussions. Whilst teachers realised that totally positive

Table 6.2: Third Student Survey Results

Your Opinion Counts (1): Student Survey

72 respondents

1. Two most important things learned in maths in past month

BODMAS	division	graphs	prob solvg	multiplication	volume	rate/speed	tables	operations	it's everywhere	easier ways	mn/med/mode	usg formula
17	17	8	5	5	4	4	4	4	4	3	3	3

area	average	fractions	prime nos	schedules	check work	ask 4 help	limitations	perimeter	angles	measures	diagrams	mass
2	2	2	2	2	2	2	2	1	1	1	1	1

sq roots	%ages	time	circ of circle	neatness	patience	ma huge	pay attentn	left > right	for job/salary	can do it	homework
1	1	1	1	1	1	1	1	1	1	1	1

2. Problem/topic with which you still have difficulty *[More than one response accepted]*

division	fractions	X tables	word prob	multiplication	rate/speed	volume	area	compre prob	cross X	shapes	circles
9	9	8	5	4	4	4	3	2	1	1	1

Roman nos	mass	%ages	algebra	time	BODMAS	mean	consistency	easier ways	all maths
1	1	1	1	1	1	1	1	1	1

3. What would you like most help with? *[More than one response accepted]*

division	fractions	volume	tables X	prob solvg	area	shapes	graphs	ratespeed	%ages	time
16	6	6	5	4	2	2	2	2	2	2

angles	BODMAS	circumf	skills	symmetry	meas conv	multiplication	mass	simplifying	easier ways	everything
2	1	1	1	1	1	1	1	1	1	1

4. Feeling in maths class at moment. *[More than one response accepted]*

Interested	Relaxed	Good/Happy	Successful	Confused	Smart/clever	Bored	Rushed	Worried
34	26	32	22	19	16	13	10	10

Easy	Trying	Fantastic	Confident	Learning	Tired	Frustrated	Enthusiastic	Curious
5	4	4	3	3	2	2	2	1

Understding	Excited	Fast	Challenged	Stressed	Difficult	Annoyed	Brainless	Help!!
1	1	1	1	1	1	1	1	1

Total responses: 217 (72%)
Positive responses: 156 (28%)
Negative responses: 61

Number of options used by respondents

0	*2*	2	*20*	4	*17*	6	*5*	8	*0*
1	*8*	3	*11*	5	*8*	7	*1*	9	*0*

5. Biggest worry in maths at present. *[More than one response accepted]*

X tables	nothing	division	silly mistakes	ppl copying	fractions	BODMAS	right/wrong	time	ranking	u/s inv qu	finishing	being smart
9	6	5	5	4	4	3	3	2	2	2	2	2

noise	forgetting	difficulty	focus/conc	setting out	confusion	distractions	volume	3D shapes	money	prob solvg	rate/speed	mass
2	2	1	1	1	1	1	1	1	1	1	1	1

BODMAS: A rule for the order of operations = **B**rackets **O**ff, **D**ivide, **M**ultiply, **A**dd, **S**ubtract responses were highly unlikely, they did need to consider the connotations of students saying they were ‘confused’, ‘bored’, ‘rushed’ and ‘worried’.

Student Survey: ‘Your Opinion Counts 2’

The fourth student survey directly focused on portfolio matters (see Appendix 47). Questions sought opinions related to the class journals, student initiated and created problems and concluded with thoughts on assessment. Seventy one students across Years 4/5 to 7 shared their opinions near the close of the first year of the study.

Over half of the students (42) had made entries in their class mathematics journals and 40 of them had enjoyed the experience (see Table 6.3 overleaf). Overwhelmingly students acknowledged that mathematics was a big part of their lives. Whether they had made an entry or not had little effect on their overwhelming positive response (69 of 71) regarding the possibility of creating interesting problems from their own and peers’ journal entries. At that stage, over half had had an opportunity to do so. Fifty eight students believed that they were capable of writing challenging problems about life. This was interesting to the teacher focus group as a strong request for greater challenge had been noted earlier in the second student survey (see Table 6.1).

When it came to assessment of their mathematics learning, almost all of the student respondents had formed clear opinions. Forty nine saw themselves as being capable of designing sound instruments, with rubrics seen as “very useful” or better by 44. Another 20 students found rubrics helpful, meaning that 64 of the 71 respondents were finding that rubrics provided useful feedback. However, when it came to students preferred types of assessment and feedback, rubrics ranked only sixth, well after the traditional methods of letter grades, marks and scores. Notably, almost three quarters of the student respondents now liked to assess their work before the teacher, a situation not possible under what had been the prevailing traditional assessment system. However, it was clear that students had not yet comprehended the full potential of the word-based rubric. Only two of the five higher ranked feedback options, written and spoken comments, offered feedback of similar formative depth.

Contrastingly, students found more than three times the number of advantages over disadvantages in assessing their work prior to teacher assessment. Once again, they had

Table 6.3: Fourth Student Survey Results

Your Opinion Counts (2): Student Survey

Respondents: 71

1. Did you make an entry in a journal?

Yes	No
(42) **59%**	(29) **41%**

2. *If yes*, enjoy the opportunity? (42 - yes)

Yes	No
(40) **95%**	(2) **5%**

3. Maths - a big part of your life?

Yes	No
(68) **96%**	(3) **4%**

4. Interesting problems possible from boys' entries?

Yes	No
(69) **97%**	(2) **3%**

5. Opportunity to write a problem?

Yes	No
(39) **55%**	(32) **45%**

6. Capable of writing challenging problems about life?

Yes	No	Undecided
(58) **82%**	(10) **14%**	(3) **4%**

7. Able to design worthwhile maths assessments?

Yes	No	Undecided
(49) **69%**	(19) **27%**	(3) **4%**

8. Are rubrics useful for assessment and feedback?

great idea	very useful	helpful	bit useful	nothing gained
(26) **37%**	(18) **25%**	(20) **28%**	(7) **10%**	**0**

9. Preferred types of assessment and feedback [No ranking response = 8 High score indicates low ranking]

	Ranking		Ranking		Ranking		
A,B,C,D,E **45**	(307) ***1***	**marks/scores** **37**	(334) ***2***	**written comments** **35**	(361) ***3***		
ticks/crosses **25**	(374) ***4***	**spoken comments** **17**	(386) ***5***	**rubrics** **30**	(394) ***6***	**pass/fail** **22**	(454) ***7***

10. Do you like to assess your work before teacher?

Yes	No
(51) **72%**	(20) **28%**

11. Advantage of assessing before teacher

Find mistakes	18
Understand standard	14
Boost mark	8
Form an opinion	8
Stop cheats	1
Be teacher	1
Chance discuss w. tchr	1

Total advantages listed 51

Number of options selected			
0	**2**	4	**7**
1	**6**	5	**4**
2	**26**	6	**5**
3	**20**	7	**1**

Disadvantages	
Nothing to gain	4
Would cheat	1
Too much work	2
Teacher always right	1
Could get it wrong	1
Don't know how to	1
Effect confidence maybe	1
Don't want to face my work	1
Find mistakes	1
Build false hopes	1
I don't like to argue	1
In case I didn't understand something	1

Total disadvantages listed 16

not made a strong connection to the rubric as the guide in that assessment. They seemed unaware that it was the rubric which assisted them gain the highest ranked advantage of self-assessment, to ‘find mistakes’; that without it they would not ‘understand the standard’. Letter gradings, marks, and scores offered no such scope. The strong positive student opinions showed rising support for the rubric and its potential but clearly, student opinion was in a state of flux as they came to grips with the full ramifications of the changing assessment process.

As a result of a great deal of time and planning, involving students in every aspect of producing, completing and assessing tasks, teachers did not struggle to maintain student enthusiasm, disproving this chapter’s working hypothesis. As with many complex activities, the teacher focus group found that the more students became involved, within clear and thoughtful guidelines, the change process became simpler rather than more difficult and student enthusiasm for the change remained high.

THE STUDENTS’ VERDICT

The penultimate student survey was a twelve question instrument completed by 68 students. It was designed to inform the study, to assist students’ focus and further extend teachers’ general understanding. A broad range of questions was asked on perceptions and feelings towards assessment in mathematics. The intention was to use the secondary information to promote further discussion on assessment change across all teachers in the study school. Within the school’s traditional pedagogy, assessment change had not been broached to great depth, especially change which involved the students’ points of view. This study had begun to change the frequency and nature of teacher discussion but much wider and far reaching professional discussion promised further benefit. For this reason, as with much of the information gathered previously, the resultant overview was shared with the wider staff.

Forty nine of the 68 students saw assessment’s purpose as informing the teacher about how students were ‘going’ (see Table 6.4 overleaf); “To find out how the student is going, if he is listening or not, and taking it in” (see Appendix 48, p. 361). Thirteen saw it as indicating when students needed help, with one astute individual taking it as informing teachers about how teachers were ‘going’. This raised the issue of the

Table 6.4: **Fifth Student Survey Results**

Student Survey (5): *Perceptions of Assessment*: Resultant Data

[Number of respondents: 68]

****1. Why do you think the teacher assesses your work in maths?***

How I am going	See who needs help	Type of work to give
49 (72%)	13 (19%)	6 (9%)

****2. What sorts of assessment items does your teacher ask you to do in maths?***

	Mental	Tasks/projects	Tables	Tests	Homework	Problems	Oral	(Topic/operation list)
Mentions	35	23	22	22	15	9	3	18

****3. Which of those sorts of maths assessment do you like?***

	Speed tests	Tasks/Rubrics	Mental	All	Tests	Easiest	Logic	Oral	(Topic/operation list)
Mentions	20	15	13	5	3	1	1	1	9
			“I like the challenge”				“uncertainty”		

****4. Which of those sorts of maths assessments do you not like?***

	Mental	Homework	Hard	Problems	Tables	Tests	Easy	All	(Topic/operation list)
Mentions	6	5	4	4	4	4	2	2	10
		“boring”							

5. What do you think your maths results mean to your teacher

	Help/progress indicated	“A lot”	Indication of teaching effectiveness	Level
Mentions	40	9	8	4

6. What do you think your teacher does with your maths results?

Records/files	Looks at	Indicator for teach improve	Don’t know	No opinion
50	5	1	1	11

Table 6.4 continues overleaf

Table 6.4 (*contd*)**: Fifth Student Survey Results**

****7. What do you do with your maths results?***

Keep in portfolio	Take home	Try to beat	Check	Throw out	Other
26 (38%)	14 (21%)	13 (19%)	10 (15%)	2 (3%)	3 (4%)

8. How can you learn from your maths results?

Learn from mistakes	More practice needed	No answer
48 (71%)	10 (15%)	10 (15%)

****9. What effect do you think your maths results have on the maths that your teacher teaches you?***

What to teach	If help needed	Unknown	Knows if you listen	Guide for others	Nothing	No opinion
20 (30%)	13 (19%)	13 (19%)	4 (6%)	3 (4%)	4 (6%)	11 (16%)

****10. Do you like to assess your own maths?***

YES	NO	Undecided	No opinion
38 (56%)	14 (21%)	4 (6%)	12 (17%)

“No I don’t because I would rather have a teacher’s point of view” – Year 5 student

Of those with an opinion

YES	NO
68%	25%

****11. What do you think that you might learn from assessing your own maths work before the teacher does?***

Can improve before tchr sees	Checking skills	Be honest	Diff between Tch & Stu	Good/bad work	Nothing	Learn to work alone
15	11	7	6	5	2	1

****12. What’s your favourite part of maths?***

Challenge	Portfolio tasks	Easy	Getting all correct	All	(Topic/operation list)	“When it’s cancelled”
3	3	3	2	2	14	1

persistence of the lack of understanding amongst students of the purposes of assessment which had come to light in early student surveys. Teacher focus group discussion reaffirmed earlier agreement as to the benefits of students having genuine understanding of such purposes. Teachers had thought that work over the past 18 months had improved students' understanding but clearly further work remained to be done.

The style of assessment instruments had undergone marked revision during the period of assessment change. At the start of the study no teachers were setting tasks that required extended involvement in mathematics. Rubrics had not been used in mathematics at all, yet levels of student mention of such tasks and rubrics within classroom assessment structures now ranked second only to mental arithmetic. When asked for their preferred types of assessment, students ranked portfolio tasks second after multiplication speed tests. Students indicated that they now valued deeper involvement in mathematics and were appreciating assessment through rubrics.

Of the 57 student respondents who expressed an opinion on the recording of assessment rubric results, 50 believed that teachers filed their assessment results, with 40 seeing either taking their assessments home or filing them in their portfolio as important. When asked whether they liked assessing their own mathematics, the ratio of student approval to disapproval was almost 3:1, with only four students happy either way. One academically capable student stood opposed with the provocative, "No I don't because I would rather a teacher's point of view" (see Appendix 48 p. 361). That statement provoked further discussion within the teacher focus group regarding the importance of students seeing themselves as genuine contributors to the assessment process through self-assessment.

Thirty eight of the 68 students liked to assess their own maths before the teacher. In declaring the benefits of self-assessment, students wrote of enhancing their work through checking and improvement before the teacher saw it. Others wrote of learning to be honest in appraising their efforts, of learning "how to assess and you have a say" and appreciating "how hard being a teacher is" (see Appendix 48 p. 362). Only two students saw nothing to be gained by them assessing their work before the teacher. With the process portfolio concept still in its infancy, students' affirming responses regarding self-assessment were viewed as supportive of assessment change. The school’s assessment regimen had never before given students the opportunity or grounding in passing structured, meaningful judgement on their work. However, overall the results were classified as somewhat disappointing by the teacher focus group as after some 18 months work students’ perceptions of assessment and its purpose had not broadened as much as had been expected. The focus group teachers had thought that their students would have developed a much wider appreciation and understanding of all facets and functions of the assessment process. It indicated that there remained plenty of work to be done in the area of students’ understanding of the nature and purpose of assessment itself.

The Sixth Student Survey: Plus, Minus and Interesting

In ascertaining student thought and opinion of key aspects of the process portfolio, the study’s final formal instrument sought to have students summarise their experiences within the changing assessment structure in mathematics. The questionnaire was structured and concise, yet offered creative scope in expression by utilising de Bono’s (1994) Plus, Minus, Interesting (PMI) format (see Appendix 49). Students were asked their opinions of tasks set, parallel assessment, reflections, three-way interviews, highlights and possibilities for improvement. Discussion of their responses further extended the teacher focus group’s professional learning regarding the evolving nature of assessment within the process portfolio model.

The period of the study saw marked change in many aspects of assessment, particularly in that students were now given voice in the assessment process. Students’ opinions and creative input were taken into account by teachers in the generation of assessment tasks. From the first student survey to the sixth, teachers had guided students through many discussions on the point, nature and structure of assessment, all the while collecting useful feedback which was used in designing a multitude of tasks and learning materials. Individual, group, verbal and written forms of student feedback had all played important parts in developing the process portfolio model as it evolved.

As a result of the sixth student survey, collated PMI opinions regarding portfolio tasks produced a great deal of reference to doing things different and differently, as well as teachers finding a balance between tests and ‘fun’ activities. Student comment centred on engagement, challenge through reality and enjoyment in such activities. “If you do it right it can’t be wrong” and “You can figure out real life choices” (see Table 6.5) reflected strong supportive feelings related to the now accepted creative approach to task completion. Succinct, but telling was “The maths!” when one student stated what was interesting about portfolios (see Table 6.5). However, the fact that some tasks appeared to revisit mathematics learned previously, a natural function of a spiral syllabus but seen as revision by students, was given as a minus quality of tasks.

Table 6.5: Sixth Student Survey Responses – Quoted Extracts

Questions sought students’ opinions of various aspects of the Process Portfolios		
Question 1: *Tasks* PLUS You can figure out real life choices If you do it right it can’t be wrong MINUS You only do revision INTERESTING The maths	**Question 2**: *Self-assessment* PLUS You can judge what you did It helps us think about how we did the work It allows us to go over our work to see flaws so next time it is better MINUS No other teacher lets us INTERESTING Everything	**Question 3**: *Reflection* PLUS You get to reflect on the work and think what you could have done better MINUS It can be depressing looking back through really bad work INTERESTING I realised that maths is everywhere
Question 4: *3-way interviews* PLUS Telling your teacher what you want to change but if you are not there then your parents might now know what you want to change It is good to communicate between teacher, parent and student That the parent and student get the information at once MINUS Waste of a child’s time Your parent knows everything you do at school INTERESTING You get to have your say and get more confident	**Question 5**: *Best thing in PPs* The maths! Going back and seeing what you have done We can go back and see how we’ve changed Making PowerPoints Self assessments, hands on work and fun There are no tests It keeps maths work interesting You get to keep a record of all your work That all my stuff doesn’t get lost	**Question 6**: *Improving PPs* Well we could have a separate portfolio for each subject We could do more rubrics and mark our own work More varied activities More detail to the work More time to work Not so much work Work harder By having more to put and fill it
Note: The full results of the Sixth Student Survey are collated as **Appendix 33**		

Students expressed positive views in relation to self-assessment (see Table 6.5). Their responses indicated that they appreciated that judgement was required in order to self-assess their work on tasks. After completing the task, instead of simply handing it to the teacher to assess, students had to give considerable thought to passing judgement on their efforts. One student commented, “It allows us to go over our work to see flaws so next time it is better”. Students wrote positively of the chance to think about how they could have improved their work through using the rubric. “You get to reflect on the work and think what you could have done better.” Several students said that “everything” about self-assessment was interesting. Offsetting the positive thoughts were those about potential disagreement and disappointment after teacher assessment, with some not considering the time well spent; “It can be depressing looking back through really bad work”. Others were concerned about possible disappointment in comparing their self-assessment to subsequent teacher assessment. Oddly, the uniqueness of the self-assessment process drew criticism. One student’s, “No other teacher lets us” (see Table 6.5) implied that he liked the opportunity to self-assess but regretted that it only happened with mathematics. The lack of comparative grades generated by the rubric as it was being used at the time was seen as a negative by those who preferred more traditional assessment feedback and reporting.

When questioned as to the parent-student-teacher interviews, students gave strong support to their involvement. The importance of students being there was summed up well by one student’s comment: “It is good to communicate between teacher, parent and student.” Another supported the sentiment with, “Telling your teacher what you want to change but if you are not there then your parents might not know what you want to change.” “You get to have your say and get more confident” from another student added yet further depth to reasons for the three-way interviews. Positives outweighed negatives in both number and depth. However, opposing the positives were the need for student honesty in answering the many questions. One student simply thought that it was a “waste of a child’s time” (see Table 6.5).

However, students did not think that organising an interesting record of their work in their process portfolios was a waste of time. They appreciated that the collection helped them to improve by allowing them to review their achievements. Looking back on work also gave them ideas for solving unfamiliar problems, a point which several students saw as a major highlight. As for ways of improving the current process portfolio structure, generally they sought more time, *more work* and yet further increases in hands-on opportunities. One student affirmed the value of process portfolios with “Well we could have a separate portfolio for each subject” (see Appendix 49). The comment reflected the overall strong positive responses given by students in regard to their experiences with the new approach to the teaching, learning and assessment of mathematics.

Closing Comments

Unfortunately, valid assessment remains a complex task and providing students with succinct yet pervasive, constructive feedback is often difficult. Assessing the resultant student verdict about the intricacies of process portfolios following the protracted developmental work in producing the process portfolio model was no less convoluted. As with all pedagogies, no absolute claims can be made in regard to benefits for students by their learning mathematics through the approach advocated by the process portfolio model that evolved during the studied change. However, through their eager participation during the course of portfolio component development, completion and comment upon many portfolio-specific tasks and a number of surveys, students indicated a strong broad-based support for the use of process portfolio-based learning activities in mathematics. The level of engagement and the depth of understanding displayed during mathematics lessons, which were no longer teacher dominated, where students were able to express and support mathematical opinions and directions, affirmed student support for the new approach. The enthusiasm with which teachers and students in non-teacher focus group classes began to adopt portfolio components further authenticated the positive student verdict. Concerns expressed in the working hypothesis about teachers having difficulty maintaining student enthusiasm for the change were allayed by lasting student commitment to their parts in the development throughout the period of change.

THE NEXT CHAPTER

Parents complete the triangular education team. If the process portfolio was to be of genuine use to all stakeholders and of lasting importance within the school's accountability structure, parents needed to be engaged in its development. As major stakeholders in their children's education, parents' requirements and opinions deserved to be respected and considered. The chapter which follows discusses the part played by the students' parents as partners in the education process.

CHAPTER SEVEN: THE PART OF PARENTS

PARTICIPATING PARTNERS IN ASSESSMENT CHANGE

Previous chapters discussed the parts of teachers and students in the transition to process portfolios in mathematics. This chapter considers the contribution to the change made by the third stakeholder group directly involved in the study, the parents of the students in the teacher focus group's classes. In relation to teachers and students theirs was something of a minor role in the study. However, within the study school parents were a major influence through their support of their children's learning at school and at home and their communication needs in regard to the school's reporting structure. That influence meant that parents' beliefs and opinions in relation to students' learning and the format of student achievement reporting needed to be ascertained and considered. Their perceptions of the effectiveness of the portfolio as both a learning and communication tool also needed to be determined. It was important to discover parents' attitude to the process portfolio concept, a radically different assessment format from that in use at the study school at the start of the study. Through consultation and communication, parents were made participating partners in the change to assessment of mathematics through process portfolios.

In order to prompt parent participation, three formal instruments were used to gather indications of their opinions and positions in relation to the planned change in mathematics assessment in the teacher focus group's five classrooms in the school. The first was a survey which was followed by interviews, one with me in the first year and the second with the class teacher in the normal course of reporting student progress during the second year. Throughout the study period, informal teacher-parent discussions were used by teachers to gather feedback and gauge parent support for the changes being made in the assessment of mathematics.

Working Hypothesis

My experience had been that parent feedback reflected a lack of consensus on the effectiveness of school-home communications regarding student progress and achievement. Hence, the working hypothesis for this phase of the study was:

> Although the process portfolio offers a likely increase in quantity and depth of feedback, parental support for the model will reflect that lack of consensus.

Parent Survey: Connotations for Teachers

The parent survey questionnaire and an explanatory letter (see Appendix 50) were distributed to the parents of all teacher focus group classes. Parents had been informed of the nature of the study during the parent-teacher evening held earlier in the year. Of the 110 questionnaires distributed, 53 were returned completed. Data were collated using a spreadsheet with the responses to two items graphed to indicate the spread of opinion (see Table 7.1 overleaf). Responses to each question were then discussed by the teacher focus group in seeking implications for their planning and teaching generally, as well as in relation to the use of the process portfolio.

In response to question one on how the parents were taught mathematics at school, overwhelmingly parents recalled being taught through a traditional, teacher-centred approach. Instruction and practice were based on text books with rote learning of both concepts and processes expected of students. Whilst it probably could be assumed that all experienced the use of concrete materials in the early stages of school mathematics, a pedagogy which remains in place today, 12 of the respondents did not recall learning materials playing a major part in their overall mathematics instruction. Generally, it was apparent from the survey responses that lower-order conceptual and procedural recall was considered paramount over strong procedural understanding and application in the mathematics education of this particular group of parents.

Questions two and three sought parents' opinions on the effectiveness of their school mathematics learning experiences. Responses to question two showed that 43 of the 53 respondents considered the approaches effective overall, i.e. they assigned a rating of five, or higher, across the supplied one to ten scale. Thirty five of the respondents assigned a rating of between five and eight, taken as general affirmation of the approaches under which they learnt. Interestingly, 11 parents, the largest single group of respondents, indicated apprehension to strongly commit one way or the other by taking a conservative mid-point stance on the scale. When in question three, they were asked about their beliefs regarding the possible effectiveness today of the methods under which they learned mathematics, 33, a large proportion of respondents, took an affirmative view. Sixteen parents either had doubts about earlier methods, or simply opposed them. The doubters claimed that rote only helps after understanding, that it's fine for basics, but allowed no creativity in mathematics and that during their education

Table 7.1: Parent Survey Results

Number of returns: **53**

Qu. No. Question Topic

1 *How was parent taught maths at school*

Chalk & talk	Text book	Rote	Copious prac.	Concrete materials.
43	**39**	**39**	**21**	**12**

Note: Multiple responses given by all respondents

2 *Parent's rating of way they were taught*

	1 Ineffective	2	3	4	5	6	7	8	9	10 Highly effe	Uncommitted
Number of responses	**0**	**1**	**4**	**3**	**11**	**8**	**7**	**9**	**3**	**5**	**2**

3 *Do parents think that the way they were taught would be effective/relevant today?*

Yes 33		**Yes/No 5**	**No 11**
Real life sums	Needs to be backed up by concrete activities	Could have been interesting	More effective ways/concrete material
Maths not automatic, need plenty of practice, understanding and good teacher	Effective but less relevant	Rote only helps after understanding	Need more concentration
Blackboard use effective	Easier and clearer from a text bk for children & parents	More engaging methods available	No teacher time to help
Effective teacher-student interaction encouraged	"Unaware of alternatives"	Ch require heaps of practice as they have a lower ability to concentrate	Didn't work for me
Followed curriculum	Same material needs to be learned as before	Children today require faster paced lessons	Never encouraged to question
Rote creates comfortable environment, only way to learn some things		Fine for basics, but no creativity allowed in maths	Didn't relate to real world
Continual practice required after principles explained			Know more about how students learn
Hands-on greatly enhances true understanding			Maths not as relevant in work - computers
Reptition needed for concept to 'sink in'	No comment: **4**		More teacher/pupil interaction needed
Requires children to ask questions			Need to construct knowledge
Once the facts are memorised they are there forever!			
For basics such as times tables			
I think most children would respond well to rote teaching of maths			

4 *What constitutes progress in maths?*

Positive attitude	Understanding how & why?	Use of maths in real life	Improving scores	Speed with nunber facts	Help not sought
41	**35**	**34**	**33**	**26**	**12**

Note: All respondents gave multiple responses

Responses tallied: Highest ranked number 1.

5 *Indicators of real and lasting success*

Able to apply	Pos. attitude	Enjoys maths	Sees as tool	Ability with number facts	Help not sought	High scores
162	**175**	**193**	**196**	**239**	**249**	**280**
High importance					*Lowest importance*	

Note :Respondents asked to rank indicators, 1 for most important,

7 for least. All indicators unchecked/unranked given a ranking of 8.

If indicators ticked/checked, ranking of 1 applied, i.e. assumed of equal importance.

Table 7.1 continues overleaf

Table 7.1 (*cont'd*): **Parent Survey Results**

6	*Do parents feel informed of child's progress?*	Yes	Yes/No	No
		26	6	17
			Mid-semester yes; semester reports give some insight	I feel I need to meet with the teacher to get good feedback
			Only through homework and child; teachers do not volumteer information	We just see his Friday maths scores
			Only through test results	Not really, but I do know that his teacher is available for queries
	4 uncommitted		I would like a percentage of how he is within his year level	Only information received is through report cards and what he tells us about
			Would prefer a more detailed understanding of topics to be covered	Only communicated by way of report cards
			During the term little feedback from teacher	We must approach the teacher - if a child needs help, teacher should approach parent

7	*Ihow parent knows child doing well or in trouble in maths* (Multiple responses / respondent)				
		1. Homework interaction, nature of	30	**9.** Level, type and freq of questions	3
		2. By discussing with him	15	**10.** Give in	1
		3. Marks/scores	14	**11.** Completion of tasks	1
		4. Teacher communication	9	**12.** Understands explanations	1
		5. Reports	6	**13.** Inability to progress	1
		6. Real life applications	6	**14.** Type & frequency of help required	1
		7. Lack of interest/attitude	6	**15.** Cross-checking with other parents	1
		8. Ability/inability to apply concepts	5		

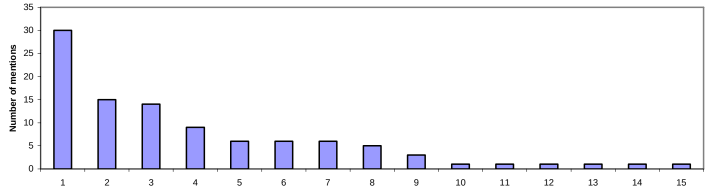


Figure 1. Indicators of trouble

8	*Do parents use maths in 'real life' with their children?*	Yes	Yes - occasionally	No	Uncommitted
		38	9	3	3

9	*Is parent confident to help child with maths h/work?*	Yes	Yes/No	No	Uncommitted
		43	1	4	5

Note: High degree of qualification of 'Yes' with, "at this level" , "in Primary school/level" and "but some methods quite different today".

10	*Parent expectations of child in mathematics* Ranked as per responses		
		1. Enjoy/positive attitude	17
		2. Ability to apply/problem solve	13
		3. To be above average	8
		4. Understand/ to be logical	7
		5. Realize personal potential	7
		6. Knowledge of rules & procedures	5
		7. Feel confident	5
		8. See relevance & application to life	6
		9. Keep pace	4
		10. To ask for assistance	3
		11. To be challenged	3
		12. Consistency in all aspects	2
		13. To improve	2
		14. Good foundational skills	2
		15. Set high personal goals	1
		16. Understand importance of maths	1
		17. Achieve to age standard	1
		18. Open mind/interested	1
		19. None	1

Many respondents expressed multiple expectations ,.

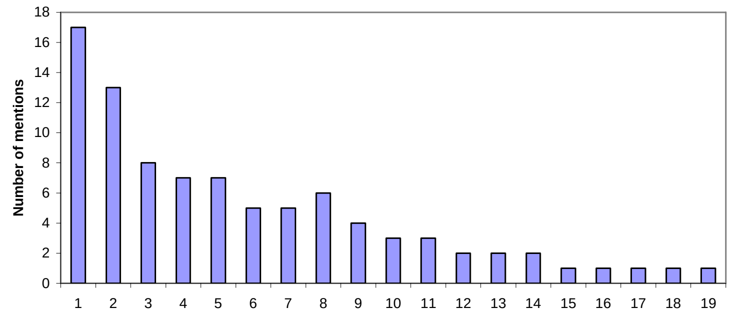


Figure 2. Parental expectations of students

Respondent quote: "While I would like to be more positive I expect, like his two brothers, it will be his worst subject."

they were unaware of alternatives. They claimed that they were “never encouraged to question why”, that the mathematics they learned “didn’t relate to anything outside school” and that “we know more today about how students learn – multiple intelligences” (see Appendix 51, p. 365).

Overall, in responding to the first three questions regarding methodology, the majority of parents believed that the way that they had been taught mathematics at school was effective and they indicated their support for the use of such methods with their children. Based on that indication, it seemed that the teachers attempting to introduce problem solving through the process portfolio, an approach which focused heavily on the understanding and application of process, not simply recall of rote learning, would do so with limited parental support.

However, responses to questions four and five, which sought parents’ views related to what they believed were indicators of progress and success in mathematics, contradicted those early assumptions. When ranking was applied to parents’ collective views regarding indicators of student progress and success in mathematics, the highest ranked were a positive attitude and understanding leading to the ability to apply that understanding. This was seen as contrary to parents’ responses to questions one to three which had indicated marked support for the traditional methods that emphasise the acquisition and mechanical recall of knowledge. Exemplifying the contradictions were the high rankings parents gave to understanding and the application of mathematics to life situations, never a major emphasis in text book-driven traditional instruction. Many respondents clearly indicated that during their schooling little emphasis had been placed on relating mathematics to students’ lives outside of school. Furthermore, characteristics that are generally linked with traditional instruction, such as ‘chalk-and-talk’ text book linked methods, ‘ability with number facts’ and ‘high scores’ were ranked lowest. Most telling was the parents’ ranking of ‘high scores’ as the least important, clearly contrary to the earlier support for traditional approaches to assessment and feedback about learning and achievement in mathematics.

Initially, parents had appeared to retreat to the perceived safety net of the pedagogies of their schooling when seeking an effective method to be applied to their children. However, subsequent responses indicated that they were actually seeking a broadening of understanding of concept and process, together with competent practical application.

This injected a positive note in relation to assessment change, countering the perception of possible parent opposition which had been implied by responses to the survey's first three questions about the effectiveness of the parents' learning of mathematics.

Following the five pedagogical questions, questioning shifted to the matter of communication in question six. In response to being asked as to whether they felt informed about their child's progress, 26 of the parents answered in the affirmative, while 17 opted for the negative. Six were indecisive and added qualifiers to their answers, such as "semester reports give some insight" and "during the term little feedback [emanates] from [the] teacher" (see Table 7.1).

The high level of indicated dissatisfaction generated concern amongst the teacher focus group as all had believed that communication between home and school was effective and regular through teachers' weekly comments in students' Record Books (aka homework diary). Many parents claimed that their only source of substantial information regarding progress was their child's formal semester report. Clearly, they perceived feedback to be a sparse commodity. The lack of parents' understanding about their child's academic progress as communicated through tests scores was plainly evident through their negative responses. However, having noted that negative connotation, a contradiction then emerged through 'marks/scores' being ranked third highest as an 'Indicator of Trouble' in responses to the seventh question. Highest ranked and with a considerable gap between first and second, was the understanding of their child's progress or lack thereof, that parents gained through seeing their child's homework (see Table 7.1).

The teacher focus group found the high level of parental support for the capacity of homework to indicate trouble in learning mathematics of interest. All recalled homework being something of a 'hot issue' at various times each school year. On a regular basis parents were known to take sides in the debate regarding the purpose, quantity and quality of homework. Within a study of this nature, homework could have raised a number of issues in light of the increasing level of discussion in schools and the press regarding the nature and value of homework over recent times as discussed by those such as Bantick (2004). However, the specific topic of homework was not to be explored directly as part of this study. It was, however, something which needed consideration by teachers in the schema for teaching and learning that evolved during the implementation of process portfolios. It was apparent from parent responses that well-designed homework embedded in process portfolio tasks had the potential to complement and reinforce learning while informing parents of their child's growing understandings, skills and achievements.

Questioning regarding their use of mathematics in 'real-life situations with their children drew 38 positive responses from the 53 parents. When the group which said, 'yes, occasionally' they used mathematics in such situations was added, the number of parents claiming 'real-life' involvement in mathematics with their children increased to 47. This further highlighted the emerging parental belief that the application of what is learned at school is crucial. Parents stated that 'mathematics in life' was of high importance and that they were able and willing to be part of the learning and application processes with their children at the primary level. This stand indicated support for the introduction of 'real-life' tasks being formulated as part of the process portfolios.

Following the strong signs of interest in 'real' mathematics, 44 respondents felt confident helping their child with mathematics problems. Only four parents lacked that confidence and a similar number proved unwilling to commit themselves either way. However, in planning tasks for students with parental support or assistance in mind, teachers needed to be aware that whilst a highly positive feeling was evident within this group the positive responses all contained qualifiers. The strongest provisos stated that these parents only felt confident in helping their child with mathematics at a primary school level.

Survey results indicated that increased communication with parents was of major importance if parental confidence in mathematics was to be maintained and strengthened. Parents needed to be made aware of what their children were learning and to feel that they were cognisant of the material and the methods used in current mathematics teaching and learning. The comment "I would prefer a more detailed understanding of what topics will be covered [each] term at the beginning of the year" (see Appendix 51, p. 366) illustrated one parent's desire for syllabus information. Comments such as, "Maths could have been so interesting and exciting yet was regarded by most as dry and boring" (see Appendix 51, p. 366) indicated that some parents did see potential excitement in the learning of mathematics. Others showed an understanding that to an increasing degree, students needed to be encouraged to approach mathematical tasks from a practical perspective.

As a practical response to parent suggestions regarding information on mathematics instruction, teachers needed to keep parents informed through parent-teacher interaction, mathematics explanation sheets such as task sheets as well as regular print and electronic communications. Mathematics news sheets similar to *The Latest Addition* (see Appendix 52) were solutions implemented by the teacher focus group.

In the final survey question, when asked to list their expectations of their child in relation to mathematics, parents placed enjoyment and a positive attitude as their clear first priority. Second in the ranking was their child’s ability to apply what was learned in solving problems. The third ranked response, ‘to be above average’, was the only parent expectation amongst the top five rankings that could be linked to assessment terminology generally associated with pedagogies labelled ‘traditional’. However, that response received less than half the support than that given to the top ranked response. The traditional approach had been advanced strongly in parental responses to the opening three questions in the survey. However, again contrast prevailed as of the 19 classifications assigned when collating parental expectations, only three responses, including ‘achieve to age standard’ and ‘keeping pace’, were classified as parts of ‘traditional’ pedagogy (see Table 7.1). With 16 of the 19 response classifications indicating expectations strongly linked to conceptual growth accompanied by procedural competence, parents, perhaps unwittingly, had moved away from their early emphatic support of traditional teaching methodologies.

Clearly, from their children, parents sought a positive approach to the learning of mathematics which led to genuine understanding and the ability to apply their understandings. Such findings augured well for teaching approaches which fostered deeper comprehension and application of concepts and processes, higher order thinking. Teachers saw mathematics teaching and learning as encapsulated in a well-constructed process portfolio as offering them opportunities to address parents’ needs and expectations. Opportunities for teachers to guide students in developing conceptual bases through building procedural competence and understanding with a sense of purpose were also becoming evident. It was seen that process portfolios communicated students’ ability to all involved; teachers, parents, peers and importantly, self.

It was apparent that parents were seeking a broader approach in the teaching of concepts and processes and the communication of student progress and achievement. The teachers perceived significant expanding opportunity to convert dissatisfied parents through the use of an informative process portfolio, an assessment and reporting tool which correctly used exposes the full narrative of student progress through its marked inherent transparency.

Parent Interviews

As with the teachers and students, parent interviews were used to expand the data base begun with responses to the parent survey. The sample of parents was designed to include representatives of all year levels involved in the study. A spread of genders, number of children at the school and time at the school was also sought. In all, 22 parents were interviewed with the characteristics of the sample indicated on the interview schedule (see Appendix 53). Whilst the number of parents interviewed was restricted in relation to the number of students, valuable qualitative and some restricted but indicative quantitative data were extracted from the interview transcripts (see example in Appendix 54). Data were collated and are displayed in Table 7.2 overleaf. From the data analysis implications for reporting to parents and the implementation of process portfolios in mathematics were then drawn.

From the interview data, it was clear that regardless of their length of experience with the school, interviewees had formed firm views about reporting and its effectiveness in communicating the information that they sought regarding their children’s achievement. Twelve of the 22 parents interviewed favoured the current format but the split indicated that within this cross section of parents there were parentally perceived shortcomings in that format. When discussing the current format, parents’ opinions varied markedly from ‘great overall view’ to ‘oblique’, from ‘specific’ to ‘need to explain outcomes’, from ‘parents are well informed’ to ‘not deep enough’. Five of the 22 parents sought some form of comparison to their child’s peer group. Other shortfalls parents identified were a lack of an apparent standardised indication of student effort, marks or grades not given, and a lack of examples of tasks or criteria against which achievements were assessed.

Table 7.2: Parent Interviews Results

Assessment and Reporting: Parent Interviews

Participants: **22**

Topic

Content of current format: opinion

Pro:	Comprehensive	Great overall view	Accurate/specific	Parents well informed	Encourages approach to teacher
Con:	Not deep enough	Want scores and places	New agey'	Need to explain outcomes	Not specific/oblique

Rating of current format

Satisfactory	Unsatisfactory
12	**10**

Current format shortcomings

Comparison to peers **5**	Marks/grades **4**	Areas of weakness	Should be an interview
Effort in each area	Examples of tasks/outcomes	Scale of achievement	

How shortcomings overcome

From teacher **9**	Record Book **7**
From son **2**	

Preference for receiving that information

From Teacher **9**	Record Book **6**
Written **3**	See work

Frequency of viewing

Frequently	Infrequently	Homework only	Never
6	**5**	**8**	**3**

Opinion of portfolio concept

Great/excellent	Good	Useful
15	**6**	**1**

Comments: This is the sort of maths I like!

Rather see it frequently

Like the idea of self-assessing - reflecting on his work

Take responsibility for his learning

Language/comprehension could be a problem **4**

Insights through 'working' concept

19 positive comments:

Good insight into thinking and progress

Criteria clear

Shows what is done well or poorly

Help all to realistically understand

Would teach ongoing logic

Could follow student thinking closely

4 *questioned value/effectiveness of self-evaluation:* Some saw students over-rating self, others under-rating themselves

Teacher-parent portfolio interview

Useful		Not useful	
20	Portfolio would add to interview opportunities Absolutely critical	**2**	Teacher always available

Current frequency of tchr interviews

1-2 / year	3-4 / year	Infrequently
13	**8**	**1**

Anything to add
(Little added across the group)

Explanation of outcomes needed
Explanation of core program sought
Teacher's comments most valuable aspect
A score actually tells you something

Participants' pertinent characteristics

Time as parent of student at this school	< 1 year	1-5 yrs	> 5 years
	3	**13**	**6**
Number of children at this school	1	> 1	
	9	**13**	
Sex of parent participant	Female	Male	
	18	**4**	

In seeking information to overcome the perceived ‘gaps’ in the reporting process, nine of the 22 parents reported that they approached the teacher. Parent J stated, “I get most of what I want to know from face-to-face with the teacher” (see Appendix 54). Parents said that they felt comfortable doing so at primary school. Seven parents were content to use their child’s Record Book to communicate with the teacher and view assessment results.

The study school’s Record Book is promoted as the cornerstone of the home-school communication ‘system’. There is a clearly expressed expectation that student, parent and teacher, the three member education ‘team’, contribute to the feedback cycle through use of the book on a weekly basis within their allocated spaces. The school’s policy stipulates that teachers are to have their students enter all appropriate assessment results onto the double page weekly display in order to keep parents informed.

Whilst the Record Book is used by parents, students and teachers to a satisfactory level, indications were that parents placed significantly reduced faith in their children as sources of information. Only two parents said that they obtained the information that they needed regarding their child from their child. Also telling here was the fact that only six parents frequently viewed their child’s schoolwork, with eight saying that the only work they saw was homework, and then they did not see all of the homework set. “If he brought more work home I would certainly have a look at it,” said Parent F (see Appendix 55, p. 371). Three stated that they never saw their child’s school work.

Positive Parent Opinion

The second half of the interviews saw the emphasis shift to the process portfolio concept. Regardless of the parent opinions expressed about current reporting in the previous part of the interview, marked parental positivity dominated discussions about process portfolios. It was immediately apparent when during the interviews parents were shown example task sheets and rubrics as part of the introduction to the concept.

All parents rated the portfolio concept as useful or higher, with 15 of the 22 expressing feelings in the ‘Great/excellent’ range. Comments included, “That is the sort of mathematics I like!” by Parent P and “I like the idea of self-assessing, reflecting on his work” by Parent N (see Appendix 55, p. 371). Thoughts along the lines that self-assessment through portfolio work would assist a student to “take responsibility for his learning” from Parent F (see Appendix 55, p. 371) and “It’s very thought provoking and good for the mind as well” from Parent C, were common (see Appendix 55, p. 370). Parents showed high levels of interest in the prospective benefits of the learning and assessment criteria and artefacts displayed in the process portfolio.

Nineteen parents made only positive comments regarding the assistance and insights that they believed they would get from the assessment criteria in task sheets and detailed assessment rubrics within the process portfolio structure. Parents believed that they would be able to follow their child’s thinking closely; that it would teach their child ongoing logic and that it would help all involved (teachers, students and parents) to gain worthwhile, realistic feedback. Only four parents expressed doubts about the value of the self-assessment aspect of the rubric. Those parents remained positive overall, but expressed concerns related to their child’s comprehension of the language used and an inclination to over or under rate themselves.

When discussing other forms of teacher feedback, 21 of the 22 parents stated that they took advantage of opportunities for parent-teacher interviews during the year. Three-way teacher-parent-student portfolio interviews were seen as potentially useful by the same number of parents. Parent A said that “A portfolio would add to interview opportunities” (see Appendix 55, p. 370). Parent E saw monitoring of student progress through a portfolio as “absolutely critical” (see Appendix 55, p. 371). The two parents who did not respond affirmatively to the questions regarding interview opportunities, did so because they found that their children’s teacher was available at any time for casual interaction. They believed that the formality of an appointment was unnecessary. They used opportunities other than formal appointments as they deemed appropriate. Nevertheless, they supported the process portfolio concept as an illustrative interview tool. The process portfolio and three-way interview concepts, both new to the study school, won strong support from this particular parent group.

Connotations for Teachers

Consequent to the feedback gained from surveys and interviews, a number of parental perceptions were shared with the wider teaching staff through discussion at subsequent staff meetings. Staff agreed that an effort rating should be given within the report, and was shown on the revised report format shown in Figure 5.10. The rating was seen by the teacher focus group as complementary to the broader portfolio strategy as it would assist parents gain a more complete impression of their child’s commitment to learning mathematics. In addition to the report format variations, teaching staff were alerted to the fact that the parents involved in providing information had requested more extensive explanations of reporting outcomes. The whole primary staff decided that the request would be met during the approaching teacher-parent information evenings when teachers would add outcome explanations to the planned discussion of programs.

Whole staff involvement in the response to the parent requests for increased levels of explanation and understanding, as well as the report format revision, was seen by teachers beyond the focus group as an appreciable benefit of the focus group’s developmental work. Subsequent staff discussions showed that the positive feedback given by parents during the teacher-parent evenings as a result of parents’ increased understandings prompted even higher levels of interest by the wider staff in the focus group’s work. All teachers recognised the potentially deeper dialogue between teachers and parents regarding student progress and commitment promoted by the breadth of assessment data displayed in the all-inclusive process portfolio.

As a result of the increased wider staff interest in parent opinion, other matters raised by parents were considered at staff meetings. It was decided that Record Books would receive renewed emphasis as vehicles for assessment results and parental responses. All assessments were to be sent home for parent perusal and then returned for inclusion in the portfolio display. Although some teachers expressed concerns as to the likelihood of materials not being returned, the general opinion was that circulation was necessary to ensure that parents were kept well informed about their child’s commitment and progress and that for meaningful comment in the Record Book parents needed to see each assessment item as they were completed and judged.

Of all the points raised with the wider staff as a result of the parents seeking more information on student progress, the three-way interview concept was the idea raised from the analysis of the parent interviews which generated the greatest discussion. Teachers were unfamiliar with interviews that involved teacher, parent *and* student. Compounding that uncertainty was the central role of the student through leading part of the discussion as a result of a presentation based on an aspect of their process portfolio. Initial apprehension was evident across the wider teaching staff.

Of course, at that stage of the development of the process portfolio structure the three-way interview concept had not been trialled, so all points discussed by teaching staff were pure conjecture. Perceptions for and against the concept were raised but it was generally agreed that whilst they were novel and untried, three-way interviews appeared to offer yet broader communication potential to assessment through the process portfolio. As a result, teachers agreed to delay any further significant comment or commitment until three-way interviews had been trialled by the teacher focus group and results reported to the wider staff at a later date.

Parents and Process Portfolios

As defined in Chapter Two, process portfolios are collections of relevant material that are designed to exhibit all of a student's work on each assessment task. The display encompasses the task sheet and assessment criteria rubric, supplied to and discussed with students at the outset, together with the earliest workings through to what is deemed by the student to be the conclusive assessed product. As the process portfolio which was developed in this study subscribed to that general concept, a large number of the parents' concerns which came to light as a result of the parent interviews were addressed during its development. Several of the parentally perceived weaknesses of the current system became strengths of the process portfolio model. The model encouraged deeper student engagement in the entire learning and assessment procedure. Other parental concerns addressed included, the lack of written explanation of task-related expectations and judgement criteria with criteria able to give parents a sense of their child's progress and achievement in relation to year level expectations.

Information-rich rubrics displaying those expectations meant that the parental desire to know where their child's level of achievement rated academically in relation to others in the year group was satisfied without actually ranking the student against the peer group. The wealth of information contained in a task-specific, language-based rubric allowed students and parents to see the range of expectations at a particular level in relation to each and every task. Apparent also from the rubric and the displayed work, was what the child had learnt and could apply and which areas of conceptual and procedural knowledge needed further attention. The standards used centred on competence, so it was readily apparent if a child was working well below or exceeding expectations within their particular group without ranking him against his peers.

The issue of ranking students against others in the group had gained periodic publicity since Prime Minister Howard raised it when announcing a proposed revised funding package for schools. The announcement was part of his pre-election values-in-schools campaign in June 2004 and was seen by the government as a means of making schools more accountable to parents (Finger, 2004). During their interviews, many parents said that they were ranked against their peers during their schooling and consequently supported the concept. They claimed that such numbers helped inform them about their child's progress. Rightly or wrongly, parents also claimed that against all of the educational jargon in reports, they perceived numbers as being relatively simple to understand and needing little or no interpretation.

However, in reality the numbers of which parent spoke are far from simple. They often convey mixed or incorrect messages (Croucher, 2004). Contrary to the parental opinion a survey conducted for the Australian Primary Principals Association revealed that all forms of ranking at either a school, state or national level were ranked lowly by parents when compared to student work samples taken home (McGregor Tan Research, 2005). Similar contrast came to light within this study when parent interview responses were compared to responses to the parent survey, discussed earlier in this chapter. Survey results revealed that when a viable informative option is offered, there is an obvious shift in parental opinion from support of traditional feedback based on scores to the backing of more comprehensive indicators of progress, such as attitude and the ability to apply what has been learnt.

It was possible that the parents involved in this study were reacting to what they perceived to be a lack of current, straightforward information about their child's progress. This was clearly a claim made by one father during interview. Parent C stated that he looked "very quickly at the ratings, but more at the comments" (see Appendix 55, p. 370). It was apparent from other parents expressing similar views during the interviews that they looked for an overall picture through the ticks across the four report columns without spending much time reading the outcomes being reported upon. The teacher's comment at the bottom of the report carried marked significance in their judgement of how their child was progressing in mathematics as it was much more straightforward in comparison to the long list of learning outcome statements. Additional comments were often sought by parents through an approach to the teacher for verbal comment. Parent E commented that he and his wife "gain the most information by approaching the teacher verbally” (see Appendix 55, p. 370). Process portfolios, under development at the time of the parent interviews, provided excellent opportunities for frequent, meaningful interactions concerning student progress based on students’ ‘learning narratives’.

Interviewed parents said that they wanted the learning narrative displayed in the process portfolio to be simply presented because they often had trouble interpreting the terms used in the report’s learning outcome statements. In response to those expressed needs, the teacher focus group examined and modified reporting learning outcome statements, trying to ensure that they were easily understood by all stakeholders, including students. The focus group maintained that the statements were important and did have an affective function in informing parents about what their child could do in mathematics. In his announcement of June 2004, Prime Minister Howard had promised to end the confusion through forcing schools to issue plain language reports (Finger, 2004). Former Federal Minister for Education, Dr Brendan Nelson, went so far as to issue a preferred format as an exemplar (see Appendix 56). Whilst the mandatory requirements of the revised federal regulations were borne in mind, the simplistic nature of the former Minister’s reporting format was rejected by the teacher focus group. It was purely summative, lacking formative feedback, the essence of the process portfolio concept. It was determined that in light of parent interview feedback, teacher beliefs and government regulation, the school would continue to work on the content and format of its report with a view to ensuring all stakeholders are served adequately.

Assessment Rubrics and Reflections: Tools for Learning

During the interviews, parents acknowledged that the assessment rubric could be a powerful teaching tool because it had the potential to supply parents and students with a great deal of formative and summative information. Through their detailed, language-rich base, assessment rubrics addressed much of the parental concern regarding the lack of current formative information available to students and parents. Rubrics provided a clear guide to standards of quality judgement and were able to be referred to regularly during task completion. Consequently, parents had information that they used to assist their children in a cooperative, constructive fashion. Parents, such as Parent J, offered strong support through, “If he knows what is expected of him he will give 150%” (see Appendix 54). In short, rubrics ensured that all concerned in the study were aware of what was required by way of task information and judgement criteria. As a result of the completed assessment process, rubrics supplied students and parents with significant feedback upon which to reflect and from which to learn.

Although no parent interviewed had experience as a student with self-assessment or guided reflection as part of their learning, overall, they indicated strong support for the concepts. They acknowledged that the concepts appeared to offer tremendous potential as teaching and learning tools. “I am for that. It would give us a greater insight into the boys’ thinking in lots of ways. I like the idea”, commented Parent K, mother of three students (see Appendix 55, p. 371). In light of the strong parent comment, the teacher focus group realised that over their years as teachers, each had used students’ reflective capabilities but only incidentally. ‘Do you think that this is your best work, David?’ is a form of questioning that I had heard in each of the classrooms at some time. The focus group realised that they were only just beginning to comprehend and utilise the true extent of their students’ powers of self-assessment and reflection within the learning process.

However, some parents did express doubts as to their child’s ability to use self-assessment and reflection effectively. Parent Q commented cautiously, “My son would say that is the very best I could do. I am working way beyond my limits” (see Appendix 55, p. 371). Countering that caution were responses such as Parent G’s, “I think it would be great - it would be interesting how the student would mark themselves. I would be very interested to see how it develops. I feel very positive about that” (see Appendix 55, p. 371). Although the comments were supportive overall, from parent interviews it was clear to the teacher focus group that parents would benefit from further information on self-assessment and reflection and how they were being used within the revised assessment structure. That need was met through mathematics newsletters.

While the focus group did agree on the need to allay revealed parental concerns regarding self-assessment through further explanatory communication, it was recognised that those concerns did begin to diminish during responses to the closing interview questions. The reduction was the result of explanation of the potential for student coaching and goal-setting guidance by teachers. Parents readily embraced the broader feedback mechanism available through the process portfolio which demonstrated a readiness to further diminish their early strong support of traditional pedagogies. However, a level of parental support for structured testing and peer group comparisons remained evident and that needed to be considered by the teacher focus group as they addressed the rebalancing of assessments that they used to ascertain and report student achievement.

Three-way Teacher-Parent-Student Interviews

A major outcome from the parent interviews was the development of three-way student progress and achievement interviews based on the student's process portfolio. The interviews were scheduled in the third term of the second year of the study as normally, no written report was made to parents at the conclusion of the third term. That meant that in line with requests made by parents interviewed earlier as part of the study, parents of all students in the teacher focus group's classes were offered an opportunity to gain increased detailed feedback about their child's progress in mathematics.

Central to the feedback were presentations to teacher and parents prepared and given by students. The presentations were based upon a piece of work, or a series of linked tasks that were displayed within the student's process portfolio. The depth, breadth and form of the presentations were limited only by the student's imagination and, of course, time available for preparation and presentation. Discussion regarding one or many aspects of the portfolio and the student's progress and achievements followed with the student taking an active role. Students explained to their parents and teacher what they had learned and how new found knowledge had been discovered and applied.

During the three-way interviews, in viewing and sharing students' portfolios and new-found knowledge, parents commonly expressed a desire to 'see it frequently'. Considering the infrequency of parents viewing student work revealed during the earlier study interviews, responses such as this were interpreted by the focus group as an indication that parents considered process portfolios to be something worthy of increased attention. Clearly, parents believed that the portfolios could tell them more than they were gleaning from feedback currently available through such instruments as the Record Book and semester reports. Comments such as, "It really shows what they have to do" and "The words make it easy to see what they have to do to get to the next level" (see Appendix 57, p. 373) affirmed strong parental support for the process portfolio.

Earlier parental doubts about students being able to assess themselves accurately prior to teacher assessment had been dispelled during the months of implementation. Teacher E stated that, “parents were very interested in reading their child’s self-reflection because these gave them greater insight into their child’s perceptions about their own performance. Several [parents]commented on the trust that seemed to be building within their sons in relation to their learning and being able to make comment on their performance before the teacher” (see Appendix 57, p. 375). Teacher D was told, “At least I can see he’s honest in his assessment, as your’s matches” (see Appendix 57, p. 373).

My observations of students’ work on display in their expanding process portfolios upon which the interviews were based indicated a steadily growing level of formative feedback supplied by teachers, peers *and* parents through completed rubrics, comments and student reflections. The growing level of constructive input was reflected in the formative nature of comments noted by teachers during the interviews.

Judging by teacher notes and reactions, the inclusion of students in the conferences strengthened trust across the stakeholder group. Teacher E reported, “My overriding comment would have to be about the relaxed nature of the discussions” (see Appendix 57, p. 375). The teacher focus group believed that trust had been increased through the demonstrated transparency of the three-way interview process. They believed that a genuine productive openness across teachers, students and parents had become apparent and that students realised that they were central to whatever steps needed to be taken in the learning process. Parents added to that with comments such as, “My son feels interested in what he’s doing as he knows it means something if there is a rubric attached. It’s almost like he feels more anxious to get the work done” (see Appendix 57, p. 374). Students also saw other implications in three-way interviews. In the final student survey comments indicated that three-way interviews would potentially mean that parents would know everything that students did at school. Naturally, a mixture of positive and negative student emotions was apparent regarding that possibility.

Several parents added that they thought that it was important that parents portrayed a positive feeling towards mathematics while others said that at home their children’s attitudes effected each other’s reactions more than theirs did as their children tended to ask siblings for help in mathematics when it was required. A number of parents noted the positive influence of their son’s progress in mathematics making the boy believe in himself more as he saw himself getting ‘smarter’. Teachers reported that parents spoke of their greater personal understanding and appreciation of school mathematics. Many parents believed that their increased positivity towards mathematics had a positive influence on their child’s attitude.

Throughout the study, positive parent perceptions were evident regarding the capacity of the process portfolio to serve parents’ needs for clear, authentic information, i.e. information that was easily comprehended because of its applicability to the world parents understood. Greater transparency in assessment and reporting meant that parents claimed greater insight into teaching practices than had been provided through the traditional summative testing and report cards. Teacher E exemplified the positive parent response to process portfolios with, “Parents liked the information provided by the assessment rubrics because they were able to clearly see the purpose of the tasks and the outcomes expected” (see Appendix 57, p. 375).

THE PARENTS’ VERDICT

The working hypothesis missed the mark somewhat. The level of parental acceptance and the virtual lack of scepticism in relation to the overall concept were surprising in this conservative traditional school. The only early doubt expressed by a small number of parents related to student self-assessment. The three-way interviews in the second year of the study saw that their concern had dissipated during the implementation process. Parental support for the process portfolios became incredibly strong and long-lasting, which held real promise for any wider implementation of process portfolios.

The very high level of parental support expressed for the process portfolio concept during the initial interviews was maintained throughout its development and implementation. Key to that support was that it was seen to add significant depth to parental understanding of their child’s learning. Parents felt comfortable with the strategy because it presented mathematics in a way to which they could relate and feel at ease discussing. Parents remained eager to receive the wealth of information offered through the complete package of task sheets, criteria-based rubrics and student artefacts.

In line with Stenmark's (1991) criteria, across conceptual and procedural mathematics, the unique process portfolio model derived through the study encouraged and displayed student work which utilised all levels of thought, from knowledge through synthesis and evaluation to the highest order, creation. Regular parental remarks regarding the obvious interrelationship of process-consolidating conceptual mathematics and their child's deepening involvement in all facets of mathematics were the major factors in their support for teachers and the evolving concept.

The three stakeholder groups directly involved in the study believed that assessment practices prior to the changes that were made had marked shortcomings. In seeking to explore viable change, five teachers had formed the teacher focus group. Students joined their teachers and made enormous contributions, while parents expressed support and delight that the school was trying to improve all aspects of mathematics teaching and learning. The basis of the third study referent, which explored the possible increase in the effectiveness of assessment through the use of process portfolios, was seen by all three stakeholders to generate a firm foundation of increasing support.

THE NEXT CHAPTER

This thesis records a study of a change to assessment of achievement in mathematics which took place over two years. However, as with many facets of education, it is likely that the change will never be classed as complete. The development begun during the study saw the evolution and implementation of a unique process portfolio model with many flexible components. The model and its components will remain under review and development by teacher change agents at the study school seeking still further pedagogical advances in the teaching of mathematics.

In assessing the wide ranging input from the three participant groups during the studied change, the final chapter reviews the results of the study in relation to the research questions. While the limitations of the study are noted, recommendations are made for the wider implementation of the process portfolio in mathematics at the study school and by inference within schools which share a compatible philosophy on the teaching and learning of mathematics.

CHAPTER EIGHT: CONCLUSIONS AND RECOMMENDATIONS

To be authentic, mathematics assessment needs to engage learners in developing and applying a variety of problem solving strategies. It must also encourage them to expand and self-monitor their mathematical skills. In this study of marked pedagogical change, at first it was the teachers engaging, testing strategies and solving problems as they were encountered; the teachers were the key learners. In a protracted learning experience, the teachers, their students and their students' parents played substantial roles in revealing and exploring the problems inherent in what was a significant paradigm shift in the teaching and assessment of mathematics.

This thesis discusses and reflects upon the learning experienced by those involved, from the start of what was a hefty task through the change process to the resultant process portfolio artefacts. The thesis is in itself a process portfolio. The study tracked the complex process of a small group of teachers fundamentally changing their teaching and assessment strategies from a traditional test-centred base to one built on the application of authentic mathematics. The change encompassed all facets of learning programs, from task formulation through to assessment and reporting. The thesis examines the learning journey of the teacher focus group as they identified problems, devised and tested ideas and reflected upon their undertakings. Adding to the impact of their learning, the teachers engaged their students in all aspects of the change.

This concluding chapter of the thesis presents the findings of the study in relation to the five research questions which framed the research design. The implications of the findings are made apparent and recommendations for the wider implementation of process portfolios in the study school and other schools are offered. Limitations within the study are identified, as are possible areas for further research. My personal reflection on the study concludes the thesis.

THE FINDINGS OF THE STUDY

The study was guided by the general research question, 'What are the problems that face teachers who seek to foster robust understanding of mathematics by broadening the teaching, learning and assessment base through utilising process portfolios?' From that general question five aims were drawn, and from those aims five specific research questions were formulated. The aims are briefly reviewed before the study findings are discussed in detail within the responses to the research questions.

The Aims of the Study

The aims of the study were detailed in Table 1.1 on page 16 and in brief were:

- To ascertain how teachers develop and implement a process portfolio;
- To investigate how teachers develop assessments suitable for a process portfolio;
- To examine how teachers use process portfolio tasks to develop mathematical understanding;
- To identify how teachers develop a process portfolio that is an effective part of reporting; and
- To reflect upon and describe the teacher professional growth inherent in the change.

In seeking to achieve the aims, reading, discussion, planning, trial and error and model development produced a state of flux within what had been a well-established traditional, test-based assessment structure in the study school. The substantial change undertaken during the course of this study encouraged investigation of good teaching practice and promoted open-minded exploration of new possibilities.

In attempting to ascertain how teachers explored and embraced new pedagogies, hindsight, that most powerful of human ‘senses’, revealed that the scope of the first aim was incredibly wide, for in reality this one aim subsumed much of the other four. However, in light of the large body of data collected and considered within the study structure, the remaining four aims did remain somewhat semi-detached from the first. Indeed, broad reflection of that which fell under the mantle of the first aim led well into more specific points which stood beneath the remaining four. The tracing of the path followed by the teacher focus group in the development of a process portfolio model saw this aim realised.

An overview of task and instrument development, the second aim, was to a large extent also implicit in the fifth aim as the development was a major facet of teacher professional skill growth. The change process was observed and scrutinised as it produced a large number of versatile assessment instruments. In linking with the second research question, the realisation of this aim revealed the changing balance in the use of summative and formative instruments within mathematics assessment. It produced evidence of wide variation across the relatively small teacher focus group in a school that allowed teachers significant professional discretion in establishing their assessment frameworks. With much of the data qualitative, collected through daily focus group interaction, accurate ‘measurement’ of change and its quality as it proceeded was difficult; judgement was required on my part.

Achievement of the third aim was reasonably straightforward as the process portfolio model was designed, tested and modified by those who were using it. That meant that the model satisfied the group’s needs and dovetailed into the existing assessment structure of the study school while taking assessment in a new direction. The research question derived from this aim weighed the advantages and disadvantages of the process portfolio, an important consideration for teachers and indeed all stakeholders in considering the implementation of such a change.

In examining the penultimate aim, which centred on fitting the process portfolio into the existing accountability structure, it was found that the school’s existing outcomes-based reporting format needed only modification, not total reformatting. If learning outcomes and criteria were clearly defined, the artefacts available through a well designed series of assessment tasks displayed in the student process portfolio made it relatively straightforward to demonstrate that the learning outcomes had been achieved. Stakeholders from teachers and students to parents and the school found that the process portfolio was an excellent communication tool regarding student achievement.

Results derived through pursuit of the final aim of examining the professional growth which accompanied assessment change, proved expansive and extremely effective. Just as students found that their roles changed and broadened, teachers modified their roles, becoming enquirers, coaches, resource procurers and mentors. As did the students, the teacher focus group learned principally from the cognitive and affective processes in which they were involved. Teachers became learners to a previously unfamiliar extent. From early doubts, they moved through the phases of learning, beginning with the problem and ending with reflection upon the learning. In learning, they were open to an unprecedented level of constructive influence from their students.

Overall, the five aims fostered the bottom-up approach to designing an effective teaching and learning program. In facing planning issues, teachers were encouraged to select contexts and interpretations that made sense to them. As they were working in a constructivist learning climate, they were given a great deal of latitude as to how they made connections within the evolving process portfolio components and the model itself. Through the study examining how teaching, learning and assessment are designed to cultivate and test connections, they developed a deeper understanding of authentic assessment and its potential when used within a process portfolio.

RESPONSES TO THE RESEARCH QUESTIONS

From the research aims five research questions were drawn. The research questions were heavily inter-related and that relationship was illustrated in Figure 3.1 on page 66. Responses to the research questions are now be addressed in relation to the study results that have been discussed in Chapters 4 through 7.

Research Question 1: *What are the issues facing teachers as they realign their teaching, learning and assessment practices with the process portfolio approach?*

The undeniable purpose of teaching is to facilitate students' learning, expanding understandings and empowering them with the ability to apply learning to the solution of problems. In the case of this study, the problems were in mathematics. The teacher focus group undertook the work to assist students gain robust mathematical understandings. However, before being able to empower students, the group faced a significant initial problem; all members had to change not only their beliefs about assessment and the forms that they applied, but their beliefs regarding learning itself. They needed to embrace a constructivist approach to teaching and learning, which for some meant abandoning many aspects of traditional approaches that they had employed for many years (see page 94). The teacher focus group members had to become change agents, they had to take risks in teaching of a nature that none of them had confronted previously.

The risks in exploring and moving from one approach to learning to an unfamiliar approach were many. The teachers had to relinquish a high level of control while they and their students learned about new concepts and new ways of working together. Crucial to that change was the focus group understanding and following constructivist learning theory in taking students from what were their current understandings into new areas of discovery and learning in an authentic context.

By design, in order to give the teachers a pragmatic slant on how learning occurred in a constructivist manner, the process portfolio development work within the study was structured following constructivist theory. The teacher focus group had to consciously develop and test hypotheses while destroying and reconstructing their knowledge and skill scaffolds. I was constantly aware of all participants breaking down and reassembling new understandings; I was doing the same. The frequent rebuilding and growing ability to transfer understandings meant that the group was able to work together to reveal the wider problems in broad assessment change. The problems included changing their dichotomous perceptions of mathematics, integrating problem solving across all mathematical strands and embracing and utilising embedded formative assessment.

Changing the Assessment Focus

Whilst this study began with a focus on mathematics assessment, time revealed that the implementation of process portfolios demanded a major revision of mathematics pedagogy. Assessment now had to be embedded throughout the teaching program, not simply tacked on at the end. Learning experiences had to guide students in building knowledge scaffolds, skills and understandings upon existing fundamentals. The pedagogical package had to be restructured but still had to suit existing syllabus parameters. Elaborations and learning outcome statements needed to be written to fit the syllabus. Through developing and trialling new approaches, sets of elaborations, learning outcomes and suitable embedded assessments were formulated (see page 109).

In this study it was found that as teachers investigated and trialled new approaches within the syllabus parameters they were encouraged by positive shifts in stakeholders' perceptions, particularly those of other staff members (see page 156). As a result, it became apparent that if those who develop new assessment practices emphasise the strengths of the emerging assessment format, offering guidance in its implementation, others are encouraged to support the new practices through adoption and adaptation. As shown through this study, wider adoption assists all involved in the change through the clarification and satisfaction of further issues as they emerge.

If, as in this study, issues are confronted as part of a collective bargaining process and teachers are given empowered voice and time, the change is meaningful. The issue of deep learning for both teachers and students was addressed by giving the teachers time to work through the previously recognised four pillars of learning: experience, reflection, abstraction and active testing. The teachers were given the required time and voice within the focus group to hypothesise and actively test strategies in incorporating balanced assessment change. The teachers became immersed in their own learning.

From Behaviourist to Constructivist

From early data it was apparent that the teacher focus group's pedagogy was grounded on behaviourist principles (see page 95). Changes in pedagogy, designed to have students move from passive learners to active learners, proved a less than simple undertaking and one not covered effectively by the literature. Early indications by the teacher focus group had been that for some classes, up to 30% of student learning had been rote learning (see page 99). Cognitive objectives were not rated as highly as 'Maths for life' based on rote learning. Initially, the teachers had to acknowledge their use of teacher-centric instruction.

As a result, the teachers needed to change, to become learners while maintaining their teaching roles; a transformation found to be of varying degrees of difficulty across the focus group. They needed to facilitate the creation of a process portfolio culture in their mathematics classrooms, a culture which saw students deeply engage in all aspects of learning, including assessment. They had to allow students in to all facets of the teaching, learning and assessment paradigms. That was a considerable undertaking, particularly when the teachers were unsure and the process portfolio was only evolving. Teacher A found it impossible, Teacher C found it very difficult, while Teachers B, D and E accepted both roles much more readily (see page 153). Challenge, revision and the rebuilding of understandings confronted the teacher focus group throughout the change process.

Mathematical Language Barriers

The literature on portfolios in learning generally concentrates on students, with relatively little direct attention given to problems confronting teachers in assessment change. Through their part in the study, teachers realised that the language of mathematics must be meaningful if students are to communicate adequately. Teachers found that their work supported Capps and Pickreign's (1993) findings that communication played a critical part in assisting students build links between ideas and the language and symbolism of mathematics. Working with teachers during this study showed that precisely the same can be said for teachers but the teachers needed training in facets of mathematical language; knowledge of it could not simply be assumed.

Within the language parameters, the teachers realised that they needed to understand the value of substantive and substantial classroom conversation; a minor teaching and insignificant assessment concept under behaviourist learning principles. In the traditional classroom, teachers working with students in formulating tasks, students discussing open-ended problems and plausible solutions, students undertaking self-assessment and reflection, are unlikely occurrences. However, the study found that in the emergent process portfolio classrooms those functions were found to be vital in the creation of an effective learning environment. Appropriate language skills facilitated genuine teacher and student engagement in the implementation of the process portfolio (see pages 134, 137, 139 and 141).

Problem Solving

Developmental work needed to broaden the teacher focus group's perception of mathematics as a number-based, dichotomous, isolated subject that was taught in a prescribed manner at a scheduled time (see page 95). It was necessary to offset their declared lack of knowledge and enjoyment of assessing, change their view of assessment as a purely summative activity to one which provided formative feedback. It needed to encourage mind-set changes in those such as Teacher D, who had commented that she had the content right, with the tasks and the assessment strategies causing her difficulties. Clearly, emphasis needed to shift from assessing the product to assessing the process.

That shift was achieved through substantial movement into the problem solving paradigm with the aim of helping students develop coherent representations of the problem and devise and test general solution procedures. The teachers realised that the most effective way to ensure that activities recognised student's general abilities in representing and organising knowledge was to have students engage in the entire problem development and solution process. They embraced authentic mathematics as the focus within which to encourage that broad student involvement (see pages 118 and 152).

Students needed to be accorded abundant opportunity to work with a wide array of problems that were seen to apply in the world outside of school. Heuristic problem-solving skills had to be developed through challenging, open tasks which used expansive practices such as group discussions and guided discovery. For teachers who had been teaching within a text-driven syllabus for years, change presented many problems. Becker and Shimada's (1997) warning that the creation of appropriate tasks with a sense of 'real world' and offering suitable challenge across a wide range of student abilities would be problematic, was well supported by the study. However, Goldin's (1992) claim that a concentration on real-life mathematics would see students unable to transfer their learning to unfamiliar situations was strongly disputed.

Catering for Different Ability Levels

In catering for all ability levels across the multiple intelligences, it was important to create tasks which challenged but did not frustrate students. The teachers agreed that having students involved in task creation allowed students to make mathematical connections that strengthened their understanding (see page 129). Allowing the necessary level of empowerment while retaining subtle control and guidance did not come easy across the focus group. Within the group, it was agreed that students of lesser ability in mathematics were able to represent their knowledge and skills effectively through process portfolio tasks and resultant artefacts. However, regardless of such broad strengths, the process portfolio strategy did not completely replace testing in the teachers' assessment structures (see pages 150 and 151). Study results revealed that the strategy had been incorporated to varying extents within the teachers' revised assessment balances.

Over time, teachers devised strategies that enabled students of different abilities to create problems or work on teacher-generated problems that recognised differences in ability. However, with scant literary guidance available, assessments that were able to identify and monitor students' differing abilities while advancing inclusivity, were found difficult to devise. The issue was effectively addressed with the strengthening of teachers' knowledge and mathematical pedagogies through exploration and discussion.

Teachers developing their professional knowledge and skills also highlighted the need for the school to support teachers in any assessment change through resourcing and timetabling. Further support through parent and teacher surveys should be used to identify issues in the teaching and learning of mathematics other than assessment.

Effective, Supportive Groups of Teachers

The work of the teacher focus group highlighted the need for teachers to work in cooperative groups in order to foster and harness the available synergy (see page 123). The focus group recognised that their group work had become a powerful learning tool as it offered mutual support, although I did have to guide that support until members felt at ease with the challenge of the change that confronted them. Group work proved highly beneficial in increasing general commitment to the change by fostering frequent professional sharing, ensuring plentiful incentive-building constructive feedback. Cooperative group work also demonstrated enormous capacity for addressing problems and advancing a wide range of new, useful responses to issues regarding the design of learning outcomes, tasks, rubrics and reflection guides.

Whilst group work was able to devise practical responses to the many issues found, it was not a straightforward process. Understanding the nature of portfolio components and devising suitable formats that were adaptable and suited a wide range of applications took a great deal of time (see page 154). Of the components, guided reflection proved particularly difficult, as it was an activity with which the teachers were unfamiliar. They took some time to assign reflection status as an important learning tool. Both the teachers and their students questioned the learning value in spending ‘precious’ time on the activity. However, after guidance, participants acknowledged and embraced its value. Teachers came to view reflection as an empowering aid to learning.

Of course, empowerment through cooperative group work was by no means the panacea for all problems encountered. Major issues were not all resolved through collaborative effort. Teacher A’s difficulties in coming to terms with the change were exacerbated by the pressures of working with a group. On the other hand, Teacher C experienced similar problems in regard to the rate of change but remained with the focus group. Teacher C’s retention was due to her use of the available group support.

Time

Heavily underscoring all of the above issues was the question of time and no amount of literature can adequately forewarn change agents of this unpredictable demand. As an issue of some magnitude within the change, it was discussed at length on many occasions. It merits further mention here so as to underline the importance of time amongst the myriad major issues unearthed through the study.

As part of the change process, the teachers were encouraged to consider all facets of the time issue. The findings of the study heavily underscored McMillan’s (2000) declaration that teachers need time to learn about new assessment concepts, develop and adapt, trial and implement those which they believe are worthy of such investment in advancing authentic assessment. The extent of the need was only revealed over time (see page 154).

Support for Change

In a local context, this study demonstrated to the teacher focus group that no single instrument or tasks could fairly assess all aspects of student performance. The focus group found that their purposes in producing a credible picture of student achievement were best served by an assessment structure which included norm-referenced and criterion-referenced assessments. The challenge was in finding a combination that worked as part of a comprehensive structure that assessed all students equitably. In that state of flux, teachers became learners and revealed not only the problems but plausible responses that satisfied both their professional needs and the needs of their students and other stakeholders; the responses had to be contextual.

However, in order to achieve that goal, support was required from across stakeholder groups. There were accountability demands from both school and parents. Whilst it was not seen as perfect, the current system was not deemed to be failing either. So, what was the point of change? The validity of the new approach and its reliability, were questioned during the early part of the study but credibility grew through meaningful stakeholder involvement and contribution (see pages 187 and 214). Student interest levels were initially high owing to the novelty and that motivation had to be maintained through the controlled expansion of the work and broadened, leading to even deeper student engagement. Home influences also played a part in that involvement, so home had to be kept abreast of developments through assessment feedback and items such as mathematics newsletters. Unlike other forms of assessment, the process portfolio openly encouraged a deeper understanding of form, flexibility and purpose across stakeholders groups.

Research Question 2: *How do teachers formulate a balance in the use of summative and formative assessments within their approach in order to foster robust understanding?*

The second research question generated a number of sub-questions which proved challenging to unravel. The interpretation of ‘robust’ in relation to understanding and the concept of achieving a balance across assessment types are strongly linked to personal judgement. Views of such questions changed appreciably within the teacher focus group during the study and are likely to continue to change during any broader implementation of process portfolios across the wider school. Realities in relation to the application of assessment formats are likely to continue to change as well, as teachers at the study school enjoy marked freedom when it comes to devising and balancing assessment formats across year levels and within their own classrooms.

In seeking approaches that they considered balanced, the teacher focus group had to bear in mind that advocates of extreme approaches to either alternative or traditional assessment ignored the crucial goal of using assessments that match the outcomes to be assessed. During the period of change they became aware that it was possible to generate a comprehensive picture of student achievement through a mixture of assessment types. Discussion revealed that the weighting that focus group members applied to the various formats over the assessment spectrum varied across the teachers as the change progressed. Therefore, findings in relation to this research question will be discussed in terms of what teachers did in redressing the shortcomings in their assessment structure and their understanding of the evolving process portfolio model.

From Closed to Open Assessments

At the start of the study, four of the five teacher focus group members used traditional pedagogy only, while the fifth’s methodology had touches of a constructivist influence. Her program and approach demonstrated an awareness of the need to ascertain students’ current understandings before planning learning experiences. In relation to assessment, a great deal of early reading and discussion was necessary in order for the focus group to reform their views and agree that while stand-alone tests did produce data that they considered useful, tests as such were not improving their students' learning outcomes. All five teachers were concerned with generating data to support reporting of student achievement and saw testing as an efficient collection tool.

The perception of tight accountability had teachers spending much time teaching whole classes with heavy use of rote learning. Summative testing marked the close of topics (see page 99). Relief of that tension took a great deal of time, discussion and many demonstrated exemplars. Within the classrooms of the four teachers that stayed with the study, changes took place at varying paces as they moved from a closed assessment structure to a more open format. This resulted in appreciable changes to their previously held perceptions of mathematics. The three teachers who over time embraced the broad use of extended, open tasks took many months to develop their skills and confidence in task creation. For traditional teacher-centric practitioners, normally reliant on themselves as creators and controllers, the difficulties were compounded by the inclusion of students as contributors in all facets of the learning. The teachers and students had to learn concurrently. However, as with many of the problems overcome during the study, at a later stage the teachers expressed support for all facets of the change in focus.

It should be noted that in making what was marked change in the nature and focus of assessment, although time spent on students developing automaticity of basic number facts was reduced, elements of rote learning through drill and practice were retained (see page 150). The teachers saw such activities as legitimate as the skills allowed students to concentrate on the central thrust of open tasks, thinking mathematically, thereby shifting the focus from calculation. The shift encouraged students to think with and about mathematics, as promoted by Booker et al. (cited in Sparrow, 2004).

Further Rebalancing of Assessments

Students had said that they found mathematics lessons, and especially mathematics homework, boring when they were simply following in the teacher's footsteps. The teachers said that multi-choice and other tests were too uninspiring to merit being the high point of a unit of work. Through the rebalance encompassing authentic tasks, students were given marked freedom in producing displays of their understandings and achievements. The ‘new’ balance saw students take pride in their work, at times developing impressive presentations to enhance their work.

The rebalancing meant that teachers needed to develop a balance between the use of closed and open questions. Similar discussions regarding an effective balance between formative and summative assessments took place in focus group meetings. Whilst prior to the change teachers had given students limited formative feedback, the new emphasis commanded significant attention be given to such feedback. Three teachers undertook marked assessment rebalancing, using the process portfolio model and all of its nuances (see page 150). In revising their assessment balance, each teacher determined their own rate and extent of change and the level of challenge that they accepted as the study progressed. Unfortunately, it cannot be claimed that this study found the optimal balance of assessments but the teachers developed what for each of them were much more equitable approaches to assessing progress and achievement in mathematics.

When seeking an optimal balance of word-based problems and numerical problems in assessments, no guidance was available in the literature. The literature had also failed to draw attention to another study finding, and that was that the teacher focus group found that many of their students had inaccurate perceptions of mathematics because by far the larger proportion of the tasks that had been asked to complete prior to the change were given in numerical form with little interpretation required. As discussed in Chapter Five, the resultant rebalance of emphasis in assessment style saw language-based performance tasks become a significant part of assessment overall (see page 151).

Student self-assessment and reflection through language-based rubrics and reflection guides had never formed part of the teacher focus group’s learning structures. For the teachers to recognise the validity of such forms of learning and establish them as part of their pedagogy, demanded major change. Through the unique learning and assessment tools developed by the group and which now complement the existing literature (as discussed and illustrated in Chapters Five and Six), students rapidly showed that they were insightful in critiquing their own work and that of their peers. That alleviated teachers’ concerns and established self-assessment and reflection as important constituents of the revised assessment mix. Whilst the literature offered nothing in the way of guidance for the group in developing the tools, the teachers' acceptance of the revealed benefits of self-assessment meant that the study supported George (1995) and Black and Wiliam (1998). Those researchers had claimed that self-assessment expanded students' powers of interpretation and judgement, enhanced achievement and shifted the focus from mere measurement to genuine learning.

The new performance-based judgement formats and redistribution of weightings across old forms as a result of the teachers gaining new understandings of the nature, purpose and importance of assessment also complemented existing literature and increased the significance of this study. Teachers moved from closed summative testing at the conclusion of a unit of work to embedded assessment designed as an integral part of unit development. Dichotomous, number-based questions, which bore little relationship to the world in which students functioned outside of school, diminished in importance (see page 151). Through a greater understanding and use of assessment and its informing and constructive purposes the teachers redressed the assessment balance.

In essence, given scope and freedom to formulate a balanced approach to assessment, the teachers considered a broad set of factors. Taken into account in the revised assessment mix were skill and knowledge development as well as application in relation to the learning outcomes sought, assessment validity and reliability, school accountability and reporting to parents. In adopting new practices, the teachers found no support for the criticism of a lack of rigour that had been aimed at student-centred teaching and assessment practices in the United Kingdom, as reported by Black (1994).

Research Question 3: *What are the advantages and disadvantages related to the use of process portfolios in the assessment of performance and progress?*

Essential to the assessment change studied was agreement by the teacher focus group that learners had a great deal to gain from a shift from behaviourist to constructivist pedagogy, for the functioning of the process portfolio is firmly founded on students 'discovering' through experience and forging meaningful new knowledge scaffolds. As with all developmental work related to the research questions, the teacher focus group arrived at realisations and formulated revised opinions after reading, discussion and first-hand discovery. Their agreement on the necessity for such a pedagogical shift was unequivocal. However, as with any change, there were gains and losses. The fourth research question sought to weigh the balance between advantages and disadvantages of the emergent model as found by those involved.

Advantages of the Process Portfolio

Although knowledge of the nature and possibilities of process portfolio assessments in mathematics was limited when the study began, reading had given indications that the assessment form held advantages for students' learning over conventional testing. Indeed, the potential advantages were the original motivation for the involvement of the teacher focus group in the time consuming change. However, the extent of the final list was unforeseen. Many of the advantages found will be discussed, but the list could well be extended by those implicit in others and undoubtedly will be by the advantages that emerge as process portfolios development continues.

Student Skill Growth and Empowerment

Although not a new finding, it was found that the study supported Kuhs' (1997) claim that process portfolios can create a student skill growth narrative (see pages 133 and 212). The model which resulted from this study displays the entire 'learning story' across all assessment tasks, from the student's initial thoughts to the solution derived. Supporting that material is a selection of peer critiques, various forms of justification and student self-assessments, teacher assessments and student reflections upon the work, all of which are based on new assessment tools developed within this study. The teacher focus group found the portfolios to be dynamic, 'living' structures, sensitive to time and progress which yielded clear indications of students' movement toward learning goals. The dynamic nature of the process portfolio meant that they were able to be designed to cater well for an individual's needs and support differentiated teaching though consistent but varied approaches. Student motivation was maintained. According to the teacher focus group, increased student engagement and ongoing communication were readily evident.

Particularly evident within the unique process portfolio model that resulted from this study was a high level of flexibility (see page 132). Using the model, teachers or students involved in the design and completion of tasks could opt to begin at a wide variety of points in the model and conclude the task one or more steps later, depending on the outcome sought. The model allowed all students to excel by providing tasks over flexible time frames and in which they could utilise their skills, such as creativity in presentation to their advantage. The flexibility available within the model offered marked scope in formulating tasks of great diversity (see page 136). It offered opportunity to add an unpredictable aspect to mathematics tasks, a quality which was lacking in the traditional approach. Inherent in such flexibility was increased engagement through cooperative planning between teachers, teachers and students and between students. Added to that was the tale revealed by the reflection process in which both teachers and students engaged.

Reflection, by the teachers and students, in groups and as individuals, was found to be a major learning vehicle across all involved in the study and deserves greater emphasis in the literature (see pages 130 and 143). Reflection on one's contribution, effort, strategy and the reasonableness of a step taken or a solution offered, promoted understanding of the learning process through justification and presentation. Expanding self-awareness increased self-esteem which in turn encouraged further risk-taking. *All* were encouraged to think divergently and test their conjectures, a part of risk-taking but for so long invisible components of school mathematics programs. The traditional teaching offered no place for such student empowerment or for teachers to share control of instruction.

The far-reaching effects of student empowerment were decidedly advantageous to learning (see page 141). Teacher focus group feedback indicated that innovative instruction and open challenging problems, together with encouragement for students to reflect upon different strategies had a positive impact upon students' beliefs about mathematics. The teachers then believed that their students became better equipped to attempt unusual problems or tasks. Critiquing skills, expanded through the use of the critique formats developed as part of the resultant process portfolio model, also equipped students with the ability to recognise incomplete and unsolvable problems and to see why at times their own work was incomplete or incorrect (see page 139). This was an enormous step in learning.

Authentic Mathematics and Motivation

Students regularly asked questions about the purpose of learning mathematics and when they were going to use what they were learning. Early in the study, analysis of questionnaire responses indicated that they were unable to see connections between classroom mathematics and their daily lives. Authentic mathematics, based on problems that students considered important, as in the emergent process portfolio model gave mathematics relevance and engaged students in beneficial ‘mathematical struggle’. Discussions revealed how students working with process portfolio tasks came to understand how mathematical concepts were connected to their lives (see page 176).

When students made connections and misunderstandings were transformed success and conceptual understanding followed. The teachers acknowledged that students needed to experience reasonable levels of success if they were to continue to engage with mathematics and if the work was to be considered challenging enough to warrant the effort yet easy enough to complete. It was affirmed that contextual process portfolio tasks offered both real world relevance and genuine chances for meaningful success. They presented opportunity to solve problems in more than one way, thereby offering challenge and motivation while improving understanding. During the study, if full success did not eventuate, the display allowed the teachers to identify difficulties and address them by adjusting instruction for students in true constructivist fashion.

Through the broader implementation of process portfolios across the study school, a consequence of the success of this study, the constructivist nature of learning will be recognised and replace current outdated traditional methodology. The study emphasised that the process portfolio facilitates such a change and helps teachers gain new understandings about learning styles. The teacher focus group found the portfolio to be inclusive and holistic and that it fostered excitement through creative, open possibilities. Through the constructivist fundamentals inherent in the process portfolio model, student ownership of the *entire* learning process loomed as a strong possibility.

Communication Highlighted

The teacher focus group found that process portfolios encouraged and facilitated communication between students, teachers and parents, generating new-found levels of sharing, collaboration and trust (see page 212). Students and teachers began to speak a common, mutually supportive language and to use mathematical language more readily. Students exhibited a sense of pride and accomplishment in their mathematics. Parents were comfortable in discussing their child’s accomplishments. All study participants found that portfolios provided useful conversation bases, particularly when students used them to demonstrate the process and progress of their learning. Teacher-to-teacher professional communication increased noticeably. The interactions promoted both verbal and written sharing and cooperation across all participant stakeholders.

Students’ writing about their learning helped them engage in learning and make mathematics their own, giving that essential student ‘buy-in’. According to the teacher focus group, writing led to the use of much more precise mathematical language by students to express thoughts and evaluate others’ ideas. The writing provided opportunities for all learners to say how they were learning and that was invaluable feedback for the teachers. Overall, the notable benefits related to boys, stereotypically not natural users of expansive language, were that their written expression increased their desire to communicate mathematically while generating a record of their growth in problem solving and enhancing their ability to express themselves clearly.

Formative Feedback

Although not used in assessment at the study school, *product* portfolios as used prior to the change may be used as summative instruments. However, as noted in earlier discussion, summative assessment provides data of limited value to learning. In contrast, *process* portfolios were found to offer abundant opportunities for formative, constructive feedback. During all stages of a task the components of the process portfolio model illustrated what students *could do*. Process portfolios were found to be entirely positive measures as they offered multi-faceted authentic information and evidence of understanding and achievement through the displayed artefacts. They also promoted academic rigour through student engagement and clearly communicated judgement criteria which ensured effective learning for students of all ability levels.

Whatever a student’s ability, a well designed, language-rich, year-appropriate rubric gave abundant formative feedback to teachers, students and parents (see page 142). While a score or grade may be seen to infer a comment, the rubric offered specific guidance as to achievement in relation to judgement standards. Rubrics promoted quality of student effort and product as well as ownership and understanding by offering assessment criteria from the start of each task. Students were no longer passive participants in assessment. They became engaged users of feedback and learnt how to manage their own learning. After self-assessment and subsequent parallel teacher assessment on the double rubric, students had a clear idea as to what their current standards were in relation to the criteria and what they needed to do to reach a higher standard. According to teacher focus group opinion, student self-assessment through rubrics proved an excellent vehicle for student improvement. The students became self-directed learners.

Students' Enjoyment of Learning

Student enjoyment of learning appears to be considered unnecessary in traditional approaches to learning. However, the deep involvement fostered by the process portfolio was found to increase the level of enjoyment in learning across all participant groups. Students demonstrated enjoyment in participation in the entire procedure, from data collection for the creation of tasks through to self-assessment and reflection (see page 187). Teachers claimed that students enjoyed reading back over their assessments and reflections as they reviewed tangible evidence of their skill and ability growth. The opportunities to explore their own progress allowed students to gain a greater awareness of their capacities and contributed significantly to the positive classroom climate. Students enjoyed opportunities to share evidence of their capacities with peers, teachers and parents. Parents expressed enjoyment in reading their child's personal insights into his learning through comments written on rubrics and in reflections (see page 213). To that, parents added positive comments regarding the highly informative and interactive three-way interviews and their genuine involvement in their son's learning.

Amongst the changes in the learning at school was the devolution of the authority of the teachers through greater student involvement in all facets of mathematical tasks. Focus group teachers spoke of enjoying the rejuvenated learning environment in their classrooms and of their renewed creativity in teaching mathematics. They also spoke of their pleasure in being able to assist students with presentation and explanatory skills. However, opportunities for novel approaches to presenting work were not restricted to students. My observations saw teachers' practices improve through the encouragement of strong student engagement in the development and exploration of higher order tasks (see page 181). For example, open question formulation skills developed during teacher focus group discussion and demonstration sessions were transferred to the classroom and were part of the revolution which saw the production of tasks and resultant student material that teachers found much more rewarding to assess.

In summary, the teacher focus group found that the further they delved in developing the process portfolio, the longer the list of advantages became. All four remaining members of the focus group, regardless of their particular level of change uptake at the close of the study, were as one in recognising and recommending the advantages of the resultant process portfolio model to the wider staff.

Disadvantages of the Process Portfolio

The list of advantages is indeed lengthy but the study became aware of a number of potential detractions to the process portfolio concept. While they may be overcome given time and experience, when teachers are considering the introduction of the concept they need to be aware of the disadvantageous ramifications.

A Matter of Time

As in any major change, the teacher focus group found the greatest problem to be a matter of time, time to explore the new structure, time to develop and plan as well as time to trial, modify and implement ideas (see page 154). Facilitating student involvement in the entire process, a fundamental quality of this process portfolio model, was by far the greatest absorber of time. Under the previous traditional structure, students were simply handed an assessment task, required to complete it and return it for teacher judgement. The assessment was generally marked, filed and forgotten. Under the process portfolio structure every facet of the traditional procedure underwent appreciable change.

The changes offered students opportunity for involvement in every facet of assessment from task writing and critiquing through to self-assessment and reflection, an enormous, extremely fruitful, but time consuming undertaking (see page 128). It was recognised that initially teachers still felt pressure to cover prescribed quantities of content. However, as the teacher focus group found, the time aspect itself changes markedly over time. As they became more experienced with the portfolio components, they and in turn their students became much more adept and efficient, reducing the time taken accordingly.

Further transforming the time disadvantage was the fact that student skill levels did expand quite rapidly, particularly when students were ‘immersed’ in a strong mathematical environment, such as Teacher D’s classroom (see page 152). Students harnessed the learning power of reflection and accepted the value provided by self-assessment and formative feedback's teacher-student coaching possibilities. Such appreciable levels of skill growth meant that the large quantities time spent were actually well invested.

Further time had to be invested in managing the portfolios, their structure and their use, for without careful management it would have been possible to amass a collection of artefacts which revealed little as to progressive student achievement. Planning, preparation and learning time had to be spent on tasks that had genuine potential to illustrate student growth. In process portfolios a great deal of teacher time had to be spent ensuring that tasks and assessments were understood and completed, with formative feedback offered at appropriate intervals. Time was a major concern.

Storage and Accessibility

Storage was another strong teacher focus group concern. Over a school year, each class produced a great deal of material and the process portfolio displayed it all, not simply the final product. Three possible solutions to the potential storage problem were trialled across the classes involved: storage in the teacher's workroom attached to the classroom, children taking the first semester portfolio home and parts of the portfolio being stored electronically. Of the three, the workroom option proved the most reliable, yielding space in the classroom with ready portfolio accessibility. However, teachers saw the electronic option as worthy of further investigation. Sending portfolios home created problems regarding teacher and even parent accessibility as some contents were lost. In some cases complete folders were misplaced. Disappointingly, in isolated cases, accessibility of teachers to parents proved a problem after sending the portfolio home. Apparently, having seen the contents, several parents no longer felt the need to discuss the contents with the teacher. Additionally, it was seen that the problem could be exacerbated if portfolios were available electronically for viewing through a web site.

Possible Problems with Student Empowerment

Under the model developed in this study, if process portfolios are adopted, a significant level of control is shared by teachers and students. Teachers had to feel comfortable with that transition. Two of the original teacher focus group had difficulty in relinquishing the traditional teacher-centred approach and empowering their students (see page 153). The two teachers also had problems recognising process portfolios as being reliable forms of progress feedback over tests. Although they tended to agree that tests usually only provided a glimpse of specific behaviours at a particular time and that tests provided only one-way communication, they continued to support testing strongly as a reliable measure (see page 150). Though they agreed that tests provided only uni-dimensional evidence, they took security from the familiar and while they expressed support for more balanced assessment formats, apprehension toward wide change restrained their moves to revise their classroom and assessment practices.

Whilst there are disadvantages in using process portfolios, teachers looking at possible change should weigh the considerable advantages against the disadvantages. This study has shown that the disadvantages related to time and storage can be overcome with careful consideration. The concern over student empowerment through the transition can certainly be turned to the advantage of all. In final considerations, the study found that the scales were heavily tilted in favour of a process portfolio culture.

Research Question 4: *Taking process portfolios into account, how do teachers develop and implement an appropriate format for the reporting of student performance and progress?*

Due to the timing of their issue and their broad audience, formal written reports are often seen as the final piece in the accountability jigsaw. To be effective they must inform all stakeholders of student progress. To be efficient they need to dovetail seamlessly into the assessment process. If learning goals and criteria have been clearly delineated, portfolio artefacts make demonstration of student achievement straight-forward, inferring that reporting should be relatively simple as well. Therefore, part of the design brief for the study was to formulate a unique interface between the resultant process portfolio recording structure and the study school’s existing reporting format.

That existing reporting format consisted of a number of elements. Casual parent teacher interaction, comments by teachers, students and parents in the student diary and the formal semestral achievement report coupled to an interview opportunity completed the reporting structure. Process portfolios were designed to complement and markedly enhance the entire package of existing procedures from oral to written reporting (see page 132).

Any form of written report needs to communicate achievement succinctly and clearly if it is to be of real value to stakeholders, particularly parents. As part of the study, the parent interviews regarding reporting structure had shown that parents were looking for concise easily understood feedback in relation to their child's achievement. In examining possible changes to the report form in relation to process portfolios, the teacher focus group considered their changing requirements as well as the fact that as yet most classes in the school were not involved in using the portfolios for assessment. A functional compromise was required. Modification of what was the current outcomes-based form was undertaken through a lengthy discussion process involving all teachers in the school. That produced another first resulting from this study, a form that affected change suited to the changing nature of assessment in the study school. The new form served the purposes of both the focus group and the school as a whole, while satisfying the new Federal Government regulations on reporting to parents. It also left sufficient scope for later affective change, should others find such beneficial (see page 149).

In the meantime, the changes made as part of the study were supported by the wider staff as they led to a more efficient assessment recording system being put in place. The study found that modification of commercially available software gave the capacity to electronically store process portfolio assessment data against pre-determined learning outcomes within the revised report form. Report preparation was then simply a matter of publishing the electronically stored document at the end of each semester.

Notwithstanding all of the above, this study highlighted the value of the broader, reinvigorated communication generated through the three-way interview utilising process portfolio-based display and discussion. In all likelihood the written report will not be discarded in favour of the interview in the near future. However, the strong emphasis placed upon the revised interview format by the teacher focus group exemplified the value they placed in face-to-face interaction which actively involved teacher, parent *and* student (see page 212).

Adding strength to what was the existing reporting structure were other new written forms of feedback. They included student reflections that revealed students' attitude toward mathematics (see page 145), the affective component, and student self-assessments parallel to teacher assessments on language-rich double rubrics (see page

142). Written responses to peers' ideas through critiques which commented upon points such as the ability to create a task, to reach and support alternative solutions and to articulate solutions further expanded the comments (see page 140). Evidence of the ability to transfer skills across contexts, diligence and levels of higher thought, including creativity, displayed within students' artefacts, ensured that the process portfolio provided a wealth of reporting feedback for all stakeholders.

Research Question 5: *What is the nature and form of professional development that facilitates teachers changing to an approach which utilises the process portfolio as an instrument of major import?*

In embracing the crucial concept of building understanding through a constructivist approach to learning, a central tenet of the process portfolio concept, the teacher focus group moved into unfamiliar aspects of pedagogy. As detailed in Chapters Four and Five, at their own pace members of the group linked the unfamiliar to the familiar and developed and trialled new approaches to teaching and assessing mathematics. Unfortunately, the literature failed to stress the need for teachers themselves to set the pace of change and soundly scaffold their new understandings; to follow a true constructivist approach in their own learning. This study exemplified that need.

Following constructivist principles, professional development assisted teachers build confidence in developing and working with the revised pedagogy (see page 123). Initially, sessions centred on teacher focus group exploration of constructivist fundamentals. The professional development 'package' then became somewhat convoluted as each member of the focus group explored particular possibilities within portfolio components and shared their findings. Individual progression meant that although group experiences occurred, professional development for each teacher was flexible and could not be rigidly scheduled. As Baker and O'Neil (1994) had claimed a decade earlier, the study confirmed that for the professional development to be of real and lasting value it had to be contextual. Intangible outcomes were shared through group discussions and the tangibles were illustrated through the emergent portfolio.

While time pressures are a 'given' with teachers generally, in relation to the pace of this change the teacher focus group worked with very few study-imposed time constraints. Focus group teachers in the study were investigating change, not working under prescribed change. However, when considering the outcomes of the study against the fifth research question it must be borne in mind that self-directed and self-paced circumstances do not always exist in relation to change in schools.

Planning in Reverse: Making the End the Beginning

Early teacher surveys and interviews revealed that at the outset the teacher focus group saw assessment as marking the end, the summation of a unit of work. Assessment was not created at the time of unit planning as a focus for the planning of learning activities. It was written once teachers felt that they had completed the necessary teaching and students had had opportunities to practise and acquire the knowledge and skills. If it was formulated during planning, it was written after the unit of work was planned but still as a summary activity. That summative assessment was synonymous with testing. If formative process portfolios were to succeed, teachers needed to reverse that thinking, change what was seen as the end into the beginning, basing planning on questions such as, ‘How will we know that they have understood?’ and ‘Can they apply their new understandings and skills across a range of authentic situations?’

The teacher focus group came to realise that in order to answer such questions, all forms of assessment needed to be aimed at improving instruction and learning. They needed to align their assessments with what they wanted their students to learn. Experience during the study showed that the norm-referenced testing that they had been using was providing little practical guidance about how they should plan authentic teaching and learning activities (see page 137). They began to plan and implement effective programs that did not stop for testing but included embedded authentic assessment.

In seeking such change, the fact that teacher learning was essential was beyond question. Through an immersion approach to learning, teachers became researchers, explored questions as they arose and devised plausible responses. Opportunities were created for the focus group to observe and coach each other regarding aspects of the change. They were given opportunities to try new practices in as risk-free environment as was possible within a functioning school environment.

Teachers and Constructivist Learning

Early data had revealed information about the backgrounds of the teacher focus group members. Introductory journal articles, resources and concepts which were designed to allow teachers to operate within their ZPDs were shared and discussed. From there, suggestions for professional development to meet their needs came from the group. As a result, learning for several months related to constructivism and assessment, its nature, place and form as well as open-ended task writing.

As a result of early learning, the teacher focus group adopted an open approach to task formulation (see page 138). From firsthand experience, the group realised that it was difficult to accurately tailor instruction to learners' ZPDs but that it was possible and that an awareness of the ZPD concept forearmed them in planning. They saw the ability to design tasks that were open to interpretation and different forms of completion which allowed students to base their learning on previous knowledge and skills as crucial. The teachers became skilled at designing tasks that moved students through the straightforward to more complex questions that encouraged higher-order thought and encouraged a variety of plausible solutions (see page 181). To that end, the task development structure that was formulated by the group as part of professional development proved highly useful and was used in both teacher and student task writing skill development.

Of major import throughout the teacher skill development was the concept of meaningful involvement of students in planning in concert with the teachers. Under the circumstances which prevailed at the start of the study, teachers simply produced the work for students to complete, ensuring passive student learning. The implementation of the process portfolio model meant that that procedure had to be changed irrevocably. A great deal of teacher discussion, peer support and experimentation followed and appreciable change emerged, change which was reflected in the work samples discussed within this thesis. By the close of the study, students were involved in data gathering, task design, task critiquing, solution, assessment and reflection (see page 191). As exclusive domains, teachers retained only the distillation of elaborations and learning outcomes from the syllabus and their part in assessment and reporting on student achievement.

However, for some time mathematics continued to be classed as an exclusive subject by the teacher focus group. Although as a result of their slowly changing perceptions the teachers acknowledged a decrease in that exclusivity, all continued to have levels of difficulty in integrating mathematics into other subject areas. Even after many months, to an appreciable extent, mathematics was still considered something that was done at a particular time. To a noticeable degree, it did remain that way throughout the study as the teachers found difficulty with the concept of students acquiring fundamental mathematics skills while completing a substantial integrated task (see page 111). Overall, the level of mathematics integration did increase as teachers became more familiar with the background, structure and possibilities of ‘real-world’ problems in well-constructed process portfolios. The change resulted from frequent focus group professional sharing.

Other approaches to professional sharing that proved significantly fruitful were peer coaching, classroom observation and structured and unstructured discussion groups. Undoubtedly, of those activities the most powerful developmental tool across all facets of the work was discussion (see page 131). It proved invaluable for teacher professional growth and stimulation. Time for focus group participant observations in classrooms also proved invaluable and resulted in numerous modifications to portfolio components.

Increased Syllabus Understanding

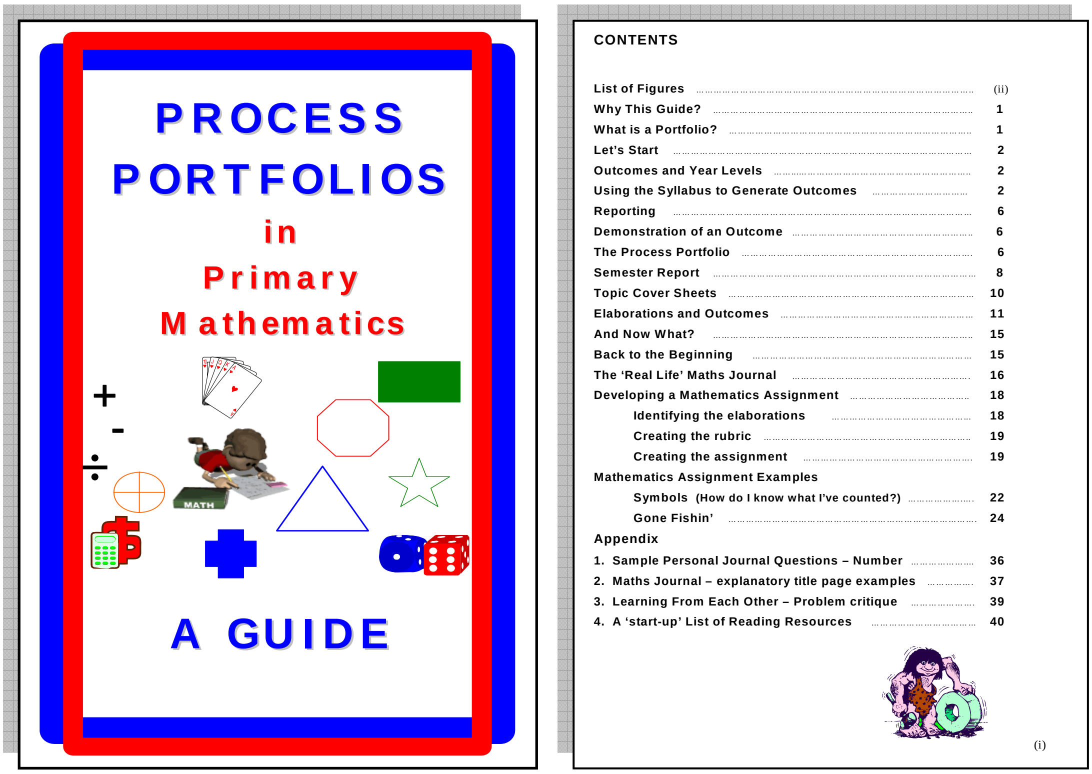
An unforeseen outcome of the professional development, and something not mentioned in the literature, was a renewed level of interest in the mathematics syllabus by the teachers. Increased understanding of the syllabus was achieved through focus group mutual tutoring. Coupled to the teachers’ interest was their desire to build stronger mathematical skills. In order to feel at ease within the far greater depths that their students were starting to plumb, the teachers believed that they needed to possess higher levels of competency across all strands of the syllabus (see page 124).

In developing their guiding role, it was emphasised that teachers cannot be expected to have *all* the answers, but that they did need strong fundamental skills and the desire to assist students as, when and where possible. As a result, it was noticeable that the teacher focus group showed discernible signs of an easing of tensions in teaching and assessing mathematics. It was noticeable that their increasing confidence enhanced the focus group's comfort with the evolving assessment structure. Through well-planned professional development which recognised participants' needs, the process portfolio evolved to become a key factor of the teaching, learning, assessment and reporting structures in their classrooms (see pages 149-153).

A Process Portfolio Guide Booklet Written for Teachers

For this study to be of marked benefit to practising teachers, useful professional development resources needed to emerge. Surveys across the three participant groups, teachers, students and parents, revealed that appreciable intangible benefits had resulted from the developmental work involved in the change to assessment. Benefits such as increased enthusiasm for and interest in mathematics have been described at length already. Blending with the intangibles were the teacher-sought tangibles, pragmatic tangibles that would assist teacher change agents fill the gaps in the guiding literature.

Teachers are busy people. If educational change is to succeed they need a starting point and if further change is to be meaningful and lasting, they need open questions to which they can seek their own contextual answers. As has been discussed, open questions increase learner 'buy-in'. In looking to satisfy both of those teacher needs, as a result of the study, a booklet of some forty five pages, *Process Portfolios in Primary Mathematics: A Guide* was written (see cover and contents in Figure 8.1).



PROCESS
PORTFOLIOS
in
Primary
Mathematics

A GUIDE

CONTENTS

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Figure 8.1: ***Process Portfolios in Primary Mathematics: A Guide***

The guide shares the results of the study through brief explanation and the resultant process portfolio model. It takes teachers from the question, ‘Why Portfolios?’ through the formulation of elaborations and outcomes from the syllabus, task writing, task critiquing, the use of real-life journals, the part of rubrics and reflection and closes by leading into reporting. All aspects of the resultant process portfolio model are published for consideration and possible further development by implementing teachers.

The process portfolio was designed to enable students to constantly improve in their application of mathematics. The guide offers change agent teachers the opportunity to work from a basic outline in developing, trialling and implementing what the teacher focus group found to be an inclusive, motivational form of teaching and assessing mathematics. Assessment, the initial subject of the work simply becomes an embedded, inextricable component of planning, teaching and learning. Professional improvement and learning are both proffered as never-closed processes under the broad banner of teacher professional development.

SUMMARISING THE OUTCOMES OF THE STUDY

This study was undertaken to examine questions related to the problems that teachers face when they look to change the teaching, learning and assessment of mathematics through process portfolios. As a result of the teacher focus group’s prolonged problem-based discovery learning, a number of major points in the existing literature were supported and confirmed in a local context. Further findings which supplemented the existing literature have been highlighted throughout the discussion of study results with many emphasised in the responses to the research questions. Of particular note were facets such as the specific nature of the professional development needs of the teacher change agents. Student and parent opinion, input and impact upon the teachers involved and hence upon the change itself, introduced numerous issues and discussion points, none of which were covered in the existing literature. Additional to the valuable intangibles that emerged from the study in the form of new understandings were what became the keys to the teachers’ developmental work, the emergent authentic assessment instruments and tools. The process portfolio model together with its constituent components, such as student critiques and reflection guides, will be put to effective use within the study school as and when wider change is instituted.

When the change began, the purpose was to develop an authentic assessment structure that would encourage deep engagement in mathematics by teachers and students alike. It was recognised that no single approach was likely to satisfy all teacher assessment purposes or philosophies; that a balance would need to be derived. To the teacher focus group, the process portfolio concept offered a level of promise superior to that of the school's current assessment practices.

As a result, this thesis has become a replica of the resultant process portfolio model. It is an authentic reflection of the assessment structure investigated. Results demonstrated that well-designed, multi-faceted process portfolios offer a vehicle that fosters improved teaching practice, learning, assessment and reporting. Evidence showed the teacher focus group that product portfolios, as used prior to the change, were saying more about the teacher than the student as they displayed *carefully selected artefacts*. Process portfolios, as designed and tested in this study, offered real insight into students' interest in mathematics and willingness to engage as the display included *all assessment pieces*. The teacher focus group found that the informative value of assessment through the process portfolio was without question, the most comprehensive and meaningful that they had experienced. It engaged students and teachers in learning and supplied all with copious worthwhile formative feedback.

Although only four of the original five teachers remained in the study to use that feedback, their willingness to become immersed in the change generated enormous potential benefit for the wider school. For practical purposes, the benefits are best illustrated and explained through *Process Portfolios in Primary Mathematics: A Guide* as the booklet gives teachers reasons for and the means to change for the benefit of their students. It shares the results of a local study but provides a framework that is transferable to other schools through the provision of flexible starting points in the transition to assessment authenticity through a viable assessment structure.

Within the theme of authenticity, the teacher focus group achieved a great deal of broad professional growth but one of the most marked realisations, a theme which featured frequently in discussions, was a realisation about assessment itself. Regardless of their implemented level of change, the group supported the view that testing, an assessment *of* learning, only measures, generating summative quantitative data. On the other hand, assessment *for* learning generates qualitative or formative feedback that constructively informs *all* involved during the learning process. The study revealed that the teacher focus group were committed to leading their school in the adoption of authentic assessment with particular emphasis on formative feedback.

Through working with the process portfolio model that was developed, the teacher focus group claimed a greater sense of purpose and improved confidence and enjoyment in teaching mathematics. All recognised the importance of their students seeing real world relevance in mathematics. Underlining those points was the need to teach students to engage, not to give up, a tendency that had been indicated by some students in surveys on their learning in mathematics. Students needed to be encouraged to persist, to be willing to struggle in acquiring skills in thinking mathematically.

The spirit of collegiality developed by the teacher focus group through their collective struggle as they investigated and produced change within their own practice, was felt across the wider staff. That spirit is there to be harnessed during a wider school transition to the authentic assessment of mathematics through process portfolios.

IMPLICATIONS FOR TEACHING AND LEARNING

Throughout this study, it was evident that for teachers to engage with meaningful change and embrace the process and its products, they need to assume a high level of ownership. In seeking to embrace authentic assessment in mathematics through process portfolios, the sparcity of pragmatic detailed literature made it difficult for the teacher change agents to unearth the problems of change *and* formulate an effective model. The model needed to be substantial enough to serve a comprehensive assessment function and user-friendly so that it was readily accepted and implemented in the classroom. The model that participant ownership produced in this study emerged from lengthy, mutually supportive collaboration between dedicated teachers and motivated students.

Through the involvement of teachers, students and parents in the change, this study showed the process portfolio to be superior to the product portfolio as it is a genuine teaching and learning device, not simply a showcase of selected artefacts. That superiority was further emphasized through its great power as a communication medium, which led to high levels of engagement in and support of learning by teachers, students *and* parents. As has become apparent throughout the discussion of the results of this study of change, the harnessing of that power through revised mathematics pedagogy exposed significant implications for teaching and learning. Whilst many implications have been discussed, several with major impact upon the change process merit particular mention in summary discussion.

For the institutions that train teachers there are serious implications within the findings of this study. It has been suggested that teachers spend between a third and half of their time engaged in assessment-related activities of some form. In the experience of the study participants, trainee teachers receive little or no training in assessment, a fact to which the teacher focus group attested. In the group's opinion, assessment is neglected as it is regarded as a summative activity, an activity adjunct to learning. Therefore, the learning activities take precedence in planning learning programs. Teachers generally, are not encouraged to take a holistic view of teaching, learning and assessment as advanced through this study.

However, in recognising the apparent shortcomings in teacher preparation, schools cannot simply criticise teacher training courses. Schools must work to fill the gaps to ensure that teachers are trained to a high level in the craft of assessment through contextually relevant in-service professional development. Best teaching practices demand best assessment practices, a fact now acknowledged within the study school.

For the study school, or any school looking to embrace change similar to that facilitated by this study, there are major implications regarding the content-driven mathematics syllabus and the associated teaching methodologies. If students are to become profoundly absorbed in all facets of the learning of mathematics, as advanced by the process portfolio model, syllabus content must be reconsidered. Currently, the sheer weight of that content in relation to the time available for mathematics instruction encourages, virtually demands, teacher-prepared and imposed learning activities, tests and assessment tasks, thereby subscribing to out-dated behaviourist methodology. Contrastingly, the process portfolio encourages student engagement from the commencement of learning and assessment through the collection of relevant data followed by the creation, completion and assessment of authentic learning and assessment tasks. Reflection upon the experience then coalesces the constructivist-based learning. Such engagement is undeniably a time consuming but meaningful and pragmatic process in scaffolding lasting understanding and building true facility in mathematics.

Whilst by necessity, teachers are pragmatic people, in seeking a balanced authentic approach to assessment which engenders deep understanding the practical needs to be underpinned by theoretical and philosophical standpoints. In this study, the evolution of the portfolio model was supported by a new appreciation of constructivist theory and philosophy on the part of the teacher focus group. Of the learning tools which comprise the model, the emergent philosophy which underpinned the teacher focus group's developmental work, and will need to form the foundation for the future work of other teacher agents, is reflected effectively in the double rubric concept.

On face value, the double rubric simply carries two sets of the criteria by which student achievement is judged. However, the criteria are far more than mere guides for judgement. They are primarily *learning* guidelines. In the optimal formula, the criteria have been generated through the collaboration of teachers and students in a climate of mutual support and learning, not simply imposed by teachers on an unsuspecting student body. Within the double rubric there are no distinctions between the criteria used by students and teachers. Teachers and students, and to a lesser extent parents, use the criteria to guide students towards shared goals and common standards. The double rubric symbolises a pedagogy which is based on mutual support and emphatic engagement in learning permeated by a strong sense of shared purpose and power. That *sharing of power* could be seen to encapsulate both the essence and the implications of the major pedagogical change advocated by this study. The study clearly demonstrated that if teachers are to change their approaches to assessment the process portfolio is one style of supporting structure that shifts the focus from the assessment *of* learning to one of embedded assessment *for* learning.

RECOMMENDATIONS RESULTING FROM THE STUDY

In the facilitation of assessment change such as that recorded in this thesis, a number of important points in relation to the engagement of teachers must addressed. As a result, several recommendations regarding the implementation of the process portfolio are offered.

Teachers need to be involved from the outset of any pedagogical development. Through reading, discussion and the sharing of exemplars they must generate and understand the ‘why’ and ‘how’ of any change. Schools need to foster such activity. Collaborative structures, such as year level teams which foster clear and frequent communication, will facilitate a cohesive sense of purpose and encourage essential open professional sharing and reflection. Those structures can also be utilised to create opportunities for teachers to plan jointly, encouraging support and strong teacher ownership of innovation.

For teachers to be comfortable innovating they need to possess mastery of the subject, at least at the level at which they are working. Teacher knowledge and skills in mathematics must be expanded through in-service training. The Year 5 Mathematics Conference, used to great effect within this study, is just one supportive structure that could be used to marked effect.

Above all, teachers need time to reconsider and change their teaching and assessment practices. They also need structured opportunities to share their new learning. One possible step is the use of negotiated ‘release’ time provided through administrators going back into classrooms or the use of relief teachers. Teachers can then collaboratively plan change and share experiences through experiences such as becoming participant observers in colleagues’ classrooms, a technique used with great effect during this qualitative research.

As with all qualitative research, the research questions were not answered emphatically. The responses to the questions at least partially resolved many of the current issues while raising further questions for investigation. As a result of this study some of the subsequent questions inviting further research are:

- Is there an optimal framework for a process portfolio in primary mathematics? This study was designed to investigate the shape of a flexible, functional model that suited the context of the study school.
- Is there an optimal effective balance across authentic assessment and testing that satisfies the purposes of teachers, students, parents and schools? Teachers in the study modified their assessment balances but naturally, as a result of marked change, were still in various states of flux at the conclusion of the study.

- What is the precise nature and shape of training that teachers need in order to develop high quality judgement skills in relation to assessment? This study satisfied the teachers involved but the question remains a major training issue.

Undoubtedly, as this study showed, other directions for research would be identified by the wider use of instruments such as parent and student surveys. The study demonstrated to the teacher focus group, no members of which had been involved in research previously, that school-based research delivers a great deal of constructive formative feedback which in turn has a beneficial influence on teaching and learning.

LIMITATIONS OF THE STUDY

For me as a teacher-administrator to study change in my employing school may be seen as a limitation in regard to my objectivity. However, it could be countered that a great deal of my motivation in fostering the change stemmed from my vested interest in the school, my professional attachment to the school and its students. My position and flexible schedule offered a multitude of opportunities to work with teachers and spend time in classrooms sharing students' learning experiences. My constant presence ensured that the work remained on track throughout the two years. A positive outcome related to carrying out the study in my employing school was my ability to interact with the teacher focus group on a daily basis and gain an in-depth appreciation of their preferred styles of learning and teaching. As this study was designed to benefit teachers and students, and did so, the cost-benefit result was extremely positive.

Also in relation to my position, the decision to investigate process portfolios could be classed as top-down in that the initial interest was mine. However, the study occurred only after consultation with study school staff and the identification of more than enough teachers who were passionate about mathematics to support the study.

That the school was for boys only opens discussion of yet another characteristic that may be classed as limiting. However, while boys have their preferred learning styles, the gender learning relationship works both ways. There are boys who naturally ascribe to preferred learning styles that are attributed to stereotypical girls, just as there are girls who prefer those styles ascribed to stereotypical boys (Hawkes, 2001). In reality, the school being a non-selective school with homogenous class characteristics meant that classes contain a wide variety of student types, preferred learning styles and abilities in mathematics. This study did not have the scope to examine such factors.

Only a small number of teachers and classes were involved. The original five teachers decreased by one as the study progressed. As the planning, consultative and implementation work was very time consuming, to manage a larger group would have proven difficult. With the original group of five representing a spread across middle and upper primary, as well as a sound cross section of general staff characteristics, the number was considered adequate and viable in relation to the goals of the study.

Within the five classes, student numbers varied as the study evolved. One class left for high school at the end of the first year and another was no longer participating as the teacher had withdrawn from the study. As a result, the number of possible participant students, and therefore parents, decreased to around seventy. However, whilst certainly needing student participation, the central focus of the study was teachers' issues, so the number of students and parents remained useful in seeking the feedback needed by the teacher focus group in their planning and developmental work.

As a result of restricted teacher and student participation, the narrowness and simplicity of the quantitative data are noted. However, the data collected were simply reflections of participant classes at the time. They revealed each class's perceptions, preferences and trends in regard to issues that the teachers considered important during their task of investigating and designing the various facets of the process portfolio.

Through the material distributed to participants, teachers and students were aware of the investigative nature of the work. Under such circumstances, a minor form of the 'Hawthorne Effect' is probably inescapable. However, countering that tendency was the high level of participant familiarity with both their teachers and me and the striving to engender a commonality of purpose throughout the study. That striving also had to fit into a series of parameters, such as limited time within the existing timetable, as major disruption of classes was inappropriate. Process portfolio tasks had to pay heed to contextual constraints such as the texts currently in use by the classes. In what may well have been the contextual limitation bottom line, government funding levels depend on schools complying with regulations on the reporting of student progress and achievement to parents. Assessment innovation itself is indirectly controlled.

A CONCLUDING PERSONAL COMMENT

The motivation for the change that this study tracked arose as a result of my disquiet over the large number of students who either disliked mathematics or could be seen ‘going through the motions’ just to complete the work in some manner, with little sense of purpose or direction. The challenge was to find what could be done to improve the situation. Students needed to realise that *everybody could experience success in mathematics* and that enjoyment was possible in grappling with mathematical challenge. It was not until I read of the *process* portfolio concept and started to consider its possibilities that I realised that it was a learning and assessment structure that had the potential to change student attitudes towards mathematics. Indeed, it also appeared to promise opportunity to enhance teacher attitudes towards the teaching of mathematics, another of my concerns.

In looking to change attitudes, the original intended outcome of the study was to produce something that would be of use to practising teachers, something that offered opportunity for change to those who were looking for better teaching, learning and assessment practices. In turn, it was foreseen that such an outcome would have a marked positive effect on students.

As a result, of the prolific intangibles that the study yielded, the experience assisted me to gain new insights into the styles, skills and talents of many in the school community. Even if they felt uncomfortable at times, committed teachers explored potentially beneficial change for the good of their students. Their students wanted to know if they could really ‘do’ mathematics, whether they were ‘smart’ enough to succeed with mathematical machinations. Parents of their students wanted their children to experience success, while they were kept ‘in the picture’.

Adding further breadth to my greater insight were the effects of copious professional reading, frequent sharing through stimulating discussions with all members of staff, attending mathematics conferences and being part of groups that reported on our work to other interested parties. For those experiences I am grateful to my teaching colleagues, the enthusiastic students and the willing parents for their cooperation, support and candour over the duration of this study; the beginning of a change that we will continue to share.

There can be no doubt as to the value of the change that this study instigated and investigated. However, if the change process that has begun is to maintain its impetus, if teachers are to fully understand and take ownership of the evolving change, then they will need to be assisted and allowed time to develop the skills and abilities to plan and implement the wider revisions. As a school administrator, I must always bear in mind the fact that meaningful, lasting change in teaching and learning hinges on classroom teachers. There can be no doubt that they are the pragmatic bridge between research and the implementation and longevity of realistic, fruitful innovation.

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Appendix 1: School Principal's Approval for Study

28 January 2004

Dear Trevor

Having read your brief, I am happy to give you permission to carry out your doctoral research into the assessment of Mathematics at the Preparatory School. As a Maths Science teacher I find the concept very interesting. It does sound like it could have wider application across the school in the future.

If I can help at anytime, please let me know.

Good luck

Greg Wain
Headmaster

Appendix 2: Explanatory Letter and Consent for Teachers

1 February 2004

Assessment of Applied Mathematics through Student Portfolios

Dear

As you are aware, we have been using ‘Show-case’ Student Portfolios for some three years, with particular emphasis falling in the area of literacy. During 2004 the revision and restructure of the portfolio approach in Mathematics, moving from the ‘Show-case’ to a ‘Process’ concept, is designed to make the portfolio a significant part of our learning, assessment and reporting program. Our boys will be undertaking investigations and problem solving on a more extensive and intensive scale as part of class Mathematics programs. Their *complete* efforts, from initial thinking to conclusions, will be kept in their portfolios, available for all concerned with their learning to review at any time, ensuring a very full picture of each boy’s progress and needs as they emerge. Another major benefit of the technique is that it opens boys’ minds to the fact that often problems are not always what they at first seem, that they can be approached in different ways, and that there may well be a number of acceptable solutions. Also, undoubtedly, the process will have an effect of broadening our view of problem solving. It is designed to illustrate the application of mathematics and remove much of that dull, rigid, demotivating ‘black and white’ perception that is so often applied to the entire mathematics ‘package’ by students. Our revised approach will aim to teach our students ‘to know what to do when they don’t know what to do!’

As this is a development of some note in the world of Mathematics education, I intend documenting the work as part of a study designed to explore all aspects of the process, from teacher learning to student progress and achievement across the change. I will, therefore, be involved with you in designing and implementing aspects of classroom teaching and assessment programs in relation to problem solving, the area on which the portfolios will be concentrating, at least initially. The study will form part of work that I am doing with the Science and Mathematics Education Centre of Curtin University of Technology in Perth towards the degree of MathEdD.

I am seeking your participation in the collection of data generated by your class through their work in Mathematics portfolios. I will also be asking both you and your class to complete questionnaires regarding mathematical and assessment perceptions at various times during the year. I shall also be discussing aspects of the program with some of your boys’ parents. It is hoped that analysis of the data gathered will facilitate the sharing of our collective experiences with other educators through professional development and conferences. Data will be treated confidentially, secured, and not stored or published under teachers’, boys’ or parents’ names, as the focus of the study is *overall trends* in the assessment of Mathematics. Individual progress will remain our focus in class, and personalised data will remain with you the class teacher. Naturally, *all* of the data generated by your class will be available for your perusal at any time. If at any time you would like to withdraw from the data collection focus group, you are able to do so simply by telling me. Such withdrawal will be without prejudice.

As part of the process, at times, I will need to discuss aspects of the work with you, as part of the focus group, and individually. We will need to review the nature and depth of tasks set, and the value of assessment feedback that we are able to provide using portfolios. If you would be willing to participate in the study, please complete the attached consent form.

Should you have any questions regarding any aspect of the above please do not hesitate to discuss them with me at any time.
Thank you for your consideration and anticipated participation.

Assessment of Applied Mathematics through Student Portfolios

Teacher Participant Consent Form

I, ____________________________________

agree / do not agree (please circle your response)

to participate in the collection of data during the study centring on assessment of Mathematics through Student Portfolios which is to be conducted by Trevor Wood at [______________________] throughout the 2004 academic year. I have read the information sheet and discussed any concerns with Trevor.

I am happy to participate in professional development sessions, focus group meetings and one-on-one discussions regarding the data collected. Such discussions may centre on the program and process as a whole, or data generated by my particular group of students and/or parents. I am also happy to complete the occasional questionnaire as applicable to the study. I am aware that all data collected through my participation will be treated confidentially, stored anonymously and securely. All data generated by my participation will be available for my perusal at any time. Publication will see all data treated anonymously.

I will be kept up-to-date with study progress and developments and have access to the full results of the work upon its completion.

I realize that I may withdraw from such participation at any time, and that such withdrawal will be without prejudice.

Signed ____________________________

Date / /04

Appendix 3: Study Log Extracts

February 04:

- **Formation of Teacher Focus Group** – letters to them – returned completed soon after. All five agreed to take part. Composition as per TFG table.
- **First meeting with Teacher Focus Group** – starting **Teacher Resource Kits** distributed and discussed. Teacher resources (as held by TRW – books, journals, etc.) aired and shared – TFG able to borrow. Student questionnaire drafting undertaken - based on my initial attempt. Notes of meeting kept in TFG Meeting Journal.
- Refining of questionnaires continued at subsequent meetings and by all involved in between such gatherings.

March 04:

- **Teacher questionnaires to Teacher Focus Group** for completion.
- **Student questionnaires** – first student survey - completed in Focus Group classes.
- Teacher questionnaire results collated and reflected upon in relation to what PD and procedure should be adopted.
- Student questionnaire results collated – individual (unnamed) class results given to respective teachers together with a copy of all responses (anonymous). Responses grouped for graphing under each question on spreadsheet.
- Teacher Focus Group meetings weekly, with all sessions recorded for later noting in my Focus Group Journal. PD and discussion of the expanding concept, together with discussion of what was happening in classrooms in relation to the study was the essence of the meetings.
- All members of the **TFG interviewed** late in Term 1 using protocol *Participant Teacher Interviews.* **TFG was asked to give written reflections** at the end of Term 1, but only the Year 7 teacher responded. (Not to push it too hard at this stage as significant material had been gathered through the focus group discussions and the interview process at the conclusion of the term.)
- Continued sharing aspects of the work with the wider staff through related *Staff Briefing* notes.
- **Year 6 began Maths Process Portfolios** (exercise books) – authentic activities

April 04: Term Two

- Second term saw TRW in classrooms with the TFG during Maths lessons for observation and working *with* the teacher. [TRW spending regular time in all classrooms, observing and team teaching, in order to facilitate moving the work along at a steady rate.]
- Analysis drafting began with lengthy section on the *Study Specific Surveys.* (Important at this point to record great detail – edit later.)
- ***Learning Theories and Maths* PowerPoint** presentation shared with focus group for discussion.
- Continued sharing aspects of the work with the wider staff through related *Staff Briefing* notes.

May 04:

- Students in Years 4, 4/5 and 5 were asked to complete **DAMT 1 or 2, *Draw a Mathematician Test***. The drawings were then examined using a simple analytical grid in relation to the level of stereotypicality in the portrayed perception. The results of that analysis, combined with student questionnaire responses, were used to select approximately 5 boys (20%) from each class to be interviewed early in Term 3 in search of answers to the questions listed on the question spreadsheet.would like to see more time given to staff professional development in mathematics.

August 05:

Chat with Teacher B re shape of portfolio model

- ☞ 10/8: B thought that we needed to continue to develop the actual model – that it would now be good to see the expanded schematic include the growing number of elements that the group is trialling, e.g. the class journal. We created a new schematic of possible permutations for later discussion across the group.
- ☞ B said that she was getting a lot out of working with C in that whilst she still felt strong frustrations with the whole general assessment question and at least helping somebody else come to grips with new developing ideas was helping her work through a number of the issues that had been building for her for some time. She was happy that at least we are all working to do something about the issues, even if we are changing at different rates.

Discussion with Teacher C re TRW's input in classroom

- ☞ 13/8: C discussed what she would like from me when I come into her class to team teach maths with her. C is still very keen but rather concerned about her slowness in being able to assimilate the change. We spoke of specific examples of this week's focus – Roman Numerals. I agreed to talk to the boys about *possible* origins of some of the numerals. I also agreed to cover the issue of the lack of a '0' in Roman numerals – the place reserving nature of the 0 in the Hindu-Arabic system – an 'open' question if ever there was one. I will write some interesting little problems, closed and open, for the boys to tackle during the time, with a little teaser to take home for homework.

Lunch time casual gathering in Common Room - sharing ideas on getting students more involved in entire portfolio process

- ☞ 17/8: B, D, E and TRW discussed suggestions. Were looking for even greater buy-in from students who were getting well into it, but we thought that the level could be extended further.

Suggestions:

- ☞ **Field trips** to gather mathematical data and ideas for tasks. Mathematics field trips are unheard of, so it would be a great novelty for students – should be a good motivator.
- ☞ **Cross class sharing of tasks completed** followed by discussions to see what students could come up with as a result
- ☞ **Mathematician-of-the-Week**: a boy from each class who has created or completed something special as part of his portfolio work visits another, or other classes to give a presentation on his work and lead discussion. Tasks needed to have real-world flavour but not necessarily wide appeal as the 'odd' task might enthuse boys even more because of its oddity.
- ☞ **Classes create tasks or problems for each other**. This could help boys appreciate the different levels of thought and difficulty that applies to different year levels and abilities. Problems could sometimes simply be critiqued, not necessary to totally solve all the time.
- ☞ **Problem-of-the-Week**: the best task/problem written by any boy across the classes is shared with all classes. The structure and nature of the problem is important thing here – not the difficulty, the level breadth and of thought required.

Appendix 4: First Teacher Interview Transcript (Teacher D)

Question 1. What were your main reasons for getting involved in our process portfolio project?
I would like to learn to do things better in math. I think that I do a reasonable job, but I don't think that I've been able to keep up with the latest trends, especially when it is assessment that you're talking about. I like the ideas that you have been sharing about working in real-life math. They sound like they could be fun and change my assessment procedures a lot. I think that they are a little old, even though I'm not. I pretty much use the same types that I had used on me at school. I'd like to learn about the new ideas and if we can change them to sui us then that would be great.
Why do you think that you use the same strategies that were used on you?
Well, I thought they worked on me, and so they would work on others. It's only recently that I've had doubts, but it's hard to find out much about it … it's a matter of time and resources I guess.
Question 2. Where would you see your strengths lying in teaching maths?
I think that I have a good understanding of all the math concepts and skills that I have to teach at primary level. I've taught from Year 1 to Year 6 and got by OK. I haven't come across anything that I couldn't do, but I could probably do some of those things better and in more exciting ways for my class. I think that my students get quite good results in testing that I do but I think that what the project offers is probably a bit more than testing and I'd like to think that I might be able to add a bit as well as learn a bit. It sounds quite exciting to me and I am studying for my Masters as well, but in admin, but this is all part of admin, isn't it?
Yes. Actually assessment is a major part of any teaching and learning program, so it certainly is part of administration.
Question 3. What are the best ways that you would see that the group could benefit from your strengths in our project?
That's a toughie…. I think that my positivity might be good in the group. I do have a good knowledge of the math involved at this level so could certainly help others out there a bit. I'm getting quite good at writing process questions for tests, so we could use some of those ideas to start our work, I guess. I have written some questions that you might call open, which seems to be what you are talking about quite a bit here.
Would you be happy to spend time in others' classrooms to help them out where you could with ideas and perhaps a bit of team teaching at times?
Certainly, that would be great. I'd get a lot out of that sort of thing, I think. I have done a little of that before with other things but would like to do more.
Question 4. Are there any weaknesses in your maths teaching skill armoury?
I don't think it is so much in the skill armoury as in the assessment area. As I said I think that the testing I do could do with some changes to get around to the sorts of things you've been suggesting. I'd like the chance to get in early and make math really exciting while we develop … what did you call it?... robust understanding. We've done a lot to build social resilience in our boys but I agree that now we need to get some of that resilience into our math. I think we all assume that most of our students have it after we teach them how to do something. I can see now that we assume a bit much.
Question 5. How could I, or we, as a group help you with those weaknesses?
Just by sharing ideas and us all bouncing ideas around for a while, I think. I think it's just a matter of us all getting together and sharing, with you guiding a little at the start I think. I'm keen to get started in the classroom as soon as I can, so the sooner we start to get some ideas that I can use with my boys the better. I guess I'll have to be willing to try a few things and fail at first, or for a while maybe. But I find that exciting. I'm confident in my knowledge of math but as I said think my assessment is too narrow.
Question 6. Give me a picture of the assessment set-up you use with your maths class.
Well, we have quite a bit I guess. In mentals we have a couple of tests of 20 questions each week.

What sorts of questions do you use there? Are they closed, open, or a mixture?

I guess they're generally closed really, although I usually try to add a couple that could be classed as open. Generally, there's only one correct answer, so I guess that makes them closed. Do you see us as being able to bring those open questions that you talk about even into mentals?

Yes, I do, but we'll explore those possibilities with the group at the focus group meetings.

What other types of assessment do you use?

I have math tests of course, every couple of weeks to test if they have learned what we have done over the past couple of weeks, and if they have retained some of the older material. Of course, time is limited so you can only test a limited amount of the material.

What types of questions do you use in your maths tests?

Well I guess they're generally closed too. Now I come to think about it I think that pretty well all of the assessment that I use must be closed. There's usually only one answer that I want them to get to.

Are there any other assessments that you do in maths in your class?

I set them homework assignments as well, but they're just other types of what we do in class for practice. That's about it really.

Question 7. Can you give me an approximate percentage breakdown of the various types of assessments you use? Say, what percentage of assessment would be written class tests, and so on, using groups of 5 or 10 percentage points roughly?

That's a tough question. I guess class tests would be a bit less than half, that's about 40%. I use mentals each week, so they'd be a bit less that half tests, so about 15%. Number facts are in there too, but only about 10%. Really, I ask a lot of questions, but in my assessment picture of a student it would be the rest, what's that, 40, 15, 10, about 35%, oh but I do the odd project here and there, some open questions there, but only about 5% on that I would think, so questioning would come back to about 30%, and that would be about it, 100%. They're approximates, pretty close I think, but approximates because it's a little difficult being exact about such things as things vary as you go in different topics and areas.

Question 8. What is your understanding at this early stage as to what process portfolios are?

From what you have told us it seems that they are very different from the showcase portfolios that we use now because now we just pick the best bits to go into the portfolio for parents to see. The process portfolio has the not-so-good in it too which makes it really interesting to me, but I don't know how it will go with parents. That will be interesting for us to find out later. We should talk about how we are going to find that out later. Anyway, I think that process, if they're accepted after we've developed them properly, will show a lot more of what our students do, not necessarily can do, but do do.

What do you mean by do do?

Well, you have said that everything goes in, so if he has a go at doing something but doesn't quite make it, it goes in anyway. That shows how far he could get with the problem and I guess what skills he hasn't got. It will make it very interesting for everybody, I think.

Question 9. How do you think that using process portfolios could help us improve maths teaching and learning?

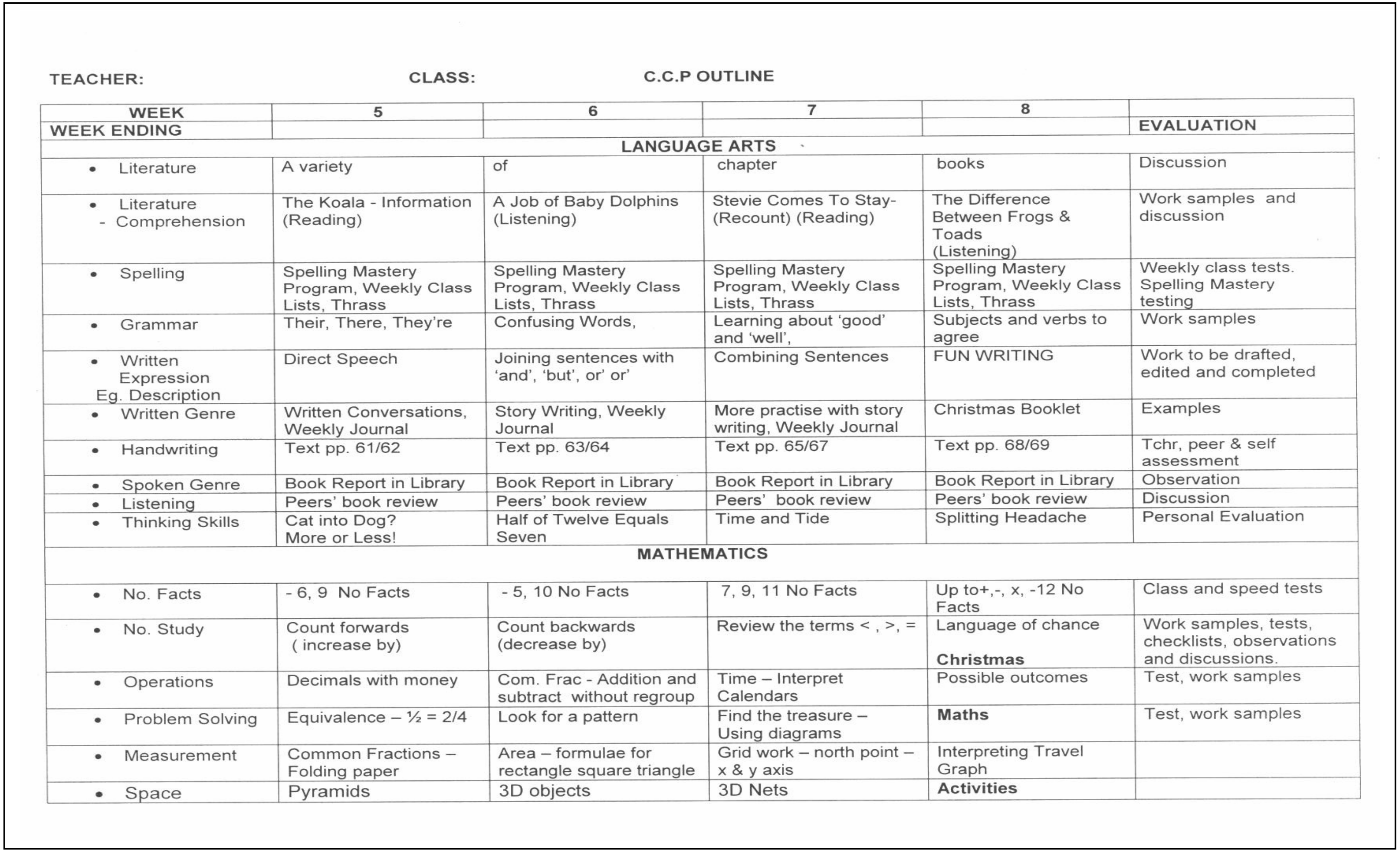
I'm not too sure really, but I think that it will help me with writing better assessment tasks for a start. As I said I think that my tasks are too closed, too narrow, so I guess that I'll be looking for help from the group to come up with good tasks, and not only that, but good assessments of those tasks, good ways to assess the tasks. If we are all on the same page with this we've got to get better at assessing and you have said that we need to look backwards from assessment to the content and the teaching if we are going to get it right. It seems to me that that's what you're saying we can do with these process portfolios.

Question 10. Are there one or two main things that you're looking for from our work together over the coming months?

I guess that I've pretty well covered it all really. It's writing good assessments that's my key I think as I've got the content right, it's just the assessment and the tasks and the assessment strategies, including rubrics for those tasks.

Thanks for joining the group and thanks for sharing your thoughts with me.

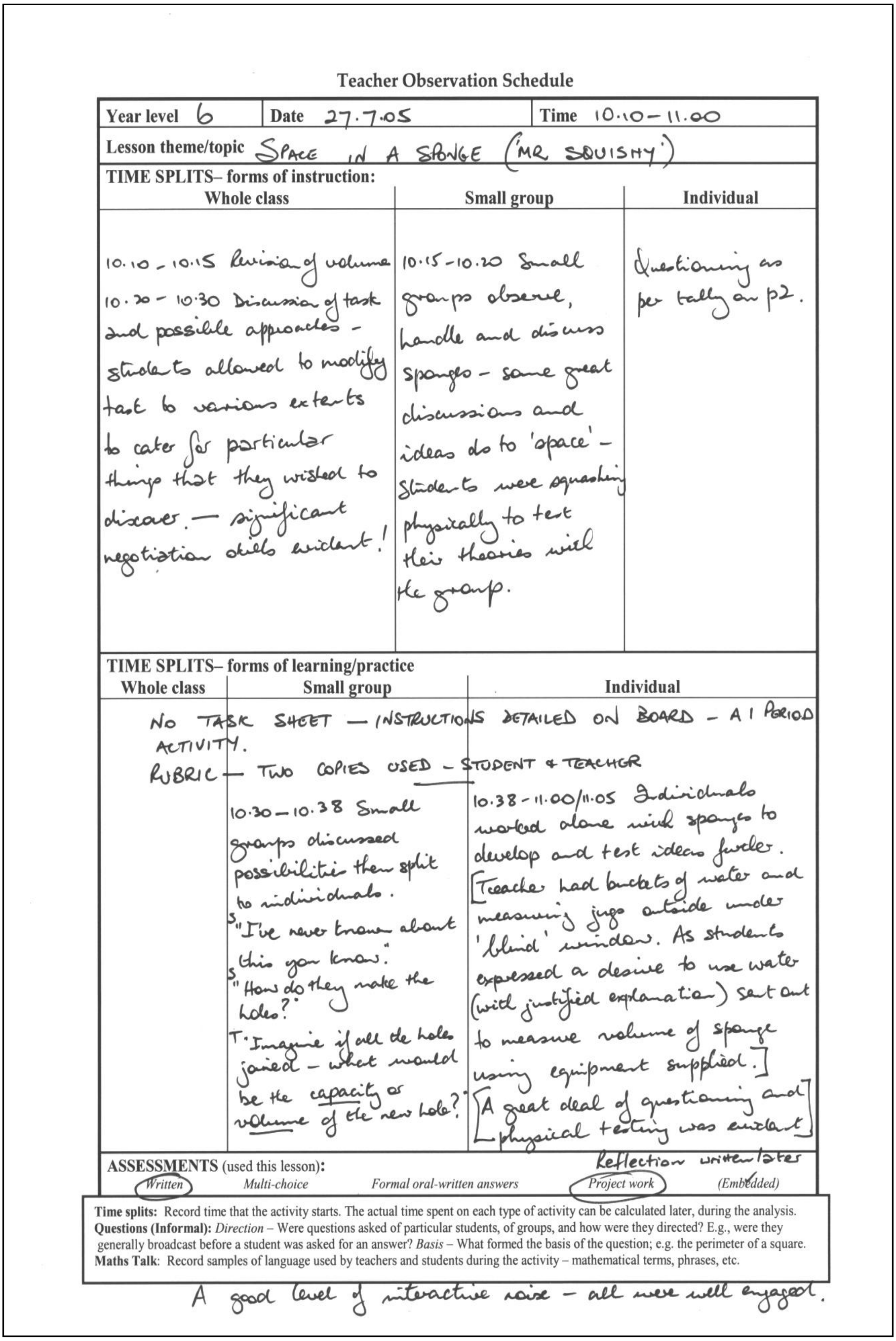
Appendix 5: Teaching Program Outline (Example)



TEACHER: **CLASS:** **C.C.P OUTLINE**

WEEK	**5**	**6**	**7**	**8**	
WEEK ENDING					**EVALUATION**
			LANGUAGE ARTS		
• Literature	A variety	of	chapter	books	Discussion
• Literature - Comprehension	The Koala - Information (Reading)	A Job of Baby Dolphins (Listening)	Stevie Comes To Stay- (Recount) (Reading)	The Difference Between Frogs & Toads (Listening)	Work samples and discussion
• Spelling	Spelling Mastery Program, Weekly Class Lists, Thrass	Spelling Mastery Program, Weekly Class Lists, Thrass	Spelling Mastery Program, Weekly Class Lists, Thrass	Spelling Mastery Program, Weekly Class Lists, Thrass	Weekly class tests. Spelling Mastery testing
• Grammar	Their, There, They're	Confusing Words,	Learning about 'good' and 'well',	Subjects and verbs to agree	Work samples
• Written Expression Eg. Description	Direct Speech	Joining sentences with 'and', 'but', or' or'	Combining Sentences	FUN WRITING	Work to be drafted, edited and completed
• Written Genre	Written Conversations, Weekly Journal	Story Writing, Weekly Journal	More practise with story writing, Weekly Journal	Christmas Booklet	Examples
• Handwriting	Text pp. 61/62	Text pp. 63/64	Text pp. 65/67	Text pp. 68/69	Tchr, peer & self assessment
• Spoken Genre	Book Report in Library	Book Report in Library	Book Report in Library	Book Report in Library	Observation
• Listening	Peers' book review	Peers' book review	Peers' book review	Peers' book review	Discussion
• Thinking Skills	Cat into Dog? More or Less!	Half of Twelve Equals Seven	Time and Tide	Splitting Headache	Personal Evaluation
			MATHEMATICS		
• No. Facts	- 6, 9 No Facts	- 5, 10 No Facts	7, 9, 11 No Facts	Up to+,-, x, -12 No Facts	Class and speed tests
• No. Study	Count forwards (increase by)	Count backwards (decrease by)	Review the terms < , >, =	Language of chance **Christmas**	Work samples, tests, checklists, observations and discussions.
• Operations	Decimals with money	Com. Frac - Addition and subtract without regroup	Time – Interpret Calendars	Possible outcomes	Test, work samples
• Problem Solving	Equivalence – ½ = 2/4	Look for a pattern	Find the treasure – Using diagrams	**Maths**	Test, work samples
• Measurement	Common Fractions – Folding paper	Area – formulae for rectangle square triangle	Grid work – north point – x & y axis	Interpreting Travel Graph	
• Space	Pyramids	3D objects	3D Nets	**Activities**	

Appendix 6: Classroom Practice Observation Schedule (Completed Example)



Teacher Observation Schedule

Year level 6	**Date** 27.7.05	**Time** 10.10–11.00

Lesson theme/topic SPACE IN A SPONGE ('MR SQUISHY')

TIME SPLITS– forms of instruction:

Whole class	Small group	Individual
10.10 – 10.15 Revision of volume 10.20 – 10.30 Discussion of task and possible approaches – students allowed to modify task to various extents to cater for particular things that they wished to discover. — significant negotiation skills evident!	10.15–10.20 Small groups observe, handle and discuss sponges – some great discussions and ideas do to 'space' – Students were squashing physically to test their theories with the group.	Questioning as per tally on p2.

TIME SPLITS– forms of learning/practice

NO TASK SHEET — INSTRUCTIONS DETAILED ON BOARD – A 1 PERIOD ACTIVITY.
RUBRIC — TWO COPIES USED – STUDENT & TEACHER

Whole class	Small group	Individual
	10.30–10.38 Small groups discussed possibilities then split to individuals. S "I've never known about this you know." S "How do they make the holes?" T "Imagine if all the holes joined – what would be the capacity or volume of the new hole?"	10.38 – 11.00/11.05 Individuals worked alone with sponges to develop and test ideas further. [Teacher had buckets of water and measuring jugs outside under 'blind' window. As students expressed a desire to use water (with justified explanation) sent out to measure volume of sponge using equipment supplied.] [A great deal of questioning and physical testing was evident]

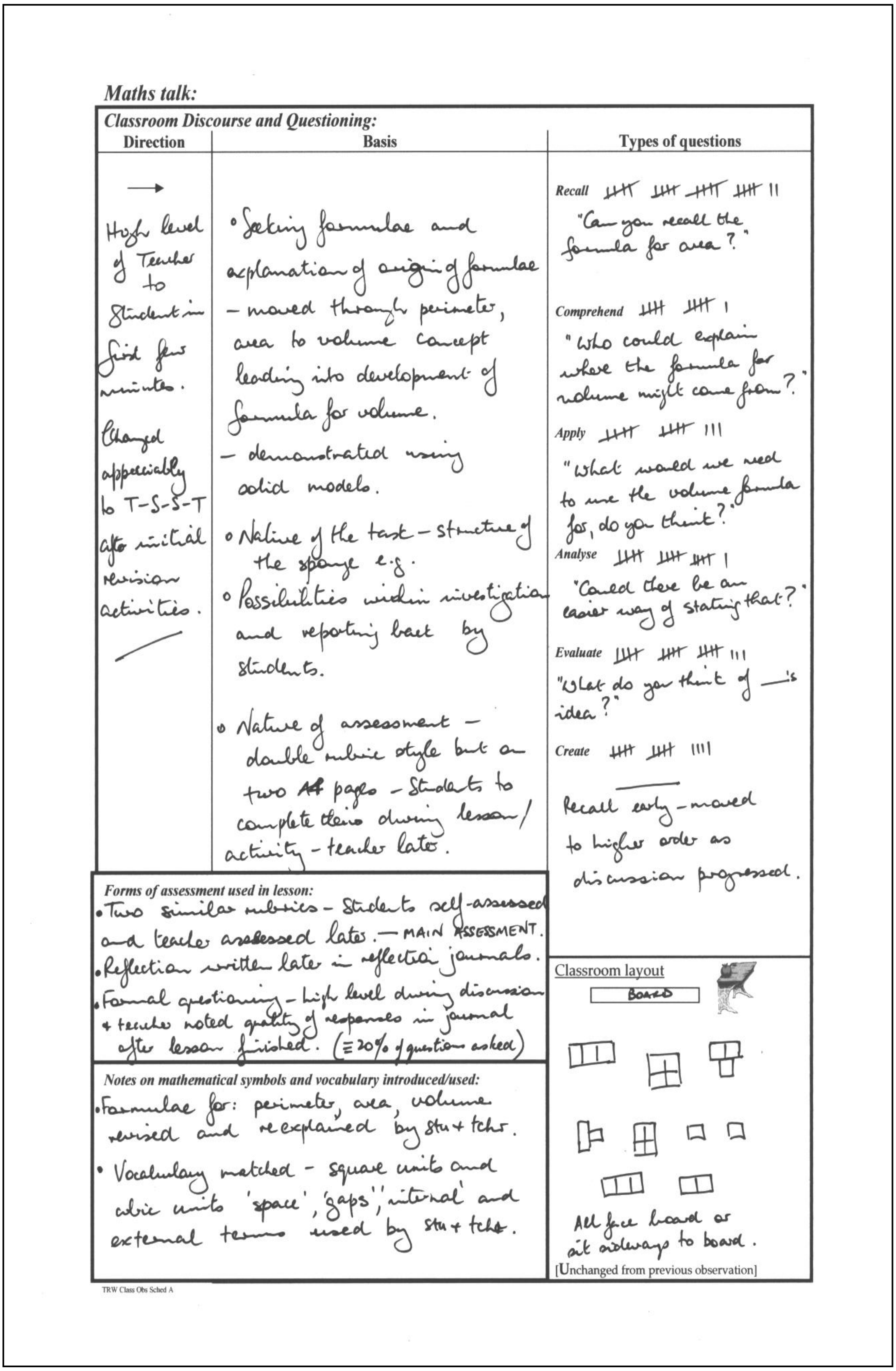
ASSESSMENTS (used this lesson):

[✓ *Written*] *Multi-choice* *Formal oral-written answers* [✓ *Project work*] [✓ *(Embedded)*]

Reflection written later

Time splits: Record time that the activity starts. The actual time spent on each type of activity can be calculated later, during the analysis.
Questions (Informal): *Direction* – Were questions asked of particular students, of groups, and how were they directed? E.g., were they generally broadcast before a student was asked for an answer? *Basis* – What formed the basis of the question; e.g. the perimeter of a square.
Maths Talk: Record samples of language used by teachers and students during the activity – mathematical terms, phrases, etc.

A good level of interactive noise – all were well engaged.



Maths talk:

Classroom Discourse and Questioning:

Direction	Basis	Types of questions
→ High level of Teacher to Student in first few minutes. Changed appreciably to T-S-S-T after initial revision activities.	• Seeking formulae and explanation of origin of formulae – moved through perimeter, area to volume concept leading into development of formula for volume. – demonstrated using solid models. • Nature of the task – structure of the sponge e.g. • Possibilities within investigation and reporting back by students. • Nature of assessment – double rubric style but on two ~~A4~~ pages – Students to complete theirs during lesson/activity – teacher later.	*Recall* 𝍸 𝍸 𝍸 𝍸 || "Can you recall the formula for area?" *Comprehend* 𝍸 𝍸 | "Who could explain where the formula for volume might come from?" *Apply* 𝍸 𝍸 ||| "What would we need to use the volume formula for, do you think?" *Analyse* 𝍸 𝍸 𝍸 | "Could there be an easier way of stating that?" *Evaluate* 𝍸 𝍸 𝍸 ||| "What do you think of —'s idea?" *Create* 𝍸 𝍸 |||| Recall early – moved to higher order as discussion progressed.

Forms of assessment used in lesson:

- Two similar rubrics – Students self-assessed and teacher assessed later. — MAIN ASSESSMENT.
- Reflection written later in reflection journals.
- Formal questioning – high level during discussion + teacher noted quality of responses in journal after lesson finished. (≡ 20% of questions asked)

Notes on mathematical symbols and vocabulary introduced/used:

- Formulae for: perimeter, area, volume revised and re-explained by stu + tchr.
- Vocabulary matched – square units and cubic units 'space', 'gaps', 'internal' and external terms used by stu + tchr.

Classroom layout

All face board or sit sideways to board.

[Unchanged from previous observation]

TRW Class Obs Sched A

Appendix 7: Student Participation Consent Form

Assessment of Applied Mathematics through Student Portfolios

Consent form

I, ________________________________ (parent/guardian), have read the information sheet

and consent form

and I **give / do not give** (please circle your response)

permission for my son ____________________________ (name) of _____ (class) to complete up to three brief questionnaires during the year, in regard to the development of his mathematics portfolio. I also agree to the collection of data generated within his portfolio for the purposes of the study, and to Mr Wood discussing said data with him at various times during the year. I understand that I will be kept informed as to my son's progress through regular updates and normal school reporting procedures. As is school practice, any major concerns regarding my son's progress within the mathematics course will be brought to my attention and discussed in depth with me. I understand that my son will remain anonymous within the data collected for the study, that the material will be treated confidentially, and I can withdraw my son from the data collection group at any time, simply by contacting Mr Wood, without needing to give reasons.

I would be **willing / not willing** (please circle your response) to discuss my son's progress in mathematics, as demonstrated in his portfolio, and my perceptions of the process, if an opportunity arose.

Signed ____________________________ (parent/guardian)

Please print parent's name ___________________________ Date / /04

Thank you parents.

Appendix 8: Explanatory Letter to Parents of Students

10 February 2004

Assessment of Applied Mathematics through Student Portfolios

Dear Parents,

As you are aware, at The Preparatory School we have been using ‘Show-case’ Student Portfolios for some three years, particularly in the area of literacy. During 2004 we are looking to revise and restructure the portfolio approach in mathematics, moving from the ‘Show-case’ to a ‘Process’ concept, a marked change which will make the portfolio a much more significant part of the learning, assessment and reporting program. It will mean that boys will be undertaking investigations and problem solving on a more extensive and intensive scale as part of their class mathematics program. Their *complete* efforts, from initial thinking to conclusions, will be kept in their portfolios, available for all concerned with their learning to review at any time, ensuring a very full picture of each boy’s progress and needs as they emerge. Another major benefit of this teaching and learning technique is that it will open boys’ minds to the fact that often mathematical problems are not always what they at first seem, that they can be approached in different ways, and that there may well be a number of acceptable solutions. The problem solving approach is designed to illustrate the application of mathematics and remove much of that dull, rigid, demotivating ‘black and white’ perception that is so often applied to the entire mathematics ‘package’ by students. The approach aims to teach them ‘to know what to do when they don’t know what to do!’

From your experience with ‘Show-case’ portfolios, you would realise that portfolios have the potential to convey a much more complete picture of a student’s work, progress and needs, than a score, or the occasional isolated brief written comment. Each of these still has a place within the overall mathematics assessment system, but ‘Process’ portfolios can supply us with much more detailed data to which we can respond through learning program design and modification, and give you broad, in-depth knowledge of your son’s abilities and successes.

As this is a development of some note in the world of education, I intend documenting the work as part of a study designed to explore all aspects of the process, from teacher training to student progress and achievement across the year. I will, therefore, be involved with the class teachers in designing and implementing aspects of the classroom teaching and assessment program, particularly in relation to problem solving. The study will form part of doctoral work that I am doing with the Science and Mathematics Education Centre of Curtin University in Perth, W.A., Australia’s only school of excellence in the teaching of mathematics. The supervisors for the study are Professor John Malone and Dr Joan Gribble.

I write seeking your permission to collect and incorporate data generated by your son through his work in developing his portfolio, and two anonymous questionnaires regarding his perceptions and progress in developing concepts and understandings. As part of the process, at times, I would like to be able to discuss with your son aspects of his mathematics learning and understanding, as reflected by the material collected in his portfolio.

Data will be treated confidentially and stored securely. As is presently the case, individual progress will remain our focus in class, and personalised data will remain with class teachers. Naturally, *all* of the data generated by your son will be available for your perusal at any time, particularly during parent-teacher interviews. *If you are agreeable to your son being part of the data collection group, please complete the consent from on page 3.* If at any time you would like to withdraw your son from the group, you are able to do so simply by notifying me. Your son would, of course, remain part of the class group for mathematics lessons and activities.

There will also be opportunities for a limited number of parents to make input into the study as to their feelings regarding the nature and depth of tasks set, and the value of assessment feedback that they are receiving regarding their son's progress. *If you would be willing to spare a few minutes on a couple of brief occasions during the year, please indicate on the attached consent form.* Time will preclude any possibility of me talking to all parents, but I would appreciate the option given by a positive indication as to your willingness to participate in future discussions. You are a key stakeholder in the assessment and reporting process at our school, so your thoughts are of significant value in this important work. As with your son's participation in the data gathering process, you can negate that expression of interest at any time, without prejudice.

It is hoped that analysis of the data gathered from both teachers, boys and you the parents, will allow me to share our collective experiences with other educators as we move towards a more comprehensive, meaningful and thereby motivating method of teaching, assessing and reporting in maths. Prep is looking to become something of a 'lighthouse' school in mathematics, a subject that has generated a great deal of concern over past years within teaching ranks, in the media and amongst our politicians.

Should you have any questions regarding any aspect of the above please do not hesitate to contact me at any time.

Thank you for your consideration and anticipated participation.

Appendix 9: Parent Invitation to Interview

17 August 2004

Dear

You may recall that earlier in the year I wrote asking permission for your son to be part of a study regarding the assessment of Mathematics. Within your positive response to that letter you indicated that you would be willing to be interviewed in relation to the reporting of your son's progress.

I am now in a position to hold such discussions and am hoping that you might be able to call in for a chat for about 15 minutes in the near future. As I will be talking to about 20 parents, I do need to be a little formal as to scheduling. Would you please give me an indication of your availability across the time slots that follow by writing a couple of preferred times in the appropriate boxes? (We are currently in Week 6.) Or, if you face a tight schedule, would you please give two or three specific times when you are available?

Thank you for your support in trying to develop an assessment and reporting system that is effective and efficient for all concerned.

Regards

Please return as soon as possible.

✂--

Availability Schedule - Week 8, Monday 30/8 – Friday 3/9			
Day	**Time**	**Day**	**Time**
Monday 30/8	11.45 – 4.30	Thursday 2/9	0815 – 1000 12.45 – 4.30
Tuesday 31/8	0815 – 0900 11.45 – 4.30	Friday 3/9	11.45 – 4.30
Wednesday 1/9	12.45 – 4.30	Specific time? Day/s? Time/s	

Appendix 10: Second Teacher Focus Group Interview Transcripts Collated

Transcripts collated with overall comments

Question 1. What's your reaction to a child's claim that learning maths makes them smarter?
***Teacher A** - It does make them smarter. They are recognizing that there's a world out there that hangs together through maths.*
What is your understanding of "smarter"?
Having a basic knowledge of a set of knowledge that they must have that they can then apply to the world as in cricket, sports, etc. That "smartness" can flow into other areas outside maths, but can also be isolated to a particular sub-section of their understanding and knowledge.
***Teacher B** - I don't think that the study of maths makes anybody any smarter. They become aware of things that they have known intrinsically and may get that impression, but it doesn't alter their IQ. Smarter is a logical conclusion though for kids to make regarding being able to do what they consider a difficult subject.*
***Teacher C** - Smart kids can use maths in other subjects and being able to do so makes them feel smarter. They see being able to do something quickly and understanding it and can possibly explain it and are comfortable with it "then you are smarter". There's so many ways that they can see English so it is seen as "easy", but they see only one way to do Maths, so it's hard.*
***Teacher D** - Perhaps I'm getting a better score on my math test, maybe getting rewarded for something at home for which they normally don't get rewarded. They've seen themselves achieve something that they hadn't done before so they're smarter. It only has to do with math, not anything else.*
***Teacher E** - They get instant feedback unlike reading and writing. 10/10 on your tables for example gives you that great feedback.*
Good at maths so he's good at everything? No, they recognize each other's areas of strength, without blurring the edges and making sweeping assessments as to total areas of strength.
Overall comment:
It seems that teachers believe that the 'closed' perception of maths held by most children means that as they master particular aspects of maths they consider that they become 'smarter'. This runs counter to achieving mastery in what are seen as more open subjects such as English. Reading and writing are seen as having a multitude of acceptable approaches. Therefore, in the eyes of students such subjects are easier than maths which seems to require a singular approach to derive the one acceptable answer (dichotomous).
Only two out of the five teachers clearly see that 'smartness' flowing into other subjects. However, one of the three remaining states that the thinking patterns behind the processes often filters through to other subjects.

Question 2. Why do you place a (Teacher D-"very") high level of importance on the teaching of primary maths?
***Teacher A** - The basic concept of number is a very important part of developing a confidence in the subject which then develops the child.*
***Teacher B** - I think that the skills in maths open up all sorts of thinking, including life skills that you need. The thinking patterns behind the processes will often filter through to other subjects.*
***Teacher C** - Maths is in everything they do, all the KLAs. It needs to have a high importance as if the kids don't see you as rating it highly they won't and they need to because it is in everything they do in some way.*
***Teacher D** – They need a math background. Math has a lot to do with a lot in everyday life. If they miss out at the beginning it takes a lot to catch up.*
***Teacher E** - It is an integral part of life. Without maths and ability, it's a necessary skills for negotiating your way through life. It comes into so many other areas.*
Overall comment:

All five teachers spoke of the importance of maths to everyday life skills. They saw it as an integral part of all aspects of the world in which we live. They saw maths skills as relating to various facets of life. However, one gains the impression that all five view basic maths skills as all-important to the acquisition of 'life skills', with anything above basic being 'trimmings', (yet one considers maths, along with English and social skills, the crux of a child's development.)

Question 3. What were the major determining factors in your arriving at the proportion of your timetable to be assigned to maths? (Claimed: A: 30%; C: 20%; B: 35%; D: 35%; E: 30%.) (Reality: A: 22%; C: 20%; B: 24%; D: 24%; E: 20%.) [Checked through timetables and observation.]

***Teacher A** – **Maths is a basic subject** with English and social skills, **the crux of a child's development**. I discussed ti with learning support teachers and other teachers, so I try to fit in 2-2.5 periods a day.*
***Teacher B** - **That's all the time that I have left** with the students and language and maths are the cornerstone of learning at school. Problem solving is important.*
***Teacher C** – I could only fit 30% when treating maths as an isolated subject because **you should do it every day**. I would like 60 mins a day in the timetable but can't because of specialist demands.*
***Teacher D** – There's not just maths lessons themselves. It's incorporated into science, spelling, means median and modes and such. I think 35% of everything in the classroom is related to maths.*
***Teacher E** – **It's just an assigned timetable load** as part of the Year 7 Transition Programme.*
*Overall comment***:**
Checking the actual timetables of the members of the focus group revealed:
Teacher A - Year 4: Effectively 22% of the complete timetable, but 26% of the time devoted to the four primary KLAs, English, Mathematics, Studies of Society and Environment and Science.
Teacher B - Year 4/5: Effectively 24% of the complete timetable, but 29% of the time devoted to the four primary KLAs.
Teacher C - Year 5: Effectively 20% of the complete timetable, but 25% of the time devoted to the four primary KLAs.
Teacher D - Year 6: Effectively 24% of the complete timetable, but 30% of the time devoted to the four primary KLAs.
Teacher E - Year 7: Effectively 20% of the complete timetable, but 25% of the time devoted to the four primary KLAs.
Interestingly, the real figures indicate that time devoted is close to the school's expectation, in some cases exceeds it. However, when time with their class teacher learning the core KLAs is considered the actual percentages increase, some to becoming reasonably close to teachers' original estimates. It would seem that their estimations/calculations only took into account that part of the teaching week spent with them.

Question 4. What would you see as the minimum proportion of a timetable that could be devoted to maths? This is regardless of whether it is integrated or not, as proportions are devoted even in integrated programs.
***Teacher A** - Not much below 30%. 25% would not be giving the boys enough time to get through enough of the curriculum to give them the knowledge base that they need. I looked at the curriculum and said I need this amount of time to teach and for the boys to take on that quantity of information.*
***Teacher B** – I see 35% as the minimum – I would like to do more but have a very full timetable and something would have to give.*
***Teacher C** – You should do at least 45 mins to an hour every day. It doesn't necessarily have to be pure maths. It can be related and integrated into other subjects. [20%]*
***Teacher D** - 25% is the right way for me. I couldn't get away with anything less.*

***Teacher E** – I think that I do about 30%. It certainly couldn't be any less and it can't be any more because other things would suffer in this timetable.*

*Overall comment***:**

Through a range high of 35% dropping down through 30 to 25. The lowest minimum set through these conversations was 7.5 periods per 50 period week, i.e. 15%. The school has an expected minimum of 10 half hour periods in the 50 period week, the equivalence of one full school day or 20% of the week, be devoted to mathematics in its various forms. It is considered desirable that mathematics is integrated into other KLAs where possible.

The level of integration varies across the teacher focus group. Naturally, teachers have their particular perceptions, so there is a wide range of factors determining such integration.

Question 5. You mentioned that you use rote learning. (Questionnaire: D & A: 30%; C: 20%; B & E: 10%). What skills do you expect the boys to acquire as part of that learning?

***Teacher A** – It's almost 100% straight knowledge, number facts, months of the year, units of measurement. Those knowledge bases are really important; they move across other areas of the curriculum.*

***Teacher B** – It's mainly number facts and times tables. I don't put a very high value on them though as calculators are available. I put more value on process.*

***Teacher C** – They should know up to 12 times table, automatic subtractions up to 20, basic fractions, measurement and time units, many things that are not operational. Days of the week and telling the time are other things that they need to just know.*

***Teacher D** – Learning formulas is important for me, understanding what each letter in a formula stands for. I do not expect boys to actually memorise the formula as their teacher wasn't expected to. I could take a sheet of formulas into exams and tests. I haven't targeted multiplication tables this year because many seem to have those skills. That's shown in homework.*

***Teacher E** – My rote time is spent on learning the rules of maths that lead to operations, like division of fractions.*

Overall comment

Two teachers have a heavy reliance on rote learning, with a third quite high at 1/5. Teachers use rote learning for the memorisation of facts that they see as needed to be recalled 'instantly', such as multiplication tables and formulae, in order to make mathematics a little more straightforward. All said that mathematical process is not taught through rote.

Question 6. Can you expand on your thinking as to the central objective of teaching mathematics?

(Questionnaire responses: A: Cognitive & Behavioural; B: Cognitive; C: Behavioural; D: Process; E: Cognitive & Process)

***Teacher A** - They've got to be able to think and use their basic knowledge base we teach them to think. We have to get them to think. I want them to be prepared to have a go.* [Cognitive]

***Teacher B** – The most important is the thinking behind what they do. If they can't work out what to apply they won't get the right answer.* [Cognitive]

***Teacher C** –Maths is designed to have students learn and follow procedural rules, the rote learning part. Teaching maths is getting students to learn all the maths rules.* [Behavioural]

***Teacher D** - You can see the cognitive in the process of their application of what they've learned. They need to think about what they do.*

[As with all of the other teacher focus group members this teacher did not know what behavioural objectives are.]

***Teacher E** - The thinking and the doing, applying are the most important parts of the whole thing.* (Cognitive]

Overall comment

This question, or the alternatives offered, were not understood well by the teachers in the original questionnaire. Discussion revealed their thoughts more effectively. Points of interest were D claiming that process (cognitive) was the central objective yet stating that 30% of mathematics learning in the class is by rote. C having only 20% rote learning within a behaviourist classroom was another interesting viewpoint.

Question 7. Describe your teaching of maths, your pedagogical approach, for me. Feel free to pull it into sections, or paint me an overall picture.
Teacher A *– They have to have a knowledge base to go forward. We have to spend some time setting the concrete blocks in place. I hand out sheets and have boys think about it for a while. Then use a procedure to unwrap a situation for them. Let's read it through 3 or 4 times to get an idea of what is wanted, have some time to think, we have a go and check and see if they have grasped it – some can go on while others need more help.*
There's a fair bit of teacher leading towards reaching a point where capable boys are able to read ahead – smarter boys can go ahead – all have to listen while the teacher addresses the class. Our slower boys can work with more able sometimes.
Teacher B *– In my actual teaching, first of all* ***I first get my content from syllabus elaborations. We all need to be working with them so that we're all moving in the same direction.*** *It's all there in the syllabus.*
I like to try to make hands-on and real world work away from pencil and paper maths. The class size, and sizes in the school really, mean whole class explanation of the road map happens and then they're split into groups to work. I do a bit of individual teaching but can't do when students have major difficulties.
Teacher C *– We have quick games with tables, A little bit of something like mentals each day, concentrating on different things such as addition, subtraction and multiplication. Now we do a week on one particular skill but in the past we did different skills every day. I changed to cope with maths grouping across the year on some days. Maths text books are not really used as a program but we pick activities to tie in with what we're doing at any point in time. I've had to become more hands on in measurement, working in groups in order to share activities because we can't all do the same thing at once. We just work through getting the skills mostly. [Over her years of teaching the applied part of maths is most neglected.]*
Teacher D - *I like to find some sort of life example and share the strategy. Then I ask them what do you think was used to come up with the answer. I go to math facts, what facts are needed, go through examples and then have them do their own. I like to explain some theory if I can, like the facts about circles.*
Teacher E *– I use whole class introduction using the text book and good examples, or I might just talk about the topic like fractions. I give an overview of what we are going to do, boys demonstrate how they reached their answer and we all look at different ways of getting the answer. Then we do the exercises as they are in the book. I usually mention any rote learning that they'll need to do as part of the topic.*
Overall comment
A exhibits a lot of behaviourist traits. Observations also showed that the room is very much teacher dominated and the teaching runs strongly on behaviourist lines. C is also strongly behaviourist, but recognizes some shortcomings needing attention – works very much in the abstract repetition arena. B strongly into procedural with students entrusted to work with process in solving problems/tasks after initial road map is revealed and discussed. D uses a lot of behaviourist, imitation working at present. The class is clearly led down the desired paths by the teacher. It is apparent that moves are being made to leave that well-trodden path, but it may take some time. E is clearly behaviourist as the closed exercises in the text book drive the program. Although it could be claimed that varying levels of cognition are taking place, very little in the way of true social constructivism is in evidence in the pedagogies employed in these classrooms. A major shift in learning emphasis is going to take place in implementing process portfolios effectively.

Question 8. What do you see as the main program content drivers within your program?
Teacher A *– I use Signpost Maths. So that I know I'm covering certain parts of number, space, and all the other bits and pieces. I add things from my own problem solving sometimes. They like that.*

Teacher B *– I see thinking skills as the main one but it is really only a small part of the curriculum now. I think about the boys' needs and plan for them mainly. I group them a bit because like groups can be taught together.*
Teacher C *– When I look at catering for the various aspects of the class, they need tables, otherwise they don't get that important grounding. Some haven't had the exposure, some have only had two years of good maths instruction and drill.*
Teacher D *– I work mainly from the Queensland Math text book. I've looked at all the areas that Year 6 have to cover and made my own math plan, plus things from the … Core KLA program. Number has more emphasis because it's in all other areas; there are more things that are number based, so they need a strong number base.*
Teacher E *- The text book has it is all laid out and sequenced for the year so the whole year group uses it in the same way in order to keep the year level at a similar point in the programme. The Year 7 overview that we gave you is based on the text book. It makes things really quite simple actually. Everybody knows where everybody should be.*
Overall comment
These answers generally supported the behaviourist approach already exposed. Text books drive the programs in four of the five classrooms. The text books used would be classed as closed skill and drill publications. None offer any open-ended questions of note and none offer significant real-life challenge. Marked change will be the result of adopting the real-life process portfolio approach to problem solving with the result that text books should diminish considerably in influence over coming months and years.

Question 9. What part, if any, does parental expectation as to their son and his maths skills play in influencing program content and teaching methodology?
Teacher A *- Not many parents have come to see me about maths. I haven't had to take much note of parent comment so far. I have had positives regarding boys learning number facts. With content, I haven't been conscious of any real strong parent influence. Parents seem happy with what happens as long as they feel boys are learning and progressing. I did have one parent who came up earlier but they seem happy now with what we've done.*
Teacher B *– I've had very little parental input or influence of expectations. In fact, I don't get it at all. I select content on student needs with this class; they are quite different and difficult. I've had to justify some content this year, like some of the games, but they've accepted it OK.*
Teacher C *– There's been no parental influence at all. Parents expect their boys to be challenged at their level. I don't think parents have strong feelings regarding any particular part of maths; they don't even know what the content is, I don't think. Only one person has asked this year because her son is being tutored, so I gave her a copy of the Year 4, 5 & 6 outline without saying exactly what they will be doing at any particular time. That gave the tutor a range of skills and topics to cover.*
Teacher D *- The only parental interaction regarding math has been through money, I mean involving the boys that are responsible for Chapel collections counting and those sorts of things. They just helped out here and there for a bit. There's really been no other parental influence at all.*
Teacher E *– I find the main concern of parents is that their son is getting what everyone else is getting. Believe me, word would get around if a different test was done by some to the main Year 7 test.*
Overall comment
Parental influence, direct at least, is not felt by the teacher focus group. The only form of influence that came through discussion was parents expecting their child to be getting the same as others in the class, to be progressing and helped to learn by teachers.

Question 10. Within your program, how do you cater for learning differences across the group?
Teacher A *- I have boys help other boys; peer tutoring. The first criteria is willingness. I am going to regroup the classroom so that a group of 8 boys who need increased level of help have the teacher for the first half hour of the day uninterrupted. Others I will set independent*

work. I am making allowances for the content and I've accepted your advice of a lesser 'load' for some boys. I'm being selective in what they are to complete but the more able are told to complete all the exercise.
This term I've concentrated on the basic text, Signpost Maths, to set a foundation upon which can be built on and I allow greater freedom of 'movement' across topics and problems.
***Teacher B** – I use different approaches as we go, teacher talk, board work, video. It caters for the different learning styles and abilities across all the boys usually.*
***Teacher C** – I've got a wide range of abilities in the class. Speed tests see score gained out of how many they completed. Sometimes there's ten problems offered. I set a minimum for all to complete with a couple of hard ones added for anybody to have a go at.*
***Teacher D** – We're changing to physical groups next term. From two groups we might go to perhaps four, two which need more help and two who can work more independently. I will work with boys that need 'extra' instruction. Those boys who can will go on with other further exercises. I'm not using much hands-on at this stage but I'll try to incorporate more.*
***Teacher E** – I find that peer tutoring in small groups or with individuals promotes discussion and produces the best maths sessions. Maths is 'happening' because we have lots of discussion going on at all levels. I have to prune expectations regarding quantity so that I cater for the slower workers. I think that we're probably a bit self-paced.*
Overall comment
Teacher A: Peer tutoring, independent work, varying expectations, set basic level for class.
Teacher B: Different approaches to teaching.
Teacher C: Minimum set for all with 'extras' for those with ability.
Teacher D: Group work and able can do more exercises.
Teacher E: Peer tutoring, pruned expectations.
Common thread of simply reducing the quantity for less able and giving more able more work. No mention of open-ended tasks/challenges to encourage risk taking, experimentation, exploration, etc.

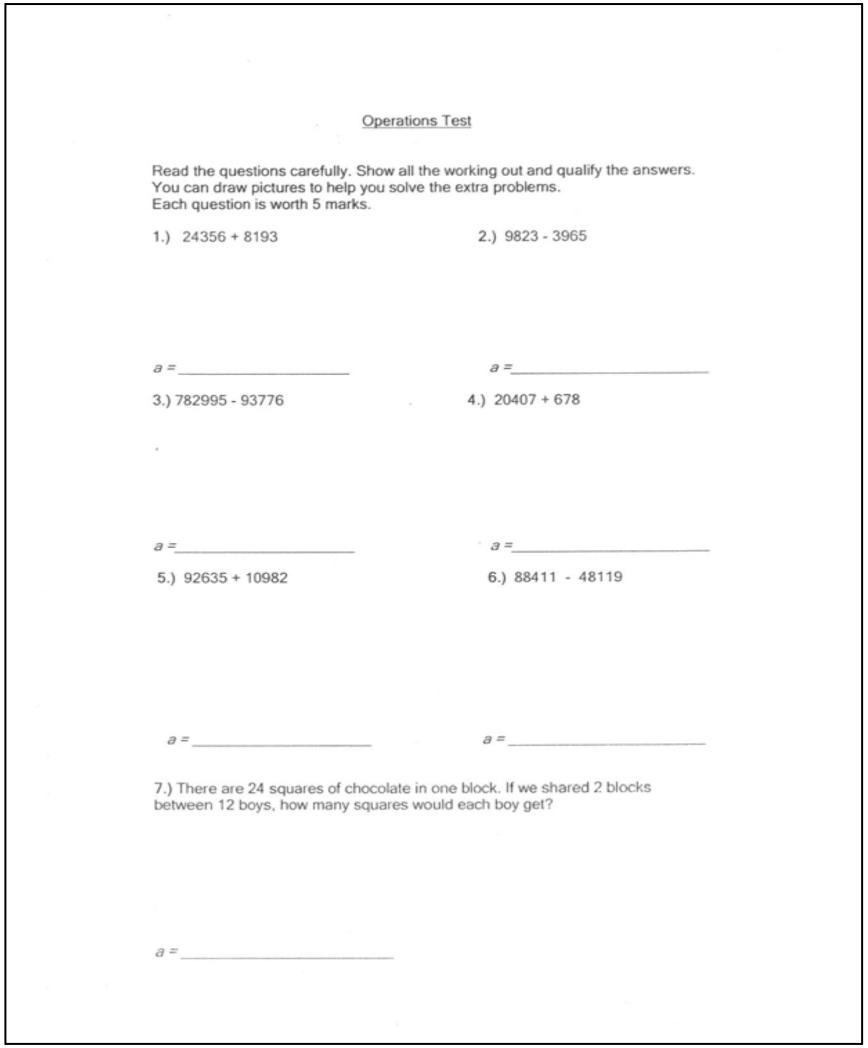
Question 11. Help me understand the link, as you see it, between what you see as your strengths and weaknesses in relation to your level of enjoyment in teaching maths.
***Teacher A** – I enjoy basic number facts and operations. I see them as a strength for me and they are needed in order to problem solve. Problem solving is frustrating for me in the classroom because it takes a long time to do relatively little. That frustration is a weakness. I know I must learn to give boys time to 'work it out'.*
***Teacher B** – I have a lot of weaknesses in teaching maths. I find it extremely frustrating; it's the only subject that hasn't fallen into place for me since leaving university. I think the changes made continually but haven't seen the results that have been expected, so I remain frustrated.*
***Teacher C** – My strength is in number and algorithms. I have weaknesses towards spatial work and problem solving; I refer to other … teachers for help there. Strengths and weakness probably do effect my selection of material for teaching but really I'm not sure as to the exact balance over the year.*
***Teacher D** – I have a math background so I enjoy it, but probability did give me some trouble for a while. I like statistics, mean, median and mode work. It's great fun and interesting for the boys.*
***Teacher E** – Maths is most enjoyable when we've got everyone **thinking along the desired lines** and we move into working groups, with teacher and peer tutors moving around the room across the groups. Peer tutoring is enjoyed by the class; the interaction is always positive.*
Overall comment
Teachers clearly liked structure within the teaching of mathematics. Number, operations and algorithms were the safe areas as most felt comfortable there. There was no mention of teacher enjoyment of real mathematical challenge. All expressed some level of reservation in primary mathematics, although the only teacher with anything other than basic training said that he enjoyed teaching it. One said that it was most enjoyable when all students were "thinking along the desired lines", which indicated a lack of scope offered to students and therefore a

closed dichotomous approach. That was confirmed through observations of the class as they worked out of their tightly structured text.

Question 12. How do you see your approach to the teaching of maths fitting into that now clichéd 'learning for life' concept?
Teacher A - *Education is about 'learning for life'. They need a concrete base upon which to build in life.* [Didn't really comprehend the concept.]
Teacher B - *My whole outlook with maths is that it's such an integral part of life that it needs to be part of all that we do. My approach to teaching it reflects those thoughts.*
Teacher C *– My approach was designed to try and get into medicine but I failed physics so went into teaching. Nothing of the higher maths I learned was ever used. I went to Teacher's College and learned how to teach maths to younger children. You've got to keep correlating what maths is used for or children will question why they learn it. I have often been a little simplistic in applying particular topics, such as volume, to life situations. I didn't really grasp the 'learning for life', or 'life-long learning' concept.*
Teacher D - *What I'm demonstrating in the classroom, if they have a basic understanding of what I'm doing it will stick with them. My goal is to give them strong basics.* [Quite a narrow view of 'learning for life'.]
Teacher E - *Not really sure – I hope that they are learning something that will prove of wider benefit as they progress.*
Overall comment
There was little concept of 'learning for life' across the teacher focus group. They saw it as learning maths skills that could be used in life, but didn't see it as fostering a thirst for learning that would influence other areas of their students' lives.
The teacher focus group obviously feel comfortable teaching basic skills with a bit of problem solving. The net is going to have to be widened dramatically if we are to move them out of their comfort zones and have their students challenged through new lines of thought and new pedagogies.

The overall thrust apparent through the teacher focus group is for strong mathematical fundamentals through the promotion of skills to learn and drills to turn!

Appendix 11: Norm-referenced Class Test (Example)



Operations Test

Read the questions carefully. Show all the working out and qualify the answers.
You can draw pictures to help you solve the extra problems.
Each question is worth 5 marks.

1.) 24356 + 8193

a = ____________________

2.) 9823 - 3965

a = ____________________

3.) 782995 - 93776

a = ____________________

4.) 20407 + 678

a = ____________________

5.) 92635 + 10982

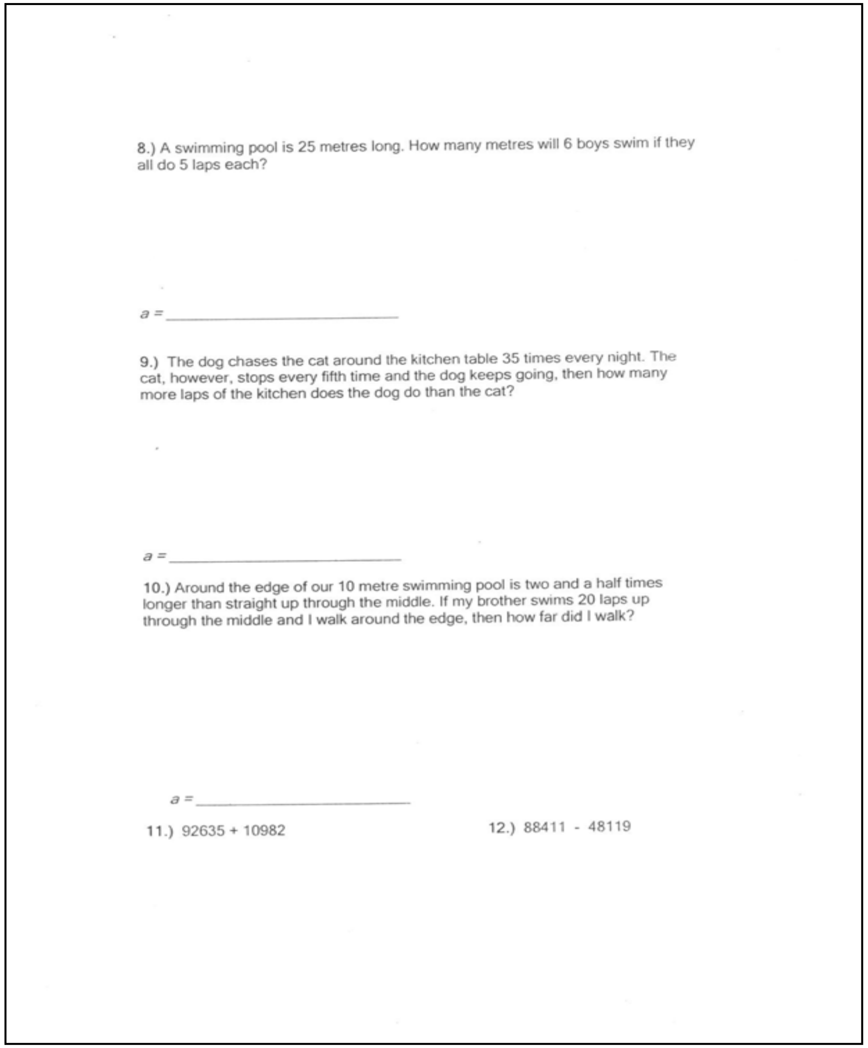
a = ____________________

6.) 88411 - 48119

a = ____________________

7.) There are 24 squares of chocolate in one block. If we shared 2 blocks between 12 boys, how many squares would each boy get?

a = ____________________



8.) A swimming pool is 25 metres long. How many metres will 6 boys swim if they all do 5 laps each?

a = ____________________

9.) The dog chases the cat around the kitchen table 35 times every night. The cat, however, stops every fifth time and the dog keeps going, then how many more laps of the kitchen does the dog do than the cat?

a = ____________________

10.) Around the edge of our 10 metre swimming pool is two and a half times longer than straight up through the middle. If my brother swims 20 laps up through the middle and I walk around the edge, then how far did I walk?

a = ____________________

11.) 92635 + 10982

12.) 88411 - 48119

Appendix 12: First Teacher Focus Group Questionnaire (Completed Example)

Portfolio Assessment in Primary School Mathematics
A study of pedagogical implications

Questionnaire for participant teachers

2004

Changes in structure, style or content in education always seem to generate issues and difficulties. As part of my MathEdD work I am conducting a study into the problems facing teachers in understanding and implementing assessment of students' mathematics learning through Working Portfolios as a major part of their assessment schedule. The study will attempt to examine the issues regarding the viability of such an assessment approach whilst seeking possible early solutions to at least some of the questions revealed. It is foreseen this study will indicate the viability of the entire school incorporating the Working Portfolio at a later date. In turn, if the assessment mode is seen as worthwhile, the R-7 incorporation will be expedited by this early work.

Thank you for taking the time to complete this questionnaire. Many of the questions have possible responses listed and a cross in the appropriate box, or boxes, to indicate your responses will suffice. However, if you feel that the response you wish to make is not offered, please add to the lists. Several questions ask for a unique personal response from you, so they offer space for short written answers. Your time and effort are genuinely appreciated as your thoughts and methods are crucial to how we will work as a team on Working Portfolios in our school. Information collected will be made available to the group as an overall summary of results but your individual answers will be kept strictly confidential and your anonymity is guaranteed.

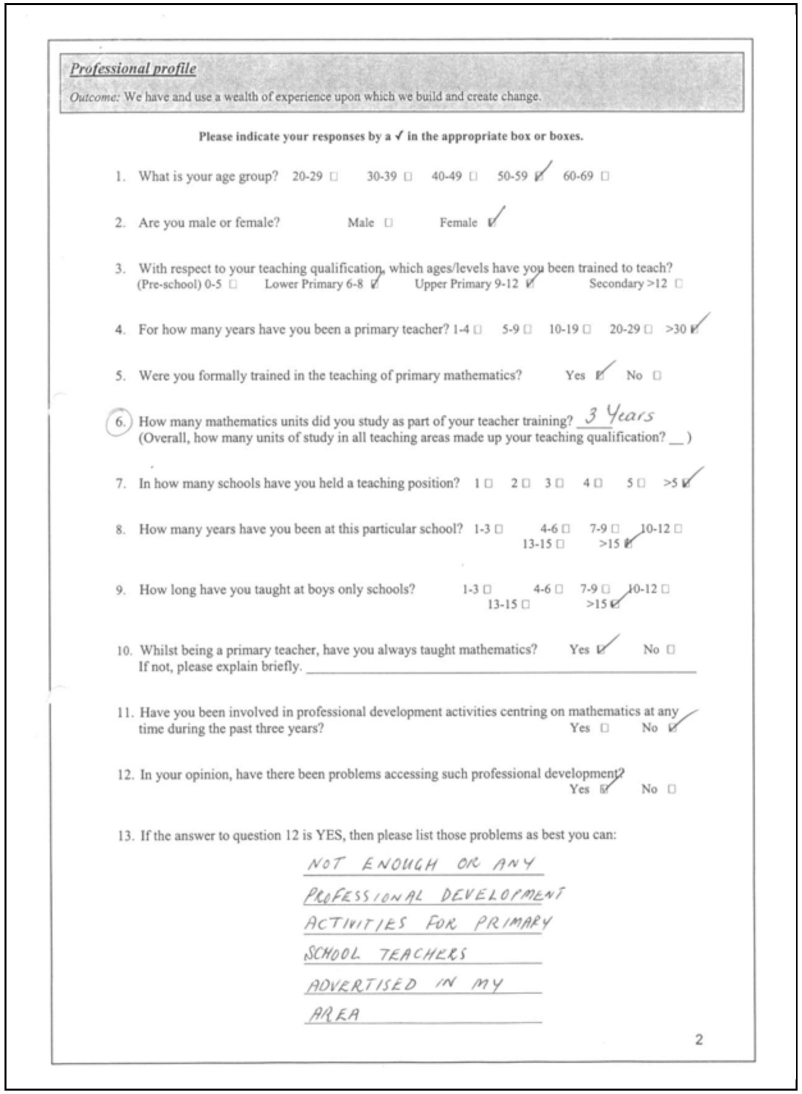
Please be aware that unlike the traditional maths test, this is not a situation seeking 'right' answers. All data will be collected, stored and analysed anonymously. In order to be of real value, the answers need to be an accurate reflection of *you*, *your* thoughts and *your* practices in relation to the techniques that *you* use in the teaching of mathematics at this time. You have been asked to be part of what is a small diverse cross- sectional group of professionals in our school because of what it is perceived that you can bring to the group by being the personality and professional that you are, and your willingness to ponder the possibilities that lie along the path ahead, a path that the group will travel and explore together.

It is likely that completion of this questionnaire will take about 30 minutes. The collated information will give us *a basis*, a starting point, upon which we will begin the exploration of a shift in our emphasis in assessment during this academic year.

I am looking forward to the project as a whole, a substantial undertaking for a small group of already hard-working teachers. I foresee that it will see us unearth and grapple with many issues as we attempt to further enhance the teaching and learning of mathematics in our school.

Thank you again for being willing to take part in this important work and for your cooperation and assistance in completing this questionnaire.

Please return the questionnaire by 12th March



Professional profile

Outcome: We have and use a wealth of experience upon which we build and create change.

Please indicate your responses by a ✓ in the appropriate box or boxes.

1. What is your age group? 20-29 ☐ 30-39 ☐ 40-49 ☐ 50-59 ☑ 60-69 ☐

2. Are you male or female? Male ☐ Female ☑

3. With respect to your teaching qualification, which ages/levels have you been trained to teach?
(Pre-school) 0-5 ☐ Lower Primary 6-8 ☑ Upper Primary 9-12 ☑ Secondary >12 ☐

4. For how many years have you been a primary teacher? 1-4 ☐ 5-9 ☐ 10-19 ☐ 20-29 ☐ >30 ☑

5. Were you formally trained in the teaching of primary mathematics? Yes ☑ No ☐

6. How many mathematics units did you study as part of your teacher training? 3 Years
(Overall, how many units of study in all teaching areas made up your teaching qualification? __)

7. In how many schools have you held a teaching position? 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ >5 ☑

8. How many years have you been at this particular school? 1-3 ☐ 4-6 ☐ 7-9 ☐ 10-12 ☐ 13-15 ☐ >15 ☑

9. How long have you taught at boys only schools? 1-3 ☐ 4-6 ☐ 7-9 ☐ 10-12 ☐ 13-15 ☐ >15 ☑

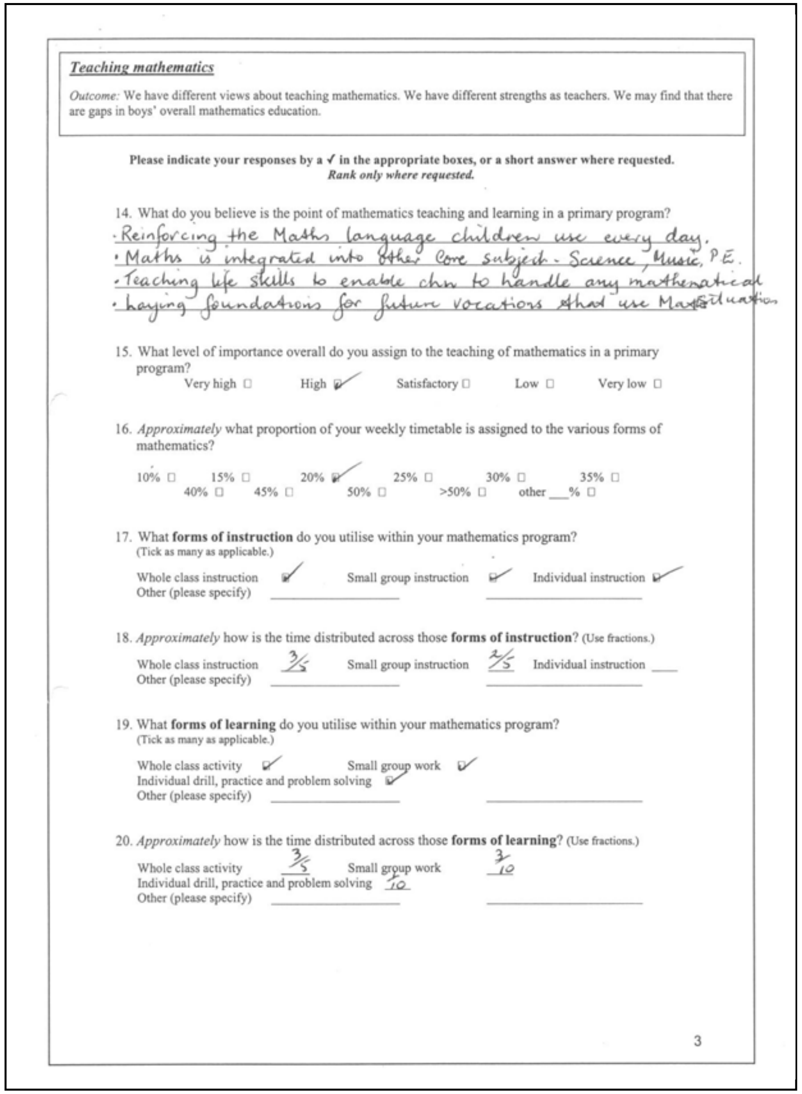
10. Whilst being a primary teacher, have you always taught mathematics? Yes ☑ No ☐
If not, please explain briefly. ____________________

11. Have you been involved in professional development activities centring on mathematics at any time during the past three years? Yes ☐ No ☑

12. In your opinion, have there been problems accessing such professional development? Yes ☑ No ☐

13. If the answer to question 12 is YES, then please list those problems as best you can:
NOT ENOUGH OR ANY
PROFESSIONAL DEVELOPMENT
ACTIVITIES FOR PRIMARY
SCHOOL TEACHERS
ADVERTISED IN MY
AREA

2



Teaching mathematics

Outcome: We have different views about teaching mathematics. We have different strengths as teachers. We may find that there are gaps in boys' overall mathematics education.

Please indicate your responses by a ✓ in the appropriate boxes, or a short answer where requested.
Rank only where requested.

14. What do you believe is the point of mathematics teaching and learning in a primary program?
- Reinforcing the Maths language children use every day.
- Maths is integrated into other Core subject - Science, Music, P.E.
- Teaching life skills to enable chn to handle any mathematical
- Laying foundations for future vocations that use Maths situation

15. What level of importance overall do you assign to the teaching of mathematics in a primary program?
Very high ☐ High ☑ Satisfactory ☐ Low ☐ Very low ☐

16. *Approximately* what proportion of your weekly timetable is assigned to the various forms of mathematics?
10% ☐ 15% ☐ 20% ☑ 25% ☐ 30% ☐ 35% ☐ 40% ☐ 45% ☐ 50% ☐ >50% ☐ other ___% ☐

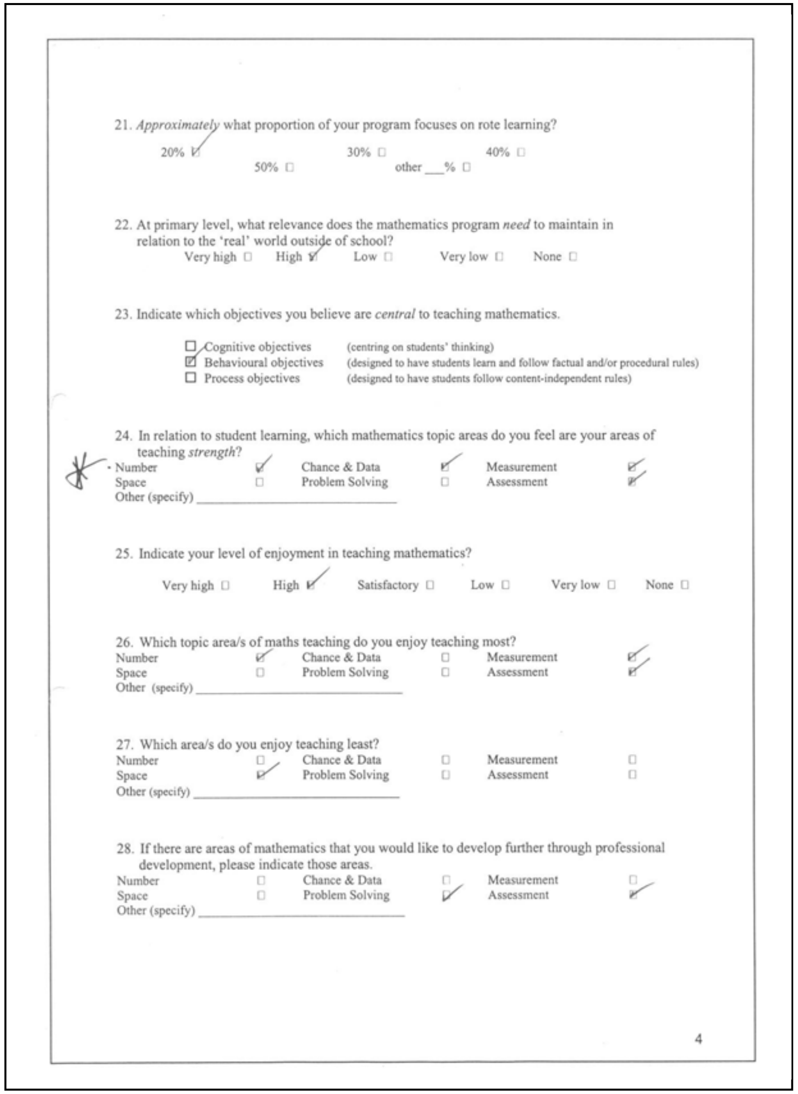
17. What **forms of instruction** do you utilise within your mathematics program?
(Tick as many as applicable.)
Whole class instruction ☑ Small group instruction ☑ Individual instruction ☑
Other (please specify) ____________ ____________

18. *Approximately* how is the time distributed across those **forms of instruction**? (Use fractions.)
Whole class instruction 3/5 Small group instruction 2/5 Individual instruction ___
Other (please specify) ____________ ____________

19. What **forms of learning** do you utilise within your mathematics program?
(Tick as many as applicable.)
Whole class activity ☑ Small group work ☑
Individual drill, practice and problem solving ☑
Other (please specify) ____________ ____________

20. *Approximately* how is the time distributed across those **forms of learning**? (Use fractions.)
Whole class activity 3/5 Small group work 3/10
Individual drill, practice and problem solving 1/10
Other (please specify) ____________ ____________

3



21. *Approximately* what proportion of your program focuses on rote learning?

20% ☑ 30% ☐ 40% ☐
50% ☐ other ___% ☐

22. At primary level, what relevance does the mathematics program *need* to maintain in relation to the 'real' world outside of school?

Very high ☐ High ☑ Low ☐ Very low ☐ None ☐

23. Indicate which objectives you believe are *central* to teaching mathematics.

☐ Cognitive objectives (centring on students' thinking)
☑ Behavioural objectives (designed to have students learn and follow factual and/or procedural rules)
☐ Process objectives (designed to have students follow content-independent rules)

24. In relation to student learning, which mathematics topic areas do you feel are your areas of teaching *strength*?

Number ☑ Chance & Data ☑ Measurement ☑
Space ☐ Problem Solving ☐ Assessment ☑
Other (specify) ____________________

25. Indicate your level of enjoyment in teaching mathematics?

Very high ☐ High ☑ Satisfactory ☐ Low ☐ Very low ☐ None ☐

26. Which topic area/s of maths teaching do you enjoy teaching most?

Number ☑ Chance & Data ☐ Measurement ☑
Space ☐ Problem Solving ☐ Assessment ☑
Other (specify) ____________________

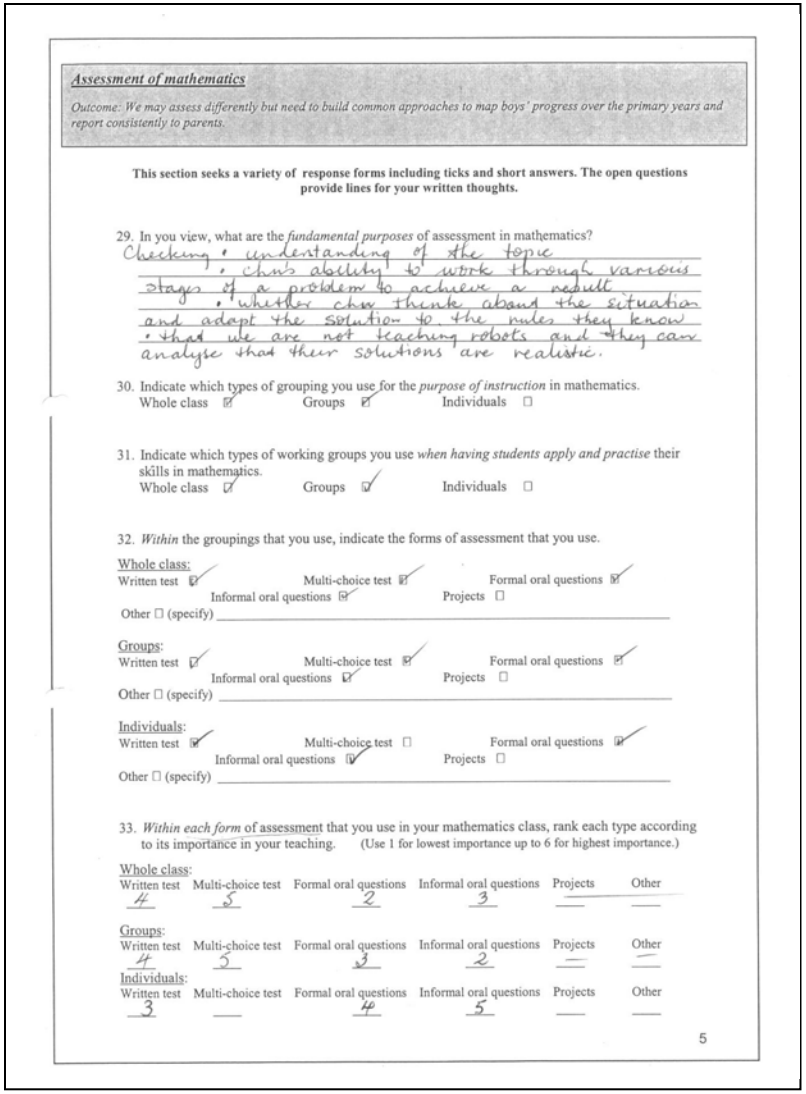
27. Which area/s do you enjoy teaching least?

Number ☐ Chance & Data ☐ Measurement ☐
Space ☑ Problem Solving ☐ Assessment ☐
Other (specify) ____________________

28. If there are areas of mathematics that you would like to develop further through professional development, please indicate those areas.

Number ☐ Chance & Data ☐ Measurement ☐
Space ☐ Problem Solving ☑ Assessment ☑
Other (specify) ____________________

4



Assessment of mathematics

Outcome: We may assess differently but need to build common approaches to map boys' progress over the primary years and report consistently to parents.

This section seeks a variety of response forms including ticks and short answers. The open questions provide lines for your written thoughts.

29. In you view, what are the *fundamental purposes* of assessment in mathematics?

Checking • understanding of the topic
• chn's ability to work through various
stages of a problem to achieve a result
• whether chn think about the situation
and adapt the solution to the rules they know
• that we are not teaching robots and they can
analyse that their solutions are realistic.

30. Indicate which types of grouping you use for the *purpose of instruction* in mathematics.

Whole class ☑ Groups ☑ Individuals ☐

31. Indicate which types of working groups you use *when having students apply and practise* their skills in mathematics.

Whole class ☑ Groups ☑ Individuals ☐

32. *Within* the groupings that you use, indicate the forms of assessment that you use.

Whole class:
Written test ☑ Multi-choice test ☑ Formal oral questions ☑
Informal oral questions ☑ Projects ☐
Other ☐ (specify) ____________________

Groups:
Written test ☑ Multi-choice test ☑ Formal oral questions ☑
Informal oral questions ☑ Projects ☐
Other ☐ (specify) ____________________

Individuals:
Written test ☑ Multi-choice test ☐ Formal oral questions ☑
Informal oral questions ☑ Projects ☐
Other ☐ (specify) ____________________

33. *Within each form* of assessment that you use in your mathematics class, rank each type according to its importance in your teaching. (Use 1 for lowest importance up to 6 for highest importance.)

Whole class:

Written test	Multi-choice test	Formal oral questions	Informal oral questions	Projects	Other
4	5	2	3		

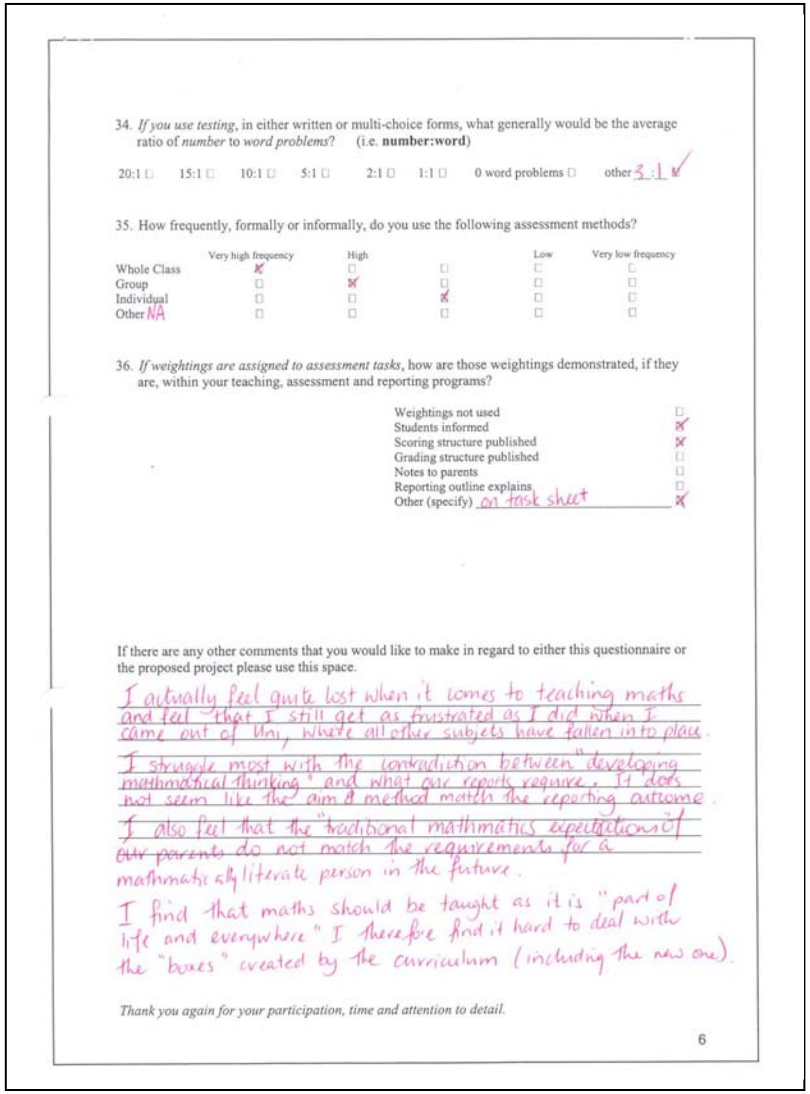
Groups:

Written test	Multi-choice test	Formal oral questions	Informal oral questions	Projects	Other
4	5	3	2	–	–

Individuals:

Written test	Multi-choice test	Formal oral questions	Informal oral questions	Projects	Other
3		4	5		

5



34. *If you use testing*, in either written or multi-choice forms, what generally would be the average ratio of *number* to *word problems*? (i.e. **number:word**)

20:1 ☐ 15:1 ☐ 10:1 ☐ 5:1 ☐ 2:1 ☐ 1:1 ☐ 0 word problems ☐ other 3 : 1 ☒

35. How frequently, formally or informally, do you use the following assessment methods?

	Very high frequency	High		Low	Very low frequency
Whole Class	☒	☐	☐	☐	☐
Group	☐	☒	☐	☐	☐
Individual	☐	☐	☒	☐	☐
Other NA	☐	☐	☐	☐	☐

36. *If weightings are assigned to assessment tasks*, how are those weightings demonstrated, if they are, within your teaching, assessment and reporting programs?

- Weightings not used ☐
- Students informed ☒
- Scoring structure published ☒
- Grading structure published ☐
- Notes to parents ☐
- Reporting outline explains ☐
- Other (specify) on task sheet ☒

If there are any other comments that you would like to make in regard to either this questionnaire or the proposed project please use this space.

I actually feel quite lost when it comes to teaching maths and feel that I still get as frustrated as I did when I came out of Uni, where all other subjects have fallen into place.

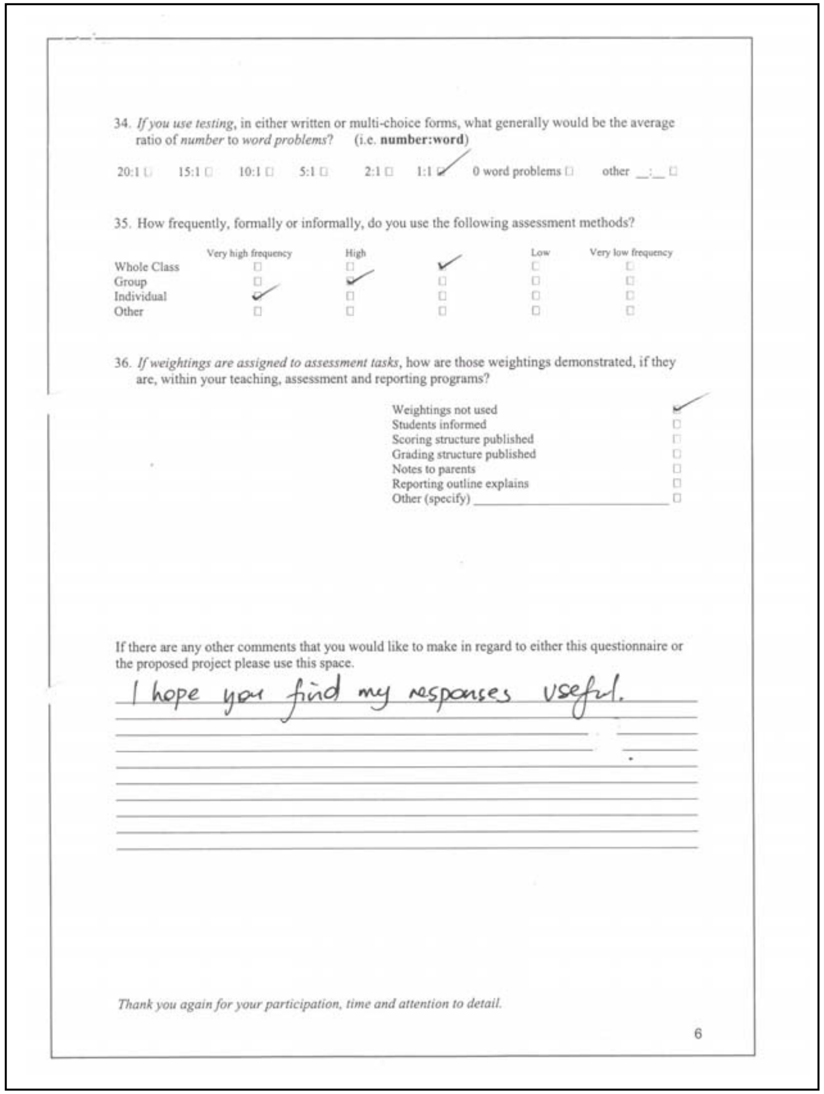
I struggle most with the contradiction between "developing mathmatical thinking" and what our reports require. It does not seem like the aim & method match the reporting outcome.

I also feel that the "traditional mathmatics expectations" of our parents do not match the requirements for a mathmatically literate person in the future.

I find that maths should be taught as it is "part of life and everywhere" I therefore find it hard to deal with the "boxes" created by the curriculum (including the new one).

Thank you again for your participation, time and attention to detail.

6



34. *If you use testing*, in either written or multi-choice forms, what generally would be the average ratio of *number* to *word problems*? (i.e. **number:word**)

20:1 ☐ 15:1 ☐ 10:1 ☐ 5:1 ☐ 2:1 ☐ 1:1 ☑ 0 word problems ☐ other __:__ ☐

35. How frequently, formally or informally, do you use the following assessment methods?

	Very high frequency	High		Low	Very low frequency
Whole Class	☐	☐	☑	☐	☐
Group	☐	☑	☐	☐	☐
Individual	☑	☐	☐	☐	☐
Other	☐	☐	☐	☐	☐

36. *If weightings are assigned to assessment tasks*, how are those weightings demonstrated, if they are, within your teaching, assessment and reporting programs?

- Weightings not used ☑
- Students informed ☐
- Scoring structure published ☐
- Grading structure published ☐
- Notes to parents ☐
- Reporting outline explains ☐
- Other (specify) ______ ☐

If there are any other comments that you would like to make in regard to either this questionnaire or the proposed project please use this space.

I hope you find my responses useful.

Thank you again for your participation, time and attention to detail.

6

Appendix 13: Teacher Focus Group Written Reflections (Examples)

Term 1 Personal Reflection *(Teacher E)*

Reflection on my participation in the project:
My participation in this project during Term 1 involved

- regular attendance at meetings
- involvement in discussions
- considerations about the form of the reflective journal I would be asking students to use.
- developing awareness that ‘the project approach’ would be the most innovative way to approach change within my pedagogical practices.

<u>Reflection on Student Questionnaire</u>
Students perceive the study of Maths in the following ways:

- in a mechanical, practical sense – it helps with lots of practical life situations.
- for educational benefits – helping to ‘grow’ our intelligence.
- for future career prospects, maths is seen to play an integral role for many.
- for recreation – playing some games
- it is a compulsory part of schoolwork.
- It will help when we are older, as opposed to now!

Students like Maths because:

- It challenges them
- It will help with later life
- You learn new things

Students dislike Maths because:

- They are slow at it
- It’s too hard/ confusing
- It’s boring/not much fun
- They don’t know how to get better at it
- Getting it wrong is a letdown.

I haven’t examined the graphs very closely yet as I came in on the end of that discussion.

Conclusion:
From the summary of results I think that I can improve the image/perception of Maths in my class with some innovation in the ways students work during lessons. I am interested in pursuing the project approach with Year 7 students, in the following sequence:

1. increase student engagement, focused discussion and investigation into alternative pathways to a correct answer, followed by reflection on learning.
2. greater involvement in open-ended investigations leading to a range of results and interpretations, with further development of reflective practices.

As with all planning and learning, there’s a need to set goals within the group’s portfolio development agenda. After working with Year 7 for a term, the most successful approach to emerge has been one that involves the students actively in small group discussion about concepts via peer tutoring and teamwork in solving problems related to understanding and knowledge development. (immersion, engagement, demonstration, reflection – this framework has been a successful model across my teaching because it incorporates a spiralling development of knowledge and understanding).

Teacher Focus Group Reflections

Term 2 2004

1. From the weekly opportunities to share and discuss thoughts and experiences you gained:

Teacher A

- The teaching of maths is a complex process.
- The need to engage in more discussion with TRW to verify what I need to do.
- ***Teachers approach teaching mathematics differently***.

Teacher B

- ***I don't feel that I have gained an awful lot from our discussions. I may have even become a little more complacent. Because instead of thinking I was the only one really struggling with teaching maths and needed to get my act together, I now realise that there are many others that are just as lost. I kind of feel a little relieved that I am not the only one.***

Teacher C

- The opportunity to work with colleagues and discuss latest trends in education;
- That I'm probably still looking at Maths teaching as I previously taught it – in my mind there's a confusion in teaching the basic concepts to fit in with the timetable and thinking about solving open-ended problems that are suitable for establishing a process Maths portfolio;
- That D & B, being younger, have a clearer understanding of the practicalities of the process portfolio;
- That the meetings were too short for us all to contribute evenly about the previous week's progress and what we hoped to achieve for the next week.
- That I'm not as confident in coming up with open-ended tasks as others in the group, especially tasks for the middle Maths group I take. The time is spent giving them the basics;
- The boys themselves are still thinking about how Maths has been taught to them in the past, and they haven't seen the connection yet in regards to the process portfolio.

Teacher D

- The opportunity to hear different teaching strategies by colleagues;
- Ideas for 'how' I would assemble process portfolio; suggestions for questions in Maths that lead to many solutions (e.g. open ended questions, as such);
- Management strategies of collaboration between people in our organization.

Teacher E

- A developing sense of teamwork;
- Increased communication about pedagogy;
- Some new ideas about adopting a problem solving approach (mainly activities I could give me my students).

2. If you found that your expectations were not met, what was it that you were looking for from the group's interactions that failed to materialise, and that you would like to have emerge as part of future meetings.

Teacher A

- I would like to have further discussions with TRW and the group to seek direction, e.g. the formation of the portfolio. I'm still a bit lost in it all actually.

Teacher B

- I know that I sound really blunt but in actual fact, I don't think I am going to get what I am looking for from the group. I would like to work with someone who has the show up and running. I don't really know what I am aiming for, therefore feel that I am meandering around in the hope that I might stumble upon it. ***It is not uncommon for teachers to feel lost teaching mathematics.*** I would really like to see some hands on, working alongside with some one who has it sorted. Like a prac teaching session. I want to feel excited about growth and gaining new understanding. I feel like I am searching in what I already know for answers, hoping that there is a stone unturned with the magic key … but it ain't happening. I need new ideas!

Teacher C

- I think we all haven't told exactly our fears on what was working or not, because somehow we could be judged by our peers (sub-consciously);
- I think ***there's a need to understand more about how others teach it and for useful professional development***, especially with assessment for learning;
- Perhaps have the colleagues meeting in a classroom so that we can use the blackboard to emphasise points;
- Maybe get the opportunity to look at some children's process Maths portfolios (different year levels – if any exist) to get a handle on what is required;
- ***Being an older person and in the private system where I haven't had much professional development, I'd like to give things a try but feel I don't have the experience in using the latest trends. I feel like a new kid on the block, but maybe that is the reaction you get when you are venturing towards the unknown.***

Teacher D

- I enjoy studying our meeting 'ideas' on paper;
- I require time to reflect over a short period of time, before making major decisions. The questionnaires and their responses were an excellent example;
- There were a lot of good ideas people spoke about at meetings. Minutes of the meeting help and I take notes!

Teacher E

- Would it help to focus our group work if we established a clearly stated set of program goals to keep referring to; what are the essential features of this project in terms of student outcomes? (like a teaching/learning charter to guide and inform our consequent actions.) E.g. is the focus to assess student progress for purposes of informing future teaching/learning directions OR is it to inform the reporting process, OR a combination of these.
- While we have discussed using rubrics in assessing information gathered, ***we need to work out how to use the rubric in designing future teaching and learning programs that incorporate problem solving*** and make sure course work is covered while designing developmental learning experiences.

3. If there are any other thoughts of which you would like me to be aware while pondering what's been and what's to come, please list them.

Teacher A

- I am having a lot of trouble with that assessment for learning. I just can't get myself to think of that type of question very easily. I could use a lot more help on it.

Teacher B

- I am quite frustrated with teaching at the moment so it might be rubbing off on how I feel about maths. I get so busy with the day to day running of things that I can’t find the time for any real, new input. I feel kind of stagnant. Is spent three days of the first week of holidays catching up with marking, another planning and I will have one more planning and one more marking day this week. It does not leave an awful lot of time to go looking for input. The last time I got really excited about teaching and found some great new material was when I was on Li’s maternity leave, because I had the time. I found great stuff on the net and had the time to visit some old teaching friends to get their ideas. Perhaps we don’t know enough about what is going on in each other’s classrooms at TSS? I am actually looking forward to taking the time to get sorted again. I know it would be impossible but it would really help if I could know what grade I was getting next year because then I can focus my research and material collection rather than having to be so general.

Teacher C

- ***I’d like to think that the system we devise will be put into practice by everyone (if that’s possible) and not just put into the to- hard basket;***
- ***I think at the beginning of the year we should have shared the idea of the process portfolio with the whole staff. I have found that to do the process portfolio with one group that is really three different classes to be difficult.***
- Next year it will be easier for me to do the portfolio on problem solving with my own class two days a week consecutively to allow continuation of discussion and writing up of notes so that the topic at hand could be integrated with other subjects.
- Length of process portfolio?
- Frequency of entries in process portfolio?
- I know how I will be assessing the boys with this p.p. How/what documentation will we circulate, so that other teaching staff understand how to use the p.p. (This will probably come in Term 4.)

Teacher D

- ***It is hard to develop the process portfolio approach in maths without exposure to models to help our planning and doing***.
- Stepping into the ‘unknown’ was at times quite emotionally draining.
- Can we enlist any experts as guest speakers to our group meetings or for an after school session?
- It is good if we can ‘scaffold’ our own learning with input from others who’ve already navigated this pathway.

Teacher E

- I got a lot from our work on assessment for learning. I realised that I had been assessment of learning – it was a subtle difference before I came to the full realisation of the difference.
- The boys enjoyed the trial runs we had which were a bit different and I learned a lot about open-ended questions and giving formative feedback during assessment tasks but writing those sorts of assessment tasks is really quite difficult when you’ve never done them before

4. Any other comments

Teacher B

After being so grumpy about the whole thing, I am very happy that something is being done. I’d rather feel frustrated than brush it under the carpet.

Appendix 14: Teacher Focus Group Meeting Journal Extracts

Meeting date: **Tuesday 10 Feb 04** Time: 1105 -1140

Major topic/s for discussion: Getting started – some of the thinking involved
Gunningham *Thinking Allowed* discussed.

Summary
B: Personal journals – students wrote answers just how they reached their conclusions.
C: Hard job as they hadn't done it before.
TRW: Need to be taught how to record thought processes; some students don't like to write. *(Possibly use concept/mind maps, cartoons, teach a peer. Brainstorm alternatives to writing.)*
B: Kept in book separate to portfolio – no worries about margins, setting out, etc. Initially "like pulling teeth from a rhinoceros with a toothache." Yesterday, great lesson, not one child solved the problem, but when they worked together they came up with a solution, but after 30 minutes no child had touched a pencil. Lots of AHA! learning had happened.
Often difficult to get many mathematically able children to express themselves in written word form. Often the quieter working children come up with 'far better journals'.
D: What are examples of questions that you can be exploring? I have problems writing open-ended questions.
B: E.g. How can you divide 12 by 2 and get 7? (Ans: Write it in Roman numerals and cut in half horizontally.)
D: What about giving them an incorrect solution to a problem and asking them to find where the error has been made?
B: A lot of it is a different way of questioning – get in there and give it a go – get a lot out of it. It's the whole process thing. Well away from the days of rote. We don't know what they will need to know later in life. We are assisting them gain the processes needed to gain the skills that they will need when they need them.
TRW: That's the same as what is happening within the focus group as well.
C: Trying to change the whole way many children think about maths. Many are frightened of the unknown.
TRW: Children still believe that rote learning is an easy way, contrary to reality. (*Brain Compatible Classrooms* – Fogarty introduced and offered on loan)
B: Always had trouble 'teaching' fractions the conventional way. However, after lots of hands on exploration of the concept, project work recorded if necessary, not using conventional ways initially. When it came to recording the strange conventional '2/3' was simply accepted with little confusion. Even the student who understood relatively little in much of maths understood what a fraction is.

Examined the resource text supplied to group (*Thinking Allowed* – Sue Gunningham, 2003):
E: An excellent resource as it has a large proportion of relevant usable material, unlike many texts. Bloom's, MI, de Bono.
C: Great to help us get started.
E: As a result of some of her own reading and study last year began to look at early stages of process portfolio – "organized chaos" initially.
B: Enjoys working more in such situations, as there was more genuine two-way interaction and real learning on both sides.
C: Stop-start nature of school's timetable may tend to interfere with 'flow'.
B: Just leave it all there to continue upon return. Enthusiasm will grow so that they are dead keen to continue.
TRW: Possibility of large slabs of time devoted to maths only occasionally. But can integrate specialist lessons with consultation with specialist teachers.
B: '***Mathematics is the hardest subject to integrate into other areas. There is a danger that it could become pointless when integrated.'***
C: Maths every day can be part of Science, etc.

A: Spoke of example of problem with daughter previous night where he used MAB blocks to build object in question. Two solved together, and will return to it tonight in order to research other questions that have emerged since.
E: There are various interpretations of problems possible. I think they need to be taught to substantiate their interpretation, understanding and solution.
C: Children need to be taught that questioning anything in maths is acceptable, necessary for genuine understanding.
A: Have to get away from the old thinking regarding timeframes in maths work.
Can I start with the puzzles that I have in my room?
B: You can start with anything. It doesn't matter what you start with as long we are starting the reasoning/supporting thinking and expression processes.
E: Questioning whether children completing a number of practice exercises are actually engaged participants in the teaching/learning process, or are they spectators.
B: Important for boys to learn through doing – the bottom line.

TRW: All reassured that we are not going to turn the whole maths learning process upside down in order to start the process of introducing portfolio work – starting with just problem solving with a view to enlarging if our work develops in the direction and such change is realistic and will provide benefits for the boys. We are looking to develop a genuine love of maths – to be seen through boys developing their own investigations to pursue.

Overall comments
Participants are becoming more vocal, expressing their views more readily, less apprehensive. The variations in experience with teaching using portfolios is becoming more noticeable with the more experienced, yet relatively young, member taking a leading role in discussions. Already participants are beginning to show less nervousness as to the complexity of what they will be undertaking within their classroom mathematics programs. In fact, it could be claimed that an appreciable professional excitement is growing. *This is the first stage of implementation – engaging in the process.*

Actions
All agreed to have a look at an early exercise using de Bono's 6 Thinking Hats as outline in Gunningham by next meeting. *(What will embed in practice, with whom and why?)*
Parents to be introduced to the process and the study by TRW within individual classrooms at Parent-Teacher Information Night (that night). Letters and consent forms to be distributed at those sessions.

Meeting date: **Tuesday 17 February 2004** Time: 1110 -1145

Major topic/s for discussion: de Bono's 6 Thinking Hats
Popham (1998) *Confessions of an assessment convert* & Curtis (2002) *The Power of Projects*
Boys writing down a mathematical process in their own words

Summary
B: Chose some hats in order to give boys a 'feel' for the Thinking Hats concept (left Blue and Green hats). Boys looked at and interpreted teacher-supplied optical illusions. Class discussions were focused on various hats in turn. E.g. boy playing with electricity cord – black: get electrocuted. ? not distracting others while he is doing that.
'I tried a written reflection of a group activity centred on the question of maths being fun. I was disappointed initially in the shallow responses. There's a need to teach students how to reflect and write about the process that they have followed. I realised that greater depth of thought was evident in responses when I used the hats to help them think about things. They were able to see good and bad in the focus that the hats added to the activity – but not all favoured hat activity. One didn't like the hats because there were no correct answers!! Another one because they give you a lot of stress and make his head hurt.'
B realised that the process had been successful following her examination of the depth of the second part of the comments in the journals.

Discussion: The rote learners like to have ‘correct’ answers. They feel comfortable with such. Black hats could be seen by some boys as criticising the teacher – “not a good place to be.” Boys also worried about having “too much information”. Want minimum to ‘do the task’. Journals work best when boys regulated by enforced sitting in silence to reflect and write.
D: Gave boys the task of writing a process step by step with reasons for each step in their journal. **D** was seeking to ascertain boys’ “level of understanding of process” (*but couldn’t boys simply have learned by rote and regurgitated?*). ***‘There are problems in trying to go away from the showcase portfolio. I’m used to it and it sits in the back of my mind, so I keep thinking of the final product in the portfolio, not the process*** as much, i.e. in relation to the portfolio’. D shared ‘best’ three – (*interesting ‘showcase’ approach still dominant.*)
D then sought advice as to how he could introduce a map describing activity with his boys. Multiple ideas supplied by group over ensuing minutes. Many ideas gave the teaching emphasis/control to the boys.
C concerned about who to involve out of maths groups – told to involve all in the activities – data will not be collected from non-participant class.

Popham: Popham’s views seen as balanced – more so than the TFG at this time. A lot to say about norm-referenced testing – something the TFG relies on, almost solely, too much anyway
Curtis: TFG appreciating the value of allowing children to explore mathematical ideas for themselves – and then use them as part of assessment – but a big step in their minds and also in such a school. Need to know more of the possibilities in such an approach

Overall comments
The group is readily embracing the concepts shared. Discussion is open and relaxed.
Group invited to borrow more resource books from TRW as a result of their examining the supplied resource list and reading articles distributed.

PD needs emerging: Greater understanding of understanding, more on constructivist learning theory

Actions
D to do hats activity on the following day – need to give an opportunity to share results at next group meeting.
Participant questionnaire to be given to focus group within the next couple of weeks.

Meeting date: **Tuesday 2 March 2004** Time: 1110 - 1145

Major topic/s for discussion: Design of questionnaire for students – participant teacher ideas regarding topics and questions – building group ownership of this aspect of the study.
Brady – *Tracing the evolution of portfolios* Grootenboer – *Kids talking about learning maths*

Summary
First need to ascertain the attitude to maths within the students of the participating classes.
Second need to discover how boys see maths as applicable to the ‘real world’ – application.
Students’ perceived strengths & weaknesses.

Discussion: Children believe that maths is done at a certain time and does not apply at any other time – at school only. So there could be a problem asking them to take it into other areas and other times. Once connections are made to the world around us it opens the subject up to students and strugglers then have opportunity and encouragement to become genuinely involved in the subject. **D**: ‘***We need to come up with some sort of plan or structure to follow in writing problems or tasks, just as a start.’***
<u>Possibility</u> - *Food projects* – centre tasks on feeding various groups and working at various levels of difficulty. E.g. Lasagne - at all different levels.

Format of questionnaire:
- Tick & flick and some short answer questions to be asked.
- Keep the number of questions down to 10-12.
- True and false questions a possibility.
- Question as to what they see as a possible strength.

- What they feel they need to know in order to be good at maths. (They perceive their ability from what they can't do rather than what they can do.
- Ask what they enjoy in maths (e.g. puzzles, graphs, etc.)
- Tick those questions which are maths questions:
- You need to be good at numbers to be good at maths – e.g. give a word problem and same as number problem.
- Look at difference between abstract and concrete maths – perceptions thereof.
- Look at boys' perceptions as to how important maths is in this world.

Grootenboer – concerns as teachers could see that their thoughts on maths tied up with very narrow thoughts of the kids – linked to much rote learning – views of maths firmly grounded in school mathematical experiences - stimulus for more discussion as list of PD needs emerges.
Brady – discussion as to what constitutes demonstrable benchmarks of achievement in a portfolio. Several forms: showcase, evaluation, documentation, instructional and process portfolios – highlighted the need for student reflection. Concerns as to how portfolios show a progression of learning – TFG could see how portfolios would have an impact on their teaching.

Overall comments
A good session in that we were able to formulate the beginning of the student questionnaire.
Note: **C** & **B** heavily involved. Need to draw **E**, **D** & **A** into discussion more. TRW needs to be silent yet more, contributing only if necessary to focus discussion, enthusiasm must not overshadow teachers' development.

PD list: Learning in general-some further understandings (how the brain learns?),

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Meeting date: **Tuesday 18 May 2004** Time: 1115 -1145

Major topic/s for discussion: Problem solving and possible portfolio 'shapes'
Professional Development: *Constructivism* PowerPoint presentation

Summary
Discussion began regarding the 'disappearing' terms of the school year and the progress of both the process and the group itself.
Problems are to become part of the general teaching of maths, not a separate activity as it is at the moment with many/most teachers.
Possible portfolio structures discussed – Year 6 doing so already in a notebook, but it is still a *separate* activity in the class. Book helps this group focus their explanations and reflections.
Year 7 has another idea – where is computer generated work, work of which boys are generally quite proud, to be kept? Is a folder OK?
What guidelines are to be given for the explanation? "Explain this question so that a Year 1 might be able to do it."
"Explain so that another can complete the task. The person carrying out the task can do nothing other than what he is told to do by you."
The goal of the explanation: to get the students to understand what they are actually doing – *understanding* is the key word.
B: '***The whole point of the process is to promote learning, to get the desired outcomes. I now realise that outcomes are more than things you just measure in a test. It seems that maths tests defeat the purpose of portfolio assessment. At the end of the unit I should be able to give a full assessment of a student's capabilities for his work in his portfolio. You should not need to do an isolated test.'***

Constructivism: The (social) constructivist approach to learning maths discussed. Constructing knowledge brick by brick with understanding as the mortar. Students having to deconstruct and reconstruct their knowledge banks building on the existing foundations but putting new understandings in place in the structure. TFG realised that the theory had enormous merit – it was fact how they were learning right now!
he has written that he actually understands what he has done."

Appendix 15: Teacher Professional Development Schedule 2005

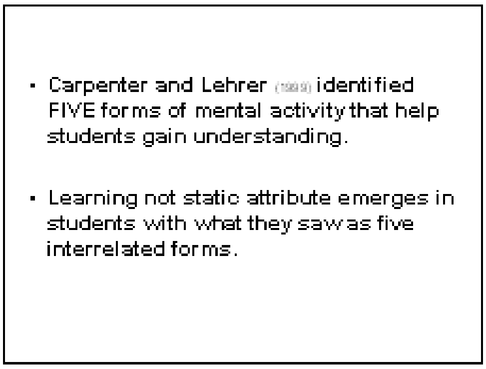
2005			
Month	**Mode**	**Procedure/Purpose**	**PD Monitoring**
February	PD presentation	*Keeping learning on track – formative assessment and the regulation of learning* (Wiliam) AAMT conference presentation Jan 2005	Journal notes Study Log
	Teacher Focus Group	Planning – joint and individual – integrating the concept to date with new classes	
	TFG fortnightly mtgs	Professional sharing	
March	PD presentation	*Mathematics and Numeracy* – MEPrac students at Bond University	Journal notes Third interviews Study Log TFG Reflections Observations
	Classroom partic.-obs.	Assistance/team teaching introducing concepts to ‘unfamiliar’ students	
	TFG fortnightly mtgs	The integrated whole process portfolio – reviewing the elements	
	Journal articles	Capps & Pickreign: *Language Connections in Maths: A Critical Part of Instruction* + others!!	
April	Classroom partic.-obs.	Team teaching and observations across TFG – mutual reviews and assistance	Journal notes Study Log Observations
	TFG fortnightly mtgs	Sharing gains to date – revealing current issues – setting goals for Term 2	
May	Classroom partic.-obs.	Team teaching and observations across TFG – mutual reviews and assistance	Journal notes Study Log Observations
	PD discussions	Wider staff included – distillation of Elaborations and Outcomes from syllabus for 2006 reports	
	TFG fortnightly mtgs	Critiquing of problems, complex rubrics, Class real-life journals	
June	Classroom partic.-obs.	Team teaching and observations across TFG – mutual reviews and assistance	Journal notes Study Log Observations TFG Reflections
	TFG fortnightly mtgs	Maths conferences and other similar possibilities- concentrated applications by students	
	Journal articles	Klenowski: *Connecting assessment and learning*	
July	PD presentation	Report to wider staff as to current ‘state of play’ with process portfolios	Study Log Observations Fourth interviews
	Classroom partic.-obs.	Team teaching and observations across TFG – mutual reviews and assistance	
	TFG Interactions	Small unscheduled, unstructured group interactions – ‘perfecting’ elements of the PP	
August	PD review	Reviewing the overall professional development undertaken throughout study.	Study Log Observations Fourth interviews TFG Reflections
	TFG Interactions	Small unscheduled, unstructured group interactions – shared ‘perfecting’ of PP elements	
	Classroom partic.-obs.	Team teaching and observations across TFG – mutual reviews and assistance	
September	PD presentation	Final report of emergent process portfolio structure to wider staff.	Study Log TFG Reflections P-T-S interviews
	TFG Interactions	Unstructured group interactions – ‘perfecting’ elements of the PP	
	Journal articles	SEDL: *School context: Bridge or barrier to change*	
October	TFG Interactions	Small group, unscheduled interactions – ‘perfecting’ elements of the PP	Survey questionnaires Study Log
	Journal articles	Reys: *Curriculum Controversy in the Maths Wars: A Battle Without Winners*	
November	TFG Interactions	Final review of all models developed – PP and its constituent elements – ‘last minute touches’	Study Log TFG Reflections

Appendix 16: Professional Development – *Understanding*

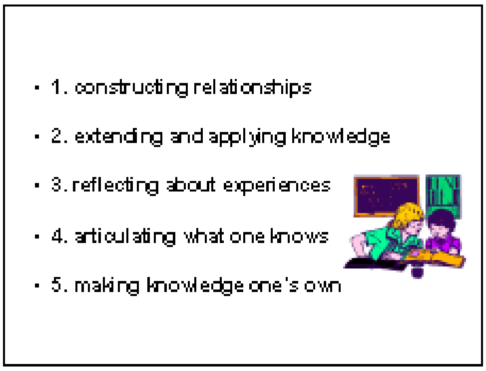
(Excerpt - opening six slides)

Understanding

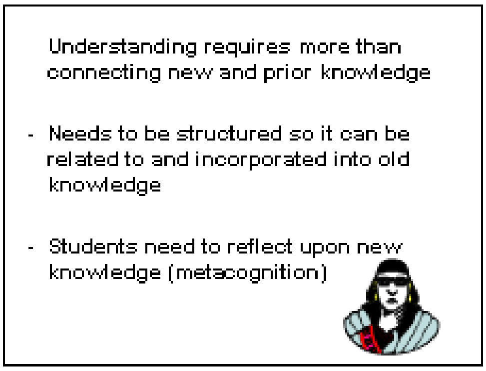
according to Carpenter & Lehrer (1999)
and Shepard (1992)



- Carpenter and Lehrer (1999) identified FIVE forms of mental activity that help students gain understanding.
- Learning not static attribute emerges in students with what they saw as five interrelated forms.

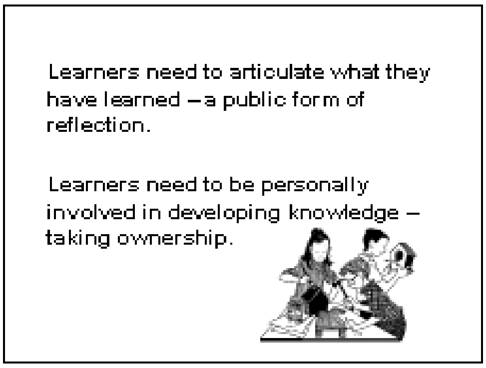


- 1. constructing relationships
- 2. extending and applying knowledge
- 3. reflecting about experiences
- 4. articulating what one knows
- 5. making knowledge one's own



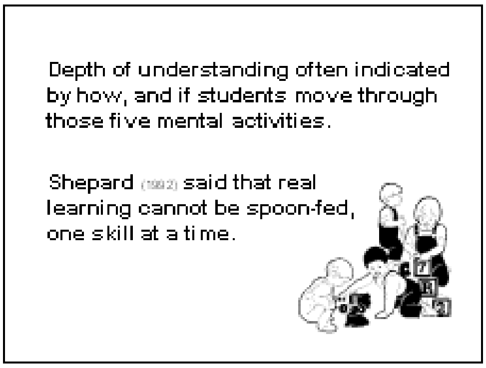
Understanding requires more than connecting new and prior knowledge

- Needs to be structured so it can be related to and incorporated into old knowledge
- Students need to reflect upon new knowledge (metacognition)



Learners need to articulate what they have learned – a public form of reflection.

Learners need to be personally involved in developing knowledge – taking ownership.



Depth of understanding often indicated by how, and if students move through those five mental activities.

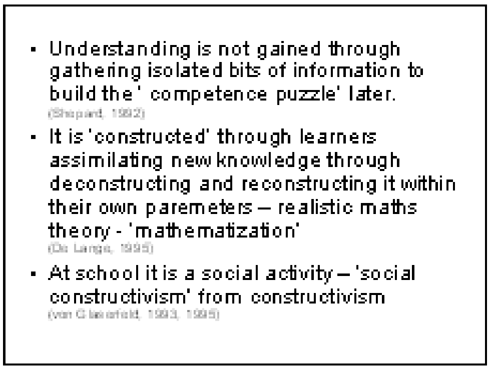
Shepard (1992) said that real learning cannot be spoon-fed, one skill at a time.

Appendix 17: Professional Development – *Learning through Constructivism*

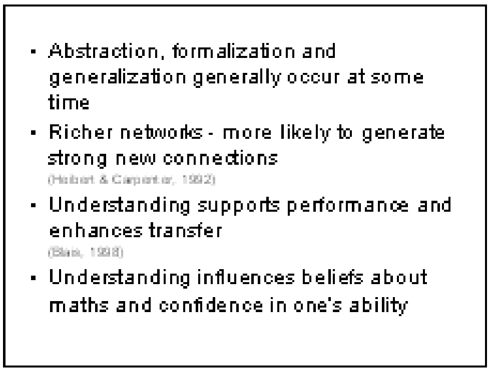
(Excerpt -opening six slides)

Learning through

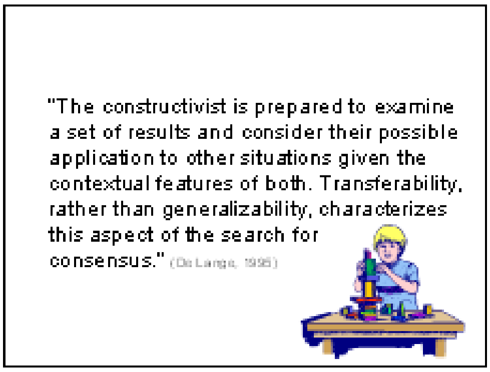
constrUCtivism



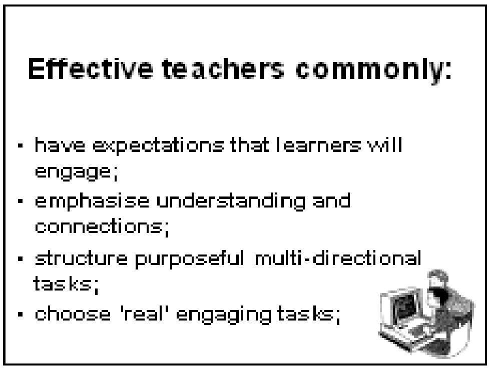
- Understanding is not gained through gathering isolated bits of information to build the ' competence puzzle' later.
  (Shepard, 1992)
- It is 'constructed' through learners assimilating new knowledge through deconstructing and reconstructing it within their own paremeters – realistic maths theory - 'mathematization'
  (De Lange, 1995)
- At school it is a social activity – 'social constructivism' from constructivism
  (von Glasersfeld, 1993, 1995)



- Abstraction, formalization and generalization generally occur at some time
- Richer networks - more likely to generate strong new connections
  (Hiebert & Carpenter, 1992)
- Understanding supports performance and enhances transfer
  (Blais, 1988)
- Understanding influences beliefs about maths and confidence in one's ability

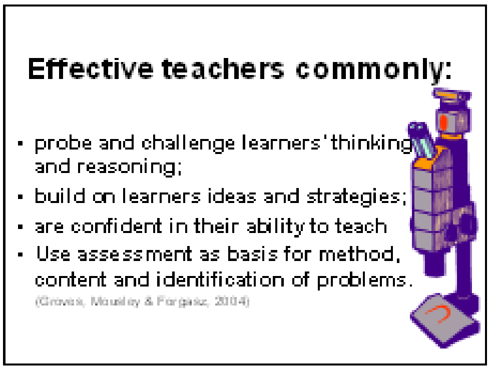


"The constructivist is prepared to examine a set of results and consider their possible application to other situations given the contextual features of both. Transferability, rather than generalizability, characterizes this aspect of the search for consensus." (De Lange, 1995)



Effective teachers commonly:

- have expectations that learners will engage;
- emphasise understanding and connections;
- structure purposeful multi-directional tasks;
- choose 'real' engaging tasks;



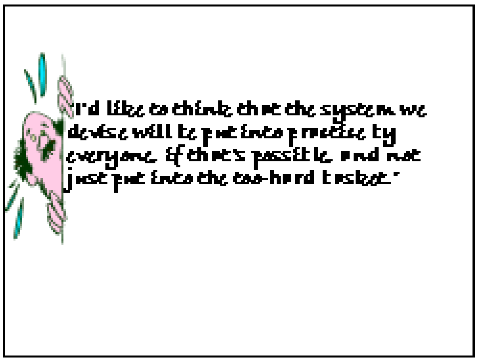
Effective teachers commonly:

- probe and challenge learners' thinking and reasoning;
- build on learners ideas and strategies;
- are confident in their ability to teach
- Use assessment as basis for method, content and identification of problems.
  (Groves, Mousley & Forgasz, 2004)

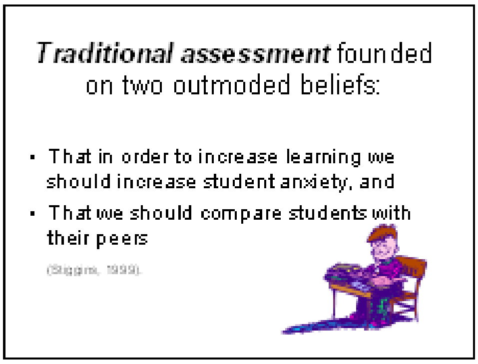
Appendix 18: Professional Development – *Assessment for Learning*

(Excerpt -opening six slides)

Assessment
for
learning



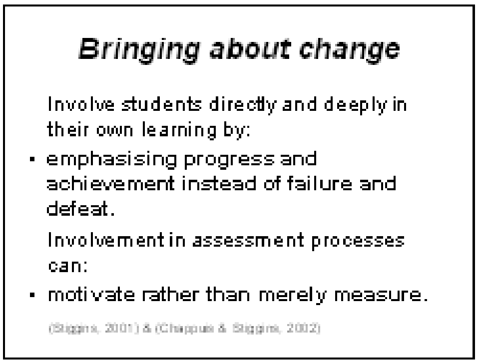
"I'd like to think that the system we devise will be put into practice by everyone, if that's possible, and not just put into the too-hard basket."



Traditional assessment founded on two outmoded beliefs:

- That in order to increase learning we should increase student anxiety, and
- That we should compare students with their peers

(Stiggins, 1999).



Bringing about change

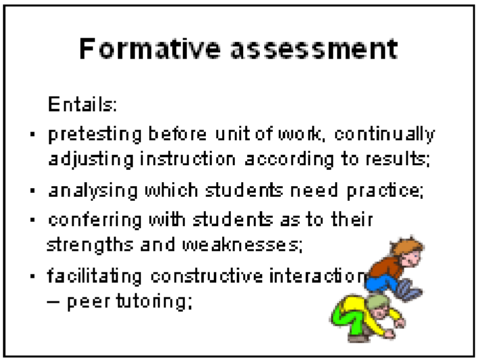
Involve students directly and deeply in their own learning by:

- emphasising progress and achievement instead of failure and defeat.

Involvement in assessment processes can:

- motivate rather than merely measure.

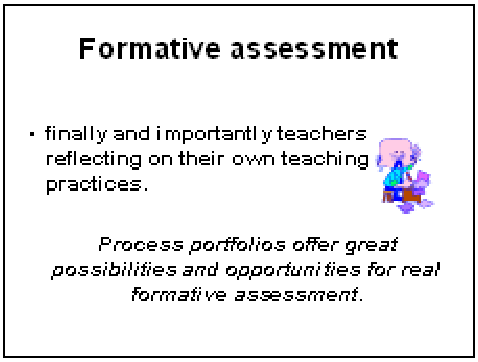
(Stiggins, 2001) & (Chappuis & Stiggins, 2002)



Formative assessment

Entails:

- pretesting before unit of work, continually adjusting instruction according to results;
- analysing which students need practice;
- conferring with students as to their strengths and weaknesses;
- facilitating constructive interaction – peer tutoring;



Formative assessment

- finally and importantly teachers reflecting on their own teaching practices.

Process portfolios offer great possibilities and opportunities for real formative assessment.

Appendix 19: Third Teacher Focus Group Interviews – Transcript Extracts

Teacher B

Question 2. In relation to your students, how has the PD and spaced learning approach assisted you in:
gaining deeper insight into the ways children assimilate and apply newly learned material
I actually believe the children assimilate much quicker than the adults do. There is a bigger problem with getting the teachers to switch over. Even myself it has been difficult. Once you introduce it to the children it involves them, they enjoy it more; it is empowering and they take it up naturally.

gaining greater insight into the ways children interpret and solve problems - *That blows me away all time, especially the discussion of them. It's great to listen as to how they would solve a problem. We had one last year that one of the kids bought up in a journal- 'How much money it would cost to go to University?' I said we wouldn't be able to find out an exact answer, how would you go about finding the information to solve this problem. The different strategies that they came up with as a group and presented to the class were outstanding. Very, very creative.*

understanding the difficulties students experience in problem solving (and identifying those students) - *The biggest problem I have had and that could be a weakness in me, is being able to work with some of the kids. Last year there was a boy who was very scientific in his approach and very orderly and he needs to have an answer and can't think outside the box – he is a bright child and he had a lot of difficulty in conforming with the concept. I think that was the area I had more difficulty in trying to convert somebody who is very set in their ways and wants to do it the same way he has been taught for the last few years. On the other hand, I think if it were adopted throughout the school it would be beneficial, by the time they reach Year 5 it won't be such a concern. He was just uncomfortable when he had to think outside of the box.*

which aspects of maths that students see as useful and therefore worth

learning and knowing - *This is the only way to go about it, if you don't discuss it you don't know. You can't really mark what a child understands – if you don't discuss it, you don't know what types of problems children see as meaningful and on what they base those*

interpretations – *Real-life or life-like that is really the key. If it applies to their life especially at this age they are engaged.* ***If it comes from them and you introduce it to the class; if a 10 year old boy has written it then most of the boys will be interested.***

Question 3. Did you vary the proportion of maths time spent on various aspects/strands of maths at all over the course of the past year? If so, how, and why?
I always do. Basically it's how much the class needs it. For instance I thought the class should be able to tell the time and I found out last year they couldn't so then I had to spend more time to do that.

Question 4. In regard to your students working on problem solving using the revised approach, i.e. task sheet and rubrics, did you notice any changes in:

attitude - *Not as much as I think will happen because the kids are still a little bit confused with the rubric sometimes. It is a new concept and I think when they have started to see more acceptance once they are more involved writing their own rubric. They know where they are going and it started to make sense to them.*

motivation and commitment - *Definitely with the assignment when we started to write our own rubric there was a lot more motivation because of the ownership factor.*

actions and reactions during lessons - *The engagement has definitely gone up because we are asking, 'What do you think?'*

skill levels - *I haven't got any proof of their skill levels – bearing in mind I was working with a difficult class that was struggling a lot in maths, I would say that it would have to come up because they are more involved with their learning.*

final products - *I would say the quality was starting to rise; there was definitely a sense a pride in their portfolio. They wanted to show it to their parents. They actually wanted to take it home to say, 'This is what I can do.' They were very happy with the final product. There was still – I am not sure if it because we teach boys – there was still I believe a lot of the final presentation was rushed. Even again after group discussions and presentations you get more out of them. If they have to write it down again, I think it is because they are boys, they don't like writing and you get 'that'll do'.*

difficulties children experienced - *I think again because I was working with a group that struggled a lot I don't think that the difficulty got any less but the way that they were able to manage the difficulty improved. Originally there were some problems with hands in the air saying, 'We can't do this.' There was an attitude and it was we can deal with this. It became obvious that there is not always a black and white answer; you can search for it. Other people are having the same problems. 'We don't really know how to do this, but that is ok because other boys don't and through talking about it we will be able to find an answer.' I suppose the biggest thing that I saw was the change that maths was not as intimidating, especially with a group of strugglers. Maths at the beginning of the year was very much too hard, I hate maths, I don't want to do it, I am no good at it, I have to do it because I am at school, the sooner this class is over the better; that changed a lot.*

Question 5. Have you used the information that the questionnaire/survey/interviews supplied? If so, how? If not, what were the barriers to your using it?
That was my biggest goal, trying to change attitudes towards mathematics. Trying to get away from the 'I hate maths' – I felt if I stuck at it we would achieve a change. Trying to make maths fun was also a goal.

Question 6. What changes has your new knowledge brought about in your:
planning - *Planning has changed in the sense that we have got the new text now as well and a new syllabus so that gives us the skeleton of what we are working with. In writing maths tasks and the rubrics for an assignment that has changed hugely because we are now involving the children so it's not something that we do in the summer holidays, you might get an idea of what you want to do. But because it needs to be developed with the kids it is more difficult to plan ahead.*

assessing - *Assessing is the same sort of answer. Whereas once upon a time I didn't, I probably knew I should involve the children with their own assessment, but I didn't do it as much because of time factors. Also I think I was a bit paranoid about having to develop statistics to be able to back up any of the quantitative assessments, whereas now the school is taking a more open approach so I know it is ok to have discussions and it is ok to evaluate a student upon that – you don't have to back up everything as such. Having that freedom has allowed assessment to become far more flexible and naturally far more open ended and well balanced.*

recording and reporting - *I still have spread sheets. An example that comes up straight away - a student did a test for me and he didn't perform very well at all, then he answered orally. At lunch break I actually wrote a paragraph about how he went orally as he was fine; that was a different way of recording. You could use photos to record what they had done. I tend to have a check list with the portfolio.*

expectations **–** *My expectations of students haven't changed much.*

Question 7. As we enter the new teaching year, is there a target that you are aiming for in relation to the process maths portfolio? If so, what is it, and how do you plan on achieving it?
The planning part is a hard thing, I have felt the excitement and motivation in my class room has dropped since 2001 and I have been struggling with it. It has become very difficult, I am

not sure if it is a result of me, environment, the students or whatever. I am hoping that as I have worked with portfolios in the past I hope that will lift the students.

If not, what is it that has proven an obstacle to the change? What needs to happen to support you in creating a target?
Again it is the meshing between accountable and flexible. One of the things that concerns me is that it is ok now in order to assess; it is what happens if you leave and somebody else comes and says, 'That's a bucket of muck,' and 'Start all over again.'
There is a real need for equipment to back up what we are setting in place.
Thanks again for the chat ….. As always, I really found it enlightening.

Teacher D

Question 1. Where do you believe that you are in the process of change in relation to:
your personal philosophy about assessing teaching and learning in maths - *On a scale from 1 to 10, about a 4. I understand the philosophy about change but I am only at the middle part of developing a strategy to make this change successful.*

the classroom reality of planning and putting new concepts into practice - *Now I think I am a little bit ahead – I have a bit more knowledge on what to put in place for the kids and ideas. But I am still referencing and still searching for new ideas. I say on a 1 to 10 again maybe a 5. It was more I wouldn't have done it unless yourself or someone else had said give this a try and see what you think. Here are a few start up ideas. I think the whole concept came about by me being thrown into the deep end.* ***I now realise that it's better to give my students tasks that they see as worthwhile, in context if you like, having meaning. That way they see a point to the work and I get to assess them effectively. We all feel that the work is worth doing.***

sharing with and learning from others (teachers, parents and students) - *When we had our group sessions there were 5 or 6 of us I felt we would have one idea throw it on the table and people would talk about it. I actually did adapt ideas for myself, I didn't actually share them – I shared a couple but I picked on a few things extra I could do. So I actually enjoyed those group sessions for my own stimulation of lessons.*

professional skill development in the areas of task writing - *There are endless ideas, I just need to find the ideas that my particular class is interested in – I have no problems in developing the task. As long as I find something the boys will enjoy.*

rubric creation - *I probably couldn't do it without the website. However, the last three I had to make them up myself. I guess I am becoming more confident.*

involving students in task writing and rubric creation – *No, I haven't but it is down the track.*

revealing your own areas of strength and weakness - *My strength's perseverance. When I ask them to do something I will try and give them as much input and help as I can until I think the message is clear. The next time we do it I'll back off a little bit. The journal is strength and if someone wanted to build a task I could help them develop it and present it.*
Probably in the variation of the task, catering for the top end and the bottom end. That is what I have trouble with.

working collaboratively with colleagues - *Still trying to get people on target on what you think is going to work. It is hard to sell the idea at the beginning, I think once they see it – what is happening then they can only see it as a positive. We are still in the development stage of convincing others.*

Teacher E

Question 2. In relation to your students, how has the PD and spaced learning approach assisted you in:
gaining deeper insight into the ways children assimilate and apply newly learned material - *Social constructivism, we have fleshed this out. Amazingly in the last 12 months we have adopted it. The philosophy has - we have engaged students. It has been a passion of mine for*

some time - *how to engage students in their own learning. I have got a long way to go of course but it's I feel as though that my main focus really is providing opportunities rather than providing content learning. Everything we learn is connected to prior learning. We don't learn anything at all unless we can truly connect it. To begin with you think that is very limiting but you don't develop an understanding of it – you don't retain it unless it's connected to prior learning. You might learn it for awhile so all the things we have learnt in the past but we now can't remember the proper learning or the real learning are things we build on. That hasn't come about through the meeting with the group I don't think. We were all trying to work out what on earth we were doing and how it was going to go and how it was going to look – we needed to have a few goes at things that were going to be promoted and come back and say this is what I think I can really use to make a difference. There is no right or wrong bits. It's all very developmental and process based.*

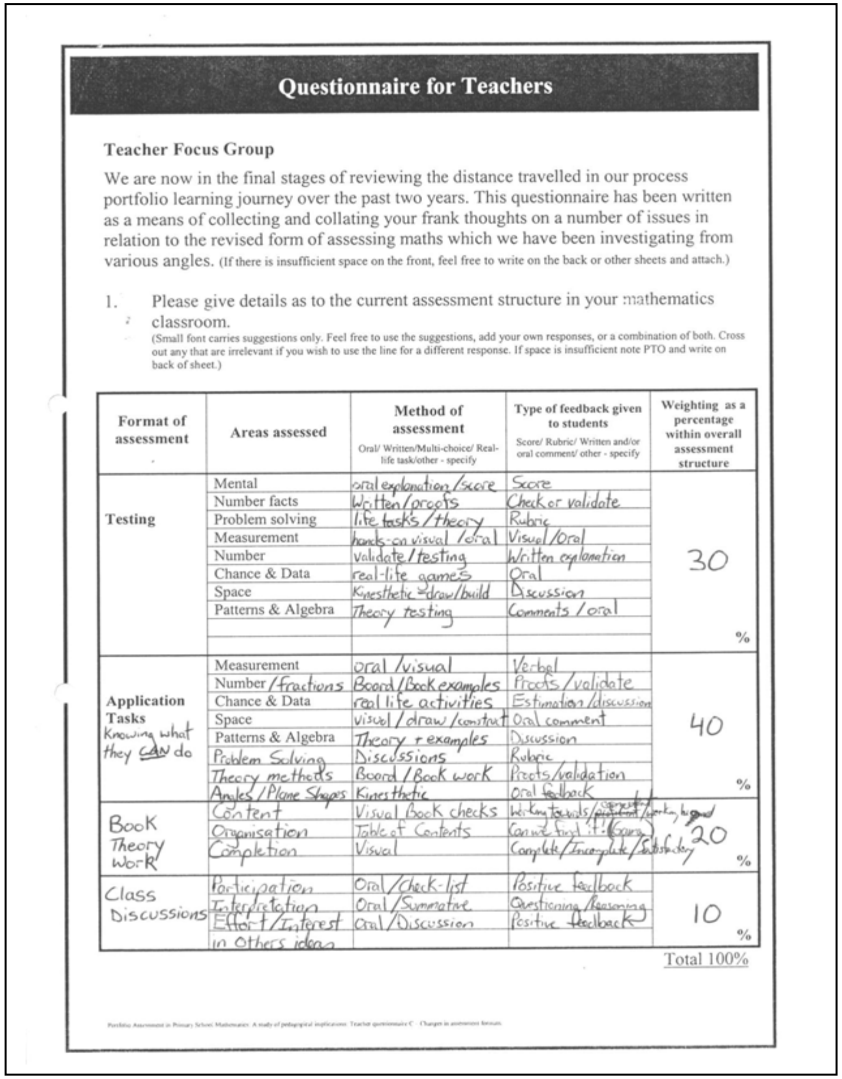
gaining greater insight into the ways children interpret and solve problems - *They need to interact.* ***I've found reflection gives me great insights into the learning experience. I think communication about the learning experience is based on reflection. Getting my students to be part of the reflection process has been very valuable for me and them.***

which aspects of maths that students see as useful and therefore worth learning and knowing - *With the journal we are seeing great connectedness. They see things as inter-related. It puts it into reality as opposed to a maths classroom. I see more reality in maths. I have been wondering for a while as to how to make it happen – we have English as the centre of the curriculum, it is a focal point – we focus a lot on the use of English in mathematics – you do that more as you work in this process. You find suddenly that mathematics pops up all amongst it.*

what types of problems children see as meaningful and on what they base those interpretations - *To begin they see the traditional type of problem as the maths problem and so we are just sort of starting to break the ice on creating tasks – the focus is shifting from having problems in maths – there might be aspects of the task that require problem solving but it is also a task that asks them to do other things than solve a problem.*

Appendix 20: Second Teacher Focus Group Questionnaire

Responses to Questions 2-6 Collated



Questionnaire for Teachers

Teacher Focus Group

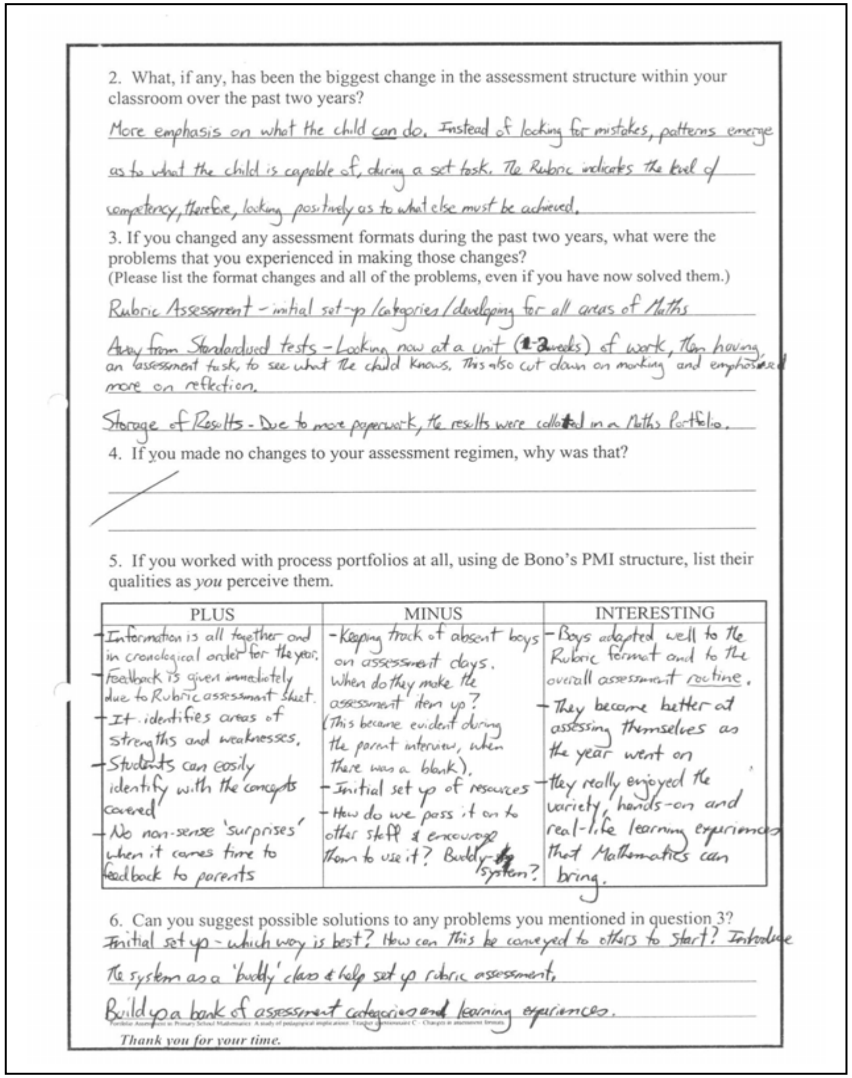
We are now in the final stages of reviewing the distance travelled in our process portfolio learning journey over the past two years. This questionnaire has been written as a means of collecting and collating your frank thoughts on a number of issues in relation to the revised form of assessing maths which we have been investigating from various angles. (If there is insufficient space on the front, feel free to write on the back or other sheets and attach.)

1. Please give details as to the current assessment structure in your mathematics classroom.
(Small font carries suggestions only. Feel free to use the suggestions, add your own responses, or a combination of both. Cross out any that are irrelevant if you wish to use the line for a different response. If space is insufficient note PTO and write on back of sheet.)

Format of assessment	Areas assessed	Method of assessment Oral/ Written/Multi-choice/ Real-life task/other - specify	Type of feedback given to students Score/ Rubric/ Written and/or oral comment/ other - specify	Weighting as a percentage within overall assessment structure
Testing	Mental	oral explanation/score	Score	30 %
	Number facts	Written/proofs	Check or validate	
	Problem solving	life tasks/theory	Rubric	
	Measurement	hands-on visual/oral	Visual/Oral	
	Number	validate/testing	Written explanation	
	Chance & Data	real-life games	Oral	
	Space	Kinesthetic - draw/build	Discussion	
	Patterns & Algebra	Theory testing	Comments/oral	
Application Tasks Knowing what they CAN do	Measurement	oral/visual	Verbal	40 %
	Number/fractions	Board/Book examples	Proofs/validate	
	Chance & Data	real life activities	Estimation/discussion	
	Space	visual/draw/construct	Oral comment	
	Patterns & Algebra	Theory + examples	Discussion	
	Problem Solving	Discussions	Rubric	
	Theory methods	Board/Book work	Proofs/validation	
	Angles/Plane Shapes	Kinesthetic	Oral feedback	
Book Theory Work	Content	Visual Book checks	Working towards/competent/working beyond	20 %
	Organisation	Table of Contents	Can we find it! (Game)	
	Completion	Visual	Complete/Incomplete/Satisfactory	
Class Discussions	Participation	Oral/Check-list	Positive feedback	10 %
	Interpretation	Oral/Summative	Questioning/Reasoning	
	Effort/Interest in Others ideas	Oral/Discussion	Positive feedback	

Total 100%

Portfolio Assessment in Primary School Mathematics: A study of pedagogical implications. Teacher questionnaire C – Changes in assessment formats.



2. What, if any, has been the biggest change in the assessment structure within your classroom over the past two years?

More emphasis on what the child can do. Instead of looking for mistakes, patterns emerge as to what the child is capable of, during a set task. The Rubric indicates the level of competency, therefore, looking positively as to what else must be achieved.

3. If you changed any assessment formats during the past two years, what were the problems that you experienced in making those changes?
(Please list the format changes and all of the problems, even if you have now solved them.)

Rubric Assessment - initial set-up/categories/developing for all areas of Maths

Away from Standardised tests - Looking now at a unit (1-2 weeks) of work, then having an assessment task, to see what the child knows. This also cut down on marking and emphasised more on reflection.

Storage of Results - Due to more paperwork, the results were collated in a Maths Portfolio.

4. If you made no changes to your assessment regimen, why was that?

5. If you worked with process portfolios at all, using de Bono's PMI structure, list their qualities as *you* perceive them.

PLUS	MINUS	INTERESTING
- Information is all together and in cronological order for the year. - Feedback is given immediately due to Rubric assessment sheet. - It identifies areas of strengths and weaknesses. - Students can easily identify with the concepts covered - No non-sense 'surprises' when it comes time to feedback to parents	- Keeping track of absent boys on assessment days. When do they make the assessment item up? (This became evident during the parent interview, when there was a blank). - Initial set up of resources - How do we pass it on to other staff & encourage them to use it? Buddy-system?	- Boys adapted well to the Rubric format and to the overall assessment routine. - They became better at assessing themselves as the year went on - they really enjoyed the variety, hands-on and real-life learning experiences that Mathematics can bring.

6. Can you suggest possible solutions to any problems you mentioned in question 3?

Initial set up - which way is best? How can this be conveyed to others to start? Introduce the system as a 'buddy' class & help set up rubric assessment.

Build up a bank of assessment categories and learning experiences.

Portfolio Assessment in Primary School Mathematics: A study of pedagogical implications. Teacher questionnaire C – Changes in assessment formats.

Thank you for your time.

2. *Biggest* change in assessment structure within classroom during study:

BB: attitude and perception; lack of need to get test back-up for assessments now; realises others have similar struggles between balance of accountability and real-life learning; authentic tasks now "carry more weight"

CC: only small changes overall - more multi-choice questions in tests; students set own goals.

DD: more emphasis on what child *can* do. Positive approach through rubric – not looking for mistakes

EE: improved process approach – building field of knowledge and applying to authentic problem solving tasks. Placing the rubric at the centre of learning; student participation in the assessment process

3. *Problems experienced* in making those assessment changes:

BB: biggest 'breakthrough' designing authentic activities to fit outcomes which then fit reports. Issues of double handling but Markbook will fix. Balance between accountability and real-life learning. Time efficiency – design of tasks and rubrics but now has format and "not recreating the wheel each time" Storage of portfolios, parent access.

CC: students have to read and analyse questions more as less easy algorithms provided; had to teach students not to guess looking for easy options – had to teach that answers needed to make mathematical sense

DD: setting up of rubric formats that were suitable for the range of mathematical activities. Leaving standardised tests and designing units of work leading to authentic summative tasks which encouraged reflection. Storage of results and products - portfolio

EE: creating authentic maths tasks; rubric design within an efficient time frame; "engaging cognitively at a deeper level of understanding" was a struggle at first "but the benefits outweigh the difficulty". Using the rubric effectively – designing rubrics specific enough to meet the needs of all learners and which would provide substantial information about the learning process, creating customised outcomes to provide clear indicators for students to use to guide their responses. Moving out of comfort zone – taking risks, learning from mistakes. Time to become efficient in rubric design…the teacher is forced into providing a detailed map of the learning pathway prior to beginning the learning sequence…no more 'fly by the seat of your pants'…rather, hello 'brain-strain'! until you develop personal proficiency and confidence in the approach, planning takes more time than traditional, instrumental approaches.

4. *Obstacles to making changes* to assessment structure:

BB: NA

CC: I thought the assessment regimen worked for the boys and myself – giving them feedback as well as class averages for the various tests. I know that developing real-life tasks and rubrics are not my main strength but working closely with someone to assist me in this area would be beneficial. I am prepared to change even though I consider myself to be a traditional teacher.

DD: NA

EE: NA

5. PMI as to process portfolios:

PLUS:

Inclusive, holistic, empowers everyone involved, creative and fosters excitement/engagement, open-minded, learning style friendly, student focussed, encourages communication, flexible, invokes sense of pride and accomplishment, data all together and sequential, rapid feedback through rubric, identifies student strengths and weaknesses, students identify with concepts covered, no 'surprises' for parents, can increase student understand of mathematics *and* the learning process, development of self esteem and self-awareness.

Students demonstrate: ownership of their work products; enjoyment in greater participation in assessment; increased understanding about the learning process they are engaged in; ***greater awareness of their capacities through opportunities to explore their own progress***; increased self-esteem through increased engagement; social constructivism – classroom climate becomes more interactive when using authentic practices.

MINUS:
Bulky…hard to store, time management, takes time to establish culture, needs recording in places other than portfolio in case of 'loss', problem with absentees 'catching-up', initial set-up of resources, how to pass it on to other staff, need to foresee the benefits "to provide the drive to work through changes to pedagogy", "change is often uncomfortable".
The process of change is developmental – takes time and effort from students and teachers; should be used in conjunction with other assessment practices to enable triangulation of data; despite the fact that you can use rubistar and you can find lots of problem-solving tasks to download from the net you still need to customise the authentic tasks and the rubrics to provide optimum learning experiences.

INTERESTING:
Great conversation pieces, students presenting like job interview, students adapted well to structure and routine, students developed their self-assessment skills, students enjoyed the hands-on and real-life learning experiences introduced, allows "a more interactive student-teacher working relationship", "providing opportunities for students to say how the learning is for them is invaluable feedback for teachers".
Parents enjoy reading their child's personal insights into their learning, particularly where comments by students are included on rubrics and reflective journal comments.
Students enjoy reading back over their assessments and reflections.
The process portfolio provides ***tangible evidence of the capacities of students at that point in time***…collectively the work artefacts provide substantial evidence about the students' skills/abilities ***in a wide range of areas other than just mathematics***.

6. *Possible solutions* to problems mentioned:

BB: Time. Suitable data base management system (Markbook). Encourage others to 'have a go' as can share without necessarily having to constantly ask others – "both time efficient and for some ego efficient." Need to have parents more involved through more regular sharing – look at e-portfolios so that parents can access, but if parents can access at home there will not be the student-teacher-parent interactions that are so beneficial and "I love that part of the whole process as the students get a great sense of accomplishment and pride. In turn it makes me feel validated and motivated."

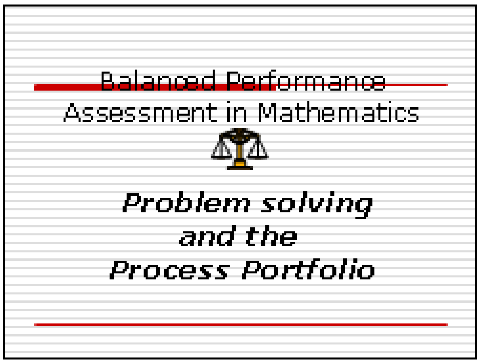
CC: Lots of reading and discussion on what has to be done. Students need to write things – use correct language.

DD: How can others be helped to start with initial set-up? Build bank of learning experiences and rubric structures. Use a buddy system.

EE: Offering tangible examples of improvement in learning outcomes for students will help with introduction to wider staff. The increased satisfaction experienced from working in authentic tasks for both students and teacher outweighs the problems associated with time and change. When you witness the increased engagement of student, their increased enthusiasm, the wide array of other skills needed in working through authentic tasks, the increased interaction in the classroom, you can see the learning experiences becoming more memorable for students.

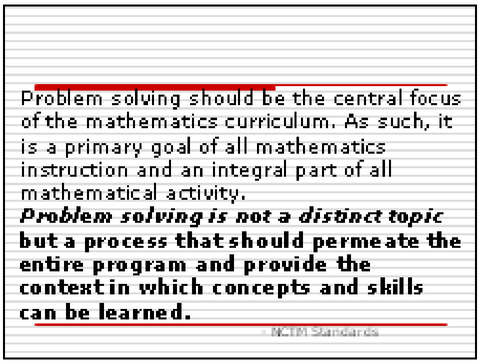
Appendix 21: Professional Development – Problem Solving and the Process Portfolio

(Excerpt - opening six slides)



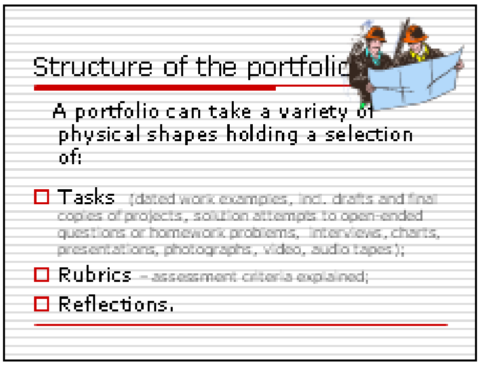
Balanced Performance Assessment in Mathematics

Problem solving and the Process Portfolio



Problem solving should be the central focus of the mathematics curriculum. As such, it is a primary goal of all mathematics instruction and an integral part of all mathematical activity.
Problem solving is not a distinct topic **but a process that should permeate the entire program and provide the context in which concepts and skills can be learned.**

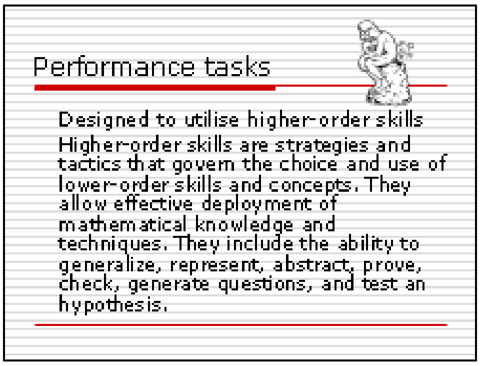
- NCTM Standards



Structure of the portfolio

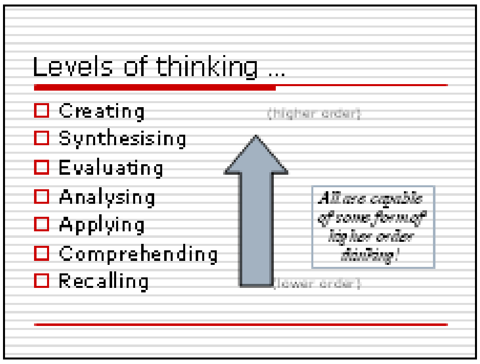
A portfolio can take a variety of physical shapes holding a selection of:

- ☐ Tasks (dated work examples, incl. drafts and final copies of projects, solution attempts to open-ended questions or homework problems, interviews, charts, presentations, photographs, video, audio tapes);
- ☐ Rubrics – assessment criteria explained;
- ☐ Reflections.



Performance tasks

Designed to utilise higher-order skills
Higher-order skills are strategies and tactics that govern the choice and use of lower-order skills and concepts. They allow effective deployment of mathematical knowledge and techniques. They include the ability to generalize, represent, abstract, prove, check, generate questions, and test an hypothesis.



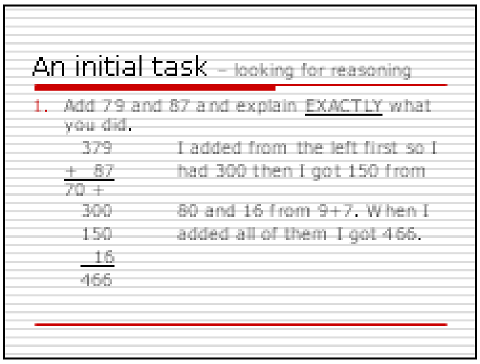
Levels of thinking …

- ☐ Creating
- ☐ Synthesising
- ☐ Evaluating
- ☐ Analysing
- ☐ Applying
- ☐ Comprehending
- ☐ Recalling

(higher order)

(lower order)

All are capable of some form of higher order thinking!



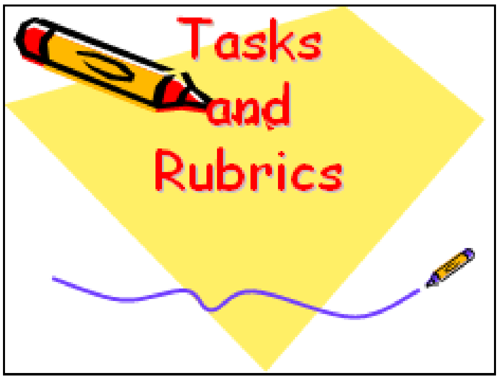
An initial task – looking for reasoning

1. Add 79 and 87 and explain EXACTLY what you did.

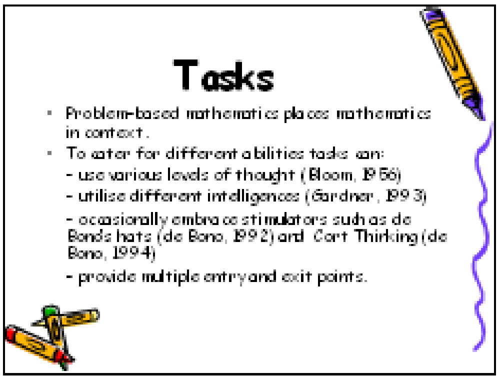
```
   379          I added from the left first so I
+   87          had 300 then I got 150 from
70 +
   300          80 and 16 from 9+7. When I
   150          added all of them I got 466.
    16
   466
```

Appendix 22: Professional Development – *Tasks and Rubrics*

(Excerpt -opening six slides)

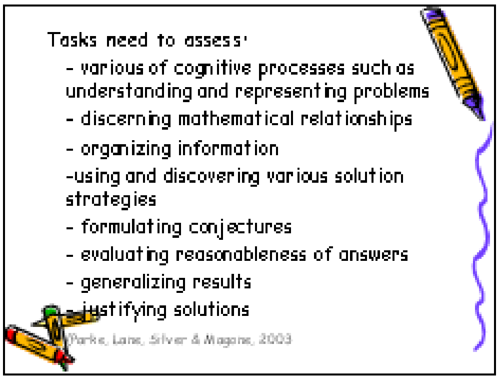


Tasks and Rubrics



Tasks

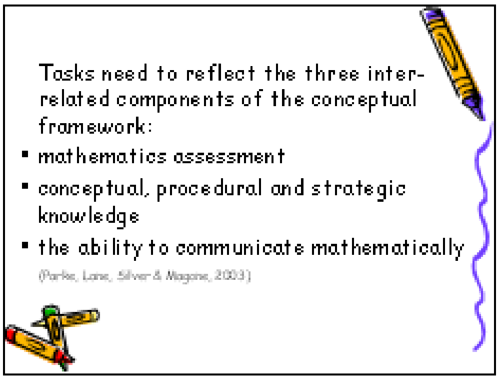
- Problem-based mathematics places mathematics in context.
- To cater for different abilities tasks can:
  - use various levels of thought (Bloom, 1956)
  - utilise different intelligences (Gardner, 1993)
  - occasionally embrace stimulators such as de Bonds hats (de Bono, 1992) and Cort Thinking (de Bono, 1994)
  - provide multiple entry and exit points.



Tasks need to assess:

- various of cognitive processes such as understanding and representing problems
- discerning mathematical relationships
- organizing information
- using and discovering various solution strategies
- formulating conjectures
- evaluating reasonableness of answers
- generalizing results
- justifying solutions

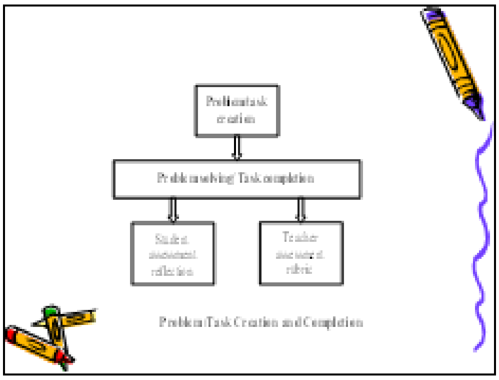
(Parke, Lane, Silver & Magone, 2003



Tasks need to reflect the three inter-related components of the conceptual framework:

- mathematics assessment
- conceptual, procedural and strategic knowledge
- the ability to communicate mathematically

(Parke, Lane, Silver & Magone, 2003)



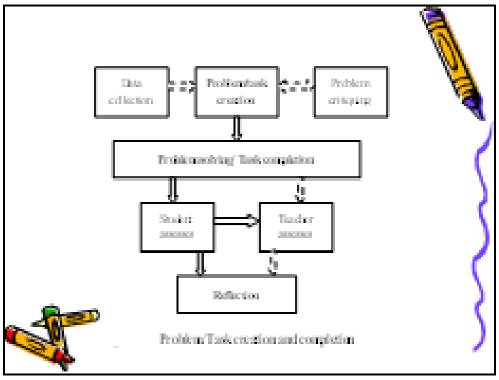
Problem/task creation

Problem solving/ Task completion

Student assessment reflection

Teacher assessment rubric

Problem/Task Creation and Completion



Data collection

Problem/task creation

Problem critiquing

Problem solving/ Task completion

Student assessment

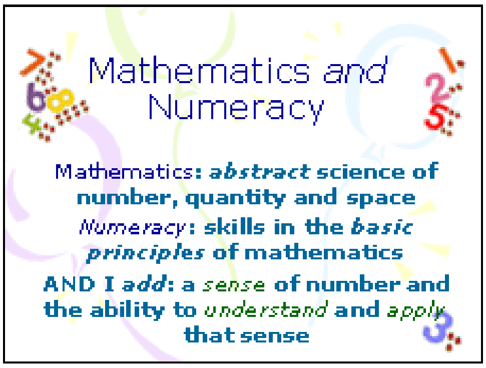
Teacher assessment

Reflection

Problem/Task creation and completion

Appendix 23: Professional Sharing – *Mathematics and Numeracy*

(Excerpt - opening six slides)

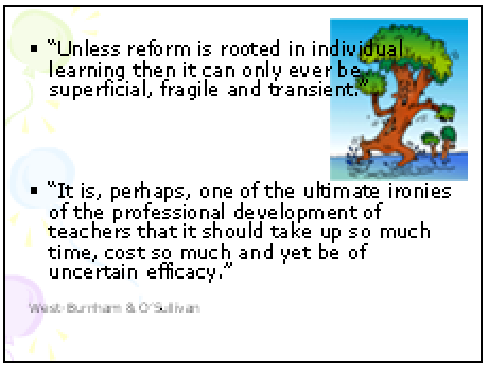


Mathematics and Numeracy

Mathematics: *abstract* science of number, quantity and space

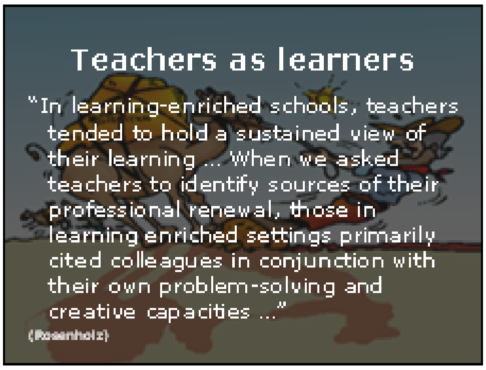
***Numeracy*: skills in the *basic principles* of mathematics**

AND I *add*: a *sense* of number and the ability to *understand* and *apply* that sense



- "Unless reform is rooted in individual learning then it can only ever be superficial, fragile and transient."
- "It is, perhaps, one of the ultimate ironies of the professional development of teachers that it should take up so much time, cost so much and yet be of uncertain efficacy."

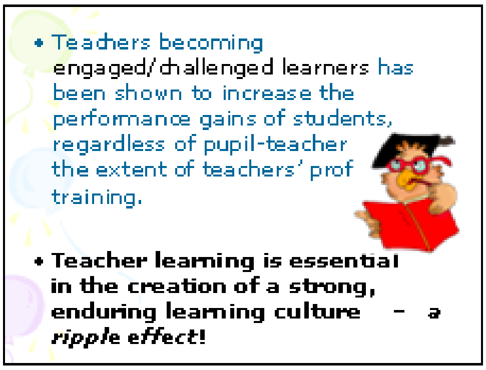
West-Burnham & O'Sullivan



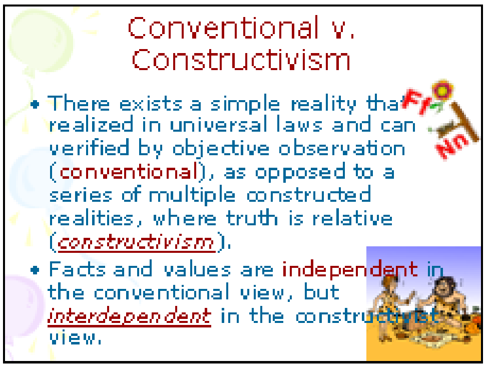
Teachers as learners

"In learning-enriched schools, teachers tended to hold a sustained view of their learning … When we asked teachers to identify sources of their professional renewal, those in learning enriched settings primarily cited colleagues in conjunction with their own problem-solving and creative capacities …"

(Rosenholz)

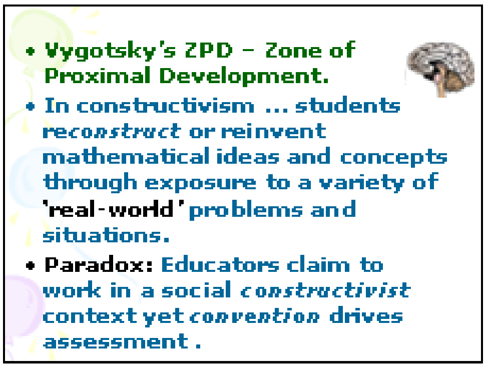


- Teachers becoming engaged/challenged learners has been shown to increase the performance gains of students, regardless of pupil-teacher the extent of teachers' prof training.
- **Teacher learning is essential in the creation of a strong, enduring learning culture – a *ripple effect*!**



Conventional v. Constructivism

- There exists a simple reality that realized in universal laws and can verified by objective observation (conventional), as opposed to a series of multiple constructed realities, where truth is relative (*constructivism*).
- Facts and values are independent in the conventional view, but *interdependent* in the constructivist view.



- **Vygotsky's ZPD – Zone of Proximal Development.**
- **In constructivism … students *reconstruct* or reinvent mathematical ideas and concepts through exposure to a variety of 'real-world' problems and situations.**
- **Paradox: Educators claim to work in a social *constructivist* context yet *convention* drives assessment .**

Appendix 24: Teacher Focus Group Meeting Journal - Further Extracts

Meeting date: **Tuesday 10 Feb 04** Time: 1105 -1140

Major topic/s for discussion: Getting started – some of the thinking involved
Gunningham *Thinking Allowed* discussed.

Summary
B: Personal journals – students wrote answers just how they reached their conclusions.
C: Hard job as they hadn't done it before.
TRW: Need to be taught how to record thought processes; some students don't like to write.
B: Kept in book separate to portfolio – no worries about margins, setting out, etc. Initially "like pulling teeth from a rhinoceros with a toothache." Yesterday, great lesson, not one child solved the problem, but when they worked together they came up with a solution, but after 30 minutes no child had touched a pencil. Lots of AHA! learning had happened.
Often difficult to get many mathematically able children to express themselves in written word form. Often the quieter working children come up with 'far better journals'.
D: What are examples of questions that you can be exploring? I have problems writing open-ended questions.
B: E.g. How can you divide 12 by 2 and get 7? (Ans: Write it in Roman numerals and cut in half horizontally.)
D: What about giving them an incorrect solution to a problem and asking them to find where the error has been made?
B: A lot of it is a different way of questioning – get in there and give it a go – get a lot out of it. It's the whole process thing. Well away from the days of rote. We don't know what they will need to know later in life. We are assisting them gain the processes needed to gain the skills that they will need when they need them.
TRW: That's the same as what is happening within the focus group as well.
C: Trying to change the whole way many children think about maths. Many are frightened of the unknown.
TRW: Children still believe that rote learning is an easy way, contrary to reality. (*Brain Compatible Classrooms* – Fogarty introduced and offered on loan)
B: Always had trouble 'teaching' fractions the conventional way. However, after lots of hands on exploration of the concept, project work recorded if necessary, not using conventional ways initially. When it came to recording the strange conventional '2/3' was simply accepted with little confusion. Even the student who understood relatively little in much of maths understood what a fraction is.
Examined the resource text supplied to group (*Thinking Allowed* – Sue Gunningham, 2003):
E: An excellent resource as it has a large proportion of relevant usable material, unlike many texts. Bloom's, MI, de Bono.
C: Great to help us get started.
E: As a result of some of her own reading and study last year began to look at early stages of process portfolio – "organized chaos" initially.
B: Enjoys working more in such situations, as there was more genuine two-way interaction and real learning on both sides.
C: Stop-start nature of school's timetable may tend to interfere with 'flow'.
B: Just leave it all there to continue upon return. Enthusiasm will grow so that they are dead keen to continue.
TRW: Possibility of large slabs of time devoted to maths only occasionally. But can integrate specialist lessons with consultation with specialist teachers.
B: Mathematics is the hardest subject to integrate into other areas. There is a danger that it could become pointless when integrated.
C: Maths every day can be part of Science, etc.
A: Spoke of example of problem with daughter previous night where he used MAB blocks to build object in question. Two solved together, and will return to it tonight in order to research other questions that have emerged since.

E: ***There are various interpretations of problems possible. I think they need to be taught to substantiate their interpretation, understanding and solution.***
C*: Children need to be taught that questioning anything in maths is acceptable, necessary for genuine understanding.*
A: Have to get away from the old thinking regarding timeframes in maths work.
Can I start with the puzzles that I have in my room?
B: You can start with anything. It doesn't matter what you start with as long we are starting the reasoning/supporting thinking and expression processes.
E: Questioning whether children completing a number of practice exercises are actually engaged participants in the teaching/learning process, or are they spectators.
B: Important for boys to learn through doing – the bottom line.
TRW: All reassured that we are not going to turn the whole maths learning process upside down in order to start the process of introducing portfolio work – starting with just problem solving with a view to enlarging if our work develops in the direction and such change is realistic and will provide benefits for the boys. We are looking to develop a genuine love of maths – to be seen through boys developing their own investigations to pursue.

Overall
Participants are becoming more vocal, expressing their views more readily, less apprehensive. The variations in experience with teaching using portfolios is becoming more noticeable with the more experienced, yet relatively young, member taking a leading role in discussions. Already participants are beginning to show less nervousness as to the complexity of what they will be undertaking within their classroom mathematics programs. In fact, it could be claimed that an appreciable professional excitement is growing. *This is the first stage of implementation – engaging in the process.*

Actions
All agreed to have a look at an early exercise using de Bono's 6 Thinking Hats as outline in Gunningham by next meeting. *(What will embed in practice, with whom and why?)*
Parents to be introduced to the process and the study by TRW within individual classrooms at Parent-Teacher Information Night (that night). Letters and consent forms to be distributed at those sessions.

Meeting date: **3 March 2005** Time: 1100-1145

Major topic/s for discussion: Real Life Maths Journals as a means of re-jigging the balance towards a more even approach – away from English as the hub of learning.

Kroll & Halaby: *Writing to learn mathematics in the primary school*
Capps & Pickreign: *Language Connections in Maths*
Albert & Antos: *Mathematics Teaching In The Middle School*
Vacca & Vacca: *Content area reading*
Scott, Williams & Hyslip: *Mathematics as communication*

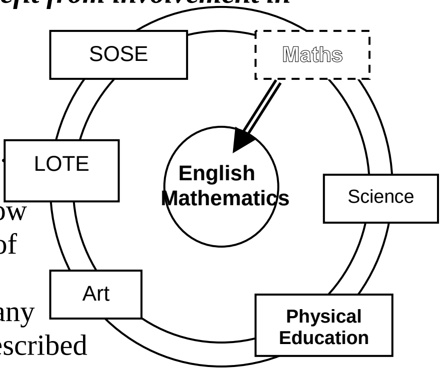
} Read by different members of the TFG

Summary
Introduced *Guide to Process Portfolios in Mathematics* to the group – for later consumption (next week draft to group members). Page on Real-life Journals to be written as yet.

Albert & Antos, Vacca & Vacca, and Scott, Williams & Hyslip discussed. All agreed that journals were basically a good idea – that students seemed to get a lot out of writing their thoughts down and sometimes sharing, at least in English. Whilst the readings indicated positive results, there was some discussion as to the level of learning that would take place in maths through writing journal entries, although noone denied that a great deal of learning seemed to be taking place through students writing reflections on their work in maths. Everyone said that they were already doing journals (English) – so they would try swinging their students over to maths as well.

B spoke of the language needed in order to do maths – *Writing to Learn Mathematics in the Primary School* by Kroll & Halaby. Maths has its own vocabulary which children needed to

become familiar with through use. E.g. ‘operation’ to a child meant a medical procedure, but not in maths.
Quote from B:
“Maths uses ordinary language in unusual ways. Writing is used successfully to develop English skills, so it could be useful in teaching mathematical vocabulary. “Students need to see mathematics as part of every aspect of their lives. They’d benefit from involvement in problem and task writing.”



Based loosely on the vocab discussion followed on moving maths in towards the centre of the learning wheel, away from the rim – English seen as the sole hub by most teachers – more integration.

D spoke of a need to change teachers’ and students’ minds as to how important maths really is. Discussion as to the closed perceptions of maths–related to closed timetables – lack of integration across the KLAs. Why closed? For the purpose of accountability, because many would teach English happily over the week, but give minimum prescribed time to maths.

Integrated activities? A need for teachers to genuinely integrate if students are to realise the all-pervasive nature of mathematics in their lives – **D**: “The journal will achieve that, I think.”
Moving to the journal focus – **E** talked of what is happening in class – focusing on maths part of it, but also bringing in lots of other aspects too – Monday afternoons to be devoted to exploration and investigation related to maths journals entries – students therefore getting a bit of both process and investigation with hands-on. **E**: “I can see it taking shape.”

Nature of entries in existing journals – tend to have follow the leader in style and presentation if exemplars are shared.
C: “Should they write questions?” “Can it be computer presented?”
D: “Why not, but it would be good if we could write questions together as a class from their entries, rather than have them do it. We could really get them thinking about the range of mathematical possibilities then.”
E: “So, what we want are simply entries that contain significant quantities of maths?”
B: “But all life entries contain maths anyway, don’t they? If you think about some of their English journal entries, I find there are lots of things in there that are mathematical, don’t you?” “What we need is an introduction for them to read to give them an idea, but not lead them as happens a bit in our journal writing now with sharing.”
E – Just move students to maths journal from their English-based journals, or keep both. “I think it would be best to have one substantial book for the class to use for maths for a start and keep the English journal going because they are comfortable with them.”
TRW to visit classes and discuss the concept and reality once the journals are ready to go. Share some ideas in order to illustrate the possibilities *without* directing and show how to offer mathematical possibilities without asking questions.
C- “If we send them home there will be a problem with parents assisting students to make the most impressive entry.

General opinion: Would like to have students make the entry in the classroom.

D – going to do an entry in their Maths Project book each Monday (weekly) as well as sharing the class journal on a rotation basis each day.
General agreement on that approach as it will fit easily into existing programs. Can increase the number of class journals and the frequency of students writing as deemed suitable in each class later.

Many different ideas as to journal’s use evolved amongst group – great to see!
Actions

- TRW to purchase ‘solid’ well bound books with plenty of pages
- Covers and title pages needed

- ☞ TRW to visit classrooms to introduce the concept with class teachers.
- ☞ Once sessions are underway teacher focus group to visit each others' classrooms to observe journal writing and sharing sessions – TRW to facilitate.
- ☞ Later, students to visit other focus group classes to share their entries – ensure variety in sharing so that stereotypical approaches are avoided if possible.

Meeting date: **17 May 2005** Time: 1100-1145

Major topic/s for discussion: Recent and current tasks
Rubrics – complex, language enriched

Summary

Only two, **D** & **E** could attend to discuss recent and current tasks with TRW.

D has implemented 3 assessment tasks in last 4 weeks. All are in the boys' portfolios. Tasks are set based on the week's topics/areas of concentration and bring in other aspects, thereby integrating many previously covered concepts. They are linked as closely as possible to journal entries made over the past few weeks.

D: Discrete facts are no longer taught as such are unearthed to a large extent during the task exploration. Children need to have facts and figures and ideas in context. ***Children solve problems best when they are presented in a context that they can relate to.***

E: "Did you come up with the task, then list skills to be taught?"

D: "No, I worked backwards from outcomes."

For example: 3D shapes topic – a boy had written a great entry on the different rides at a theme park – so, we looked at the shapes of the buildings and towers, etc.

Monday: had shapes in a bag for sensory experience, attribute description, kinaesthetics.

Wed: looked at skills and knowledge and characteristics through discussion.

Fri: moved into developing, critiquing and solving the problems and tasks

Need to get **E** & **D** to work together to help **E** – **D** help with her maths group by way of teaching/demonstrating the above routine

E having problems with parents thinking of discrete skills in discrete subjects as being all-important – grouping across classes hindering class tasks moving across wider areas of subjects and across subjects – class structure proving a problem in Year 5

D to lead **E** in guiding **E** in development of frequent and regular use of the above structures

Rubrics: **D** gave task first, followed by rubric for one term. Now gives task and rubric concurrently (Zull). Rubrics now always language-rich. Students involved in writing some tasks and some rubrics. Has found that it increases the 'ownership factor' – students really get involved in the entire process.

D sees portfolio pieces as 'mini-tests' in some ways – part of the overall programme. *(Still thinking in terms of 'tests' though!)*

D's next step is to add reporting outcomes to bottom of the rubric – leading to distillation of the rubric down to a reporting result for use in semester report – easily transferred to reporting rubric – in line with eventual goal (as explained in *Process Portfolios in Mathematics: A Guide*.)

E: "The double rubric has really changed this teacher's thinking regarding what students can and can't do and how you give them formative feedback."

Meeting date: **31 May 2005** Time: 1100-1145

Major topic/s for discussion: The Class Real-life Journal and critiques

Summary

B, **C**, **D** and **E** attended which was great as it was report preparation time and all were very busy. Asked each to summarise the use of the journal and the critique in their classroom. Levels of use varied a little across the four classes from heavy to infrequent. All liked what the journal concept did as far as generating student enthusiasm to share their stories of everyday occurrences that somehow everybody could find mathematics within.

B: Students ‘lined up’ for a chance to take the book and write. I was just treated as another bit of mathematics in the classroom. No special times or tasks were set aside for it. Most took it home overnight. While there had been a few who had written problems at first, most now simply wrote about something that had happened to them in the everyday pattern of things as they are gaining a real awareness of how much maths is ‘out there’. Direct parental influence appears to be negligible. Students do say that some parents are interested in what they are doing and why, with some having read other students’ entries.

C: Still having trouble fitting in the ‘extras’ but getting there with a bit of help and guidance from other members of TFG. Students do like the journal but **C** does forget about it a bit. Will try to increase its level of use over coming months. **B** offered to help more with its integration.

B: Had a lot of fun writing problems from entries. Students needed quite a bit of guidance at first as to how to examine peer problems and comment on the structure and content. Learning from each other proforma has proven really useful and persistence has paid off. Students are now offering each other terrific constructive criticism.

E: Older students are writing a lot about cars as that seems to be a common interest at present. Lots of talk of horsepower and kilowatts. Some have written and solved problems but others have left the maths to the class later. Students enjoy sharing their entries. Some who **E** would never have thought would do so have been very keen to make entries. The book is available at any time in the classroom and some like to take it every so often for a while and continue an entry that they have started. Some entries are pictorial ‘mind maps’ at first and slowly have the language part added over a couple of weeks. The critiquing has gone well. “It didn’t take them long to pick it up as the form really led them through it and the class has been doing peer proof reading in English for a while now.” **E** talked of the types of writing going on in the maths journal as having some effect upon the writing in the class’s English journals, something which **E** had never considered before as English always seemed to come first in such influences.

D. Now into much more student-generated material using journal as a basis and unwritten student ideas at other times. Students are getting pretty good at having interesting ideas related to current topics too! They are also getting good at offering constructive criticism verbally in class discussions as tasks and rubrics are developed. Gone fishin’ idea came from a student’s journal entry and proved to be a huge task and a huge winner with students. The critique has been used a lot and students like it because it’s structured but allows them some freedom in what they say and how they say it to other students. Now getting to the stage where students are generating far more material than can be fully utilised, so **D** has to cut and cull according to needs and interests**. “**Certainly ***a great way to keep them involved and feeling like they own the maths!*”** Students are now getting a lot better at spotting key words in problems written by others.

B: Has used the journal in all sorts of ways – as in the model that was developed earlier – has taken lots of ‘shortcuts’ across the model so that students see different ways of doing things and different levels of tasks available. “It’s not an extra. My students and I just see it as an integrated part of the whole program now.” Agreed that many students were much more able to pick out key words, as well as see what’s missing from incomplete problems.

E: Has shared concept with others outside the teacher focus group and seen some take it up – which is great! The critique has also been used by one of the other teachers with good effect too. “Other people are using elements of the portfolio now” – so there’s wider sharing going on than there was in the early stages. “People are wanting to try new ideas.”

D: Really can see the whole portfolio package coming together really well now. “There’s so much flexibility in what we’ve developed, something for everybody, I’d think.” “I’ve certainly seen a big difference in this year’s class after the early introduction of the portfolio.” “I was a bit slow last year, what with introducing bits and pieces, but much better this year.”

Overall

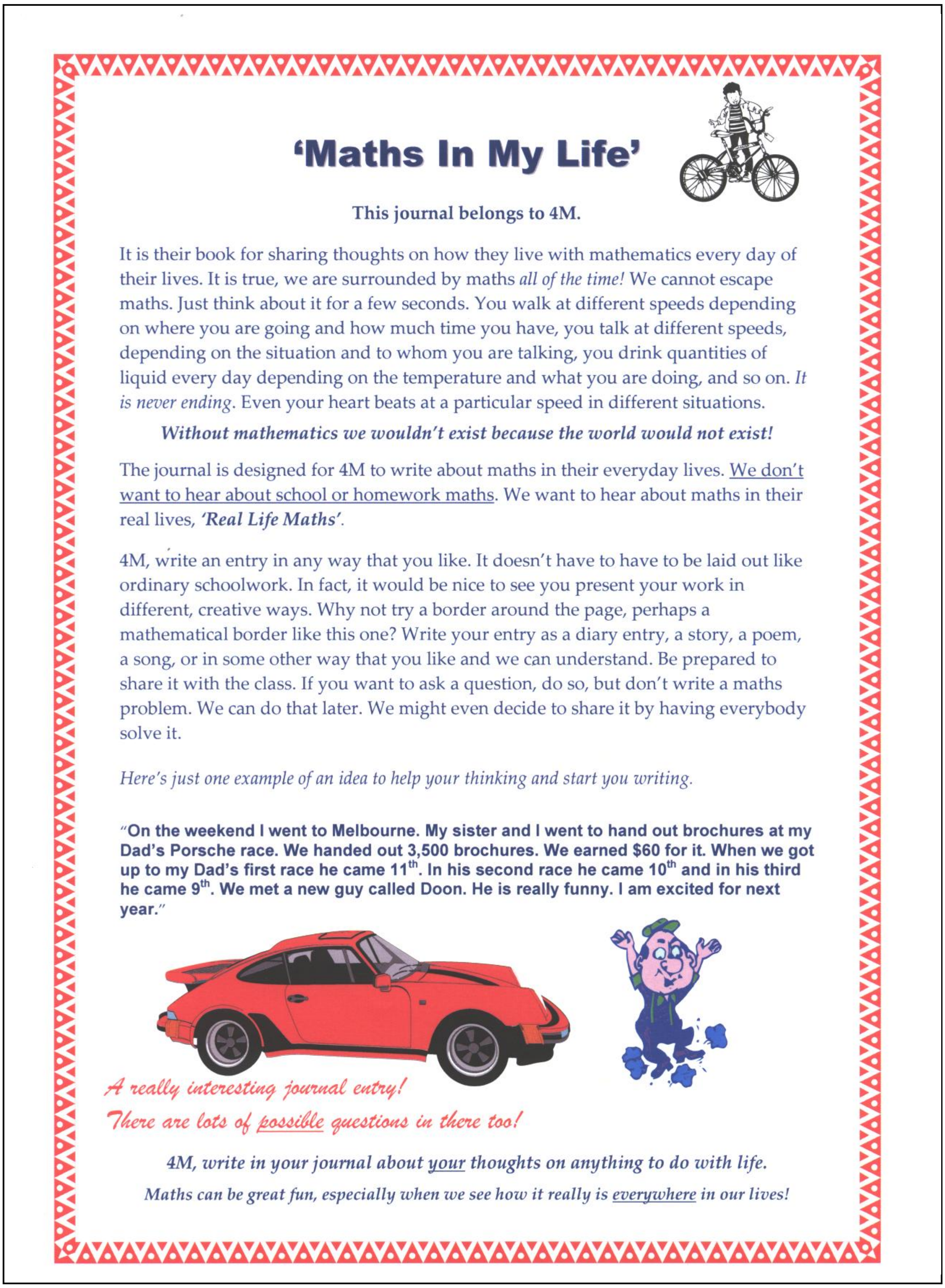
The real-life journal has had a positive effect on a number of aspects from data generation to collection, through problem writing and critiquing by students. Teachers are keen to extend the use of the journal ideas. It may well see the extension of the uses and purposes of the journal in English and that would be ironic.

Appendix 25: Student Interview Transcript (Example)

Student 4A
Thanks for doing such a great job with the maths questionnaire that we had you fill in a few weeks ago. Your answers were very interesting and I'd just like to ask you some more about what you think about maths. We'll only be a few minutes.
***DAMT**:* Thanks for doing such an interesting drawing of a mathematician. I'd like to ask you a couple of questions about your mathematician, if I could. What is the spiral purple ladder?
A staircase.
Where that does lead?
To his office upstairs.
Why did you draw a spiral staircase?
I am not sure.
Tell me a bit more about the mathematician?
He is on his computer doing maths.
So that's what a mathematician does?
Yes
QUESTIONNAIRE:
***Q1**:* What do you mean when you say, "He says if it isn't perfect he makes you do it again"?
You just have to be perfect, all the work you give to him.
Mr ___ wants it perfect…do you think that is ok?
Yes it's a good idea.
You said you would like to use more plastic money? Do you prefer other equipment for maths?
Yes
What sort of equipment?
Paddle pop sticks and things like that and MAB.
What sorts of things would you like to see the teacher write on the board for you?
Sometimes the explanation.
You talked about being educated in your questionnaire – what do you think educated means?
Learning things.
How do you connect that to money?
I am not sure
How do you do maths on your laptop?
My Dad and myself do tables on my laptop and write questions.
So you have got tables on your laptop?
No, the table table.
So what else do you do with your laptop?
I play games and I like doing creative things.
How do you use maths on the phone/Lego set?
Do you count blocks?
Yes, you need 12 or 14 or 40 to make something.
So you are going to be a lawyer?
Yes
How do you use it when you are a lawyer?
If you can use maths you can get lots of jobs by…..you need to calculate things.
You said you like learning maths?
Yes, it's fun.
What sort of challenge does it give you?
I have to figure out the answers.
You say you ask for help from a friend or Mum and
Yes.
Do you ask for help from the teacher?
Yes, sometimes.
Do you often save things up to ask at home?
Yes

Why?
Then if I don't know something my teacher asks, I ask my parents.
Do Mum and Dad both
Yes.
How do they use maths?
When they work
What do they do?
I don't know. Maybe they use it for their bank account.
You say you find maths easy most of the time? Would it be good if it were a bit harder?
Yes.
What if the numbers were bigger?
No, the numbers don't really matter.
So bigger numbers don't necessarily mean more difficult.
No
What does?
Division, long division.
So additions and subtractions no problem. So divisions are the problem?
Yes.
***Q3**:* You wrote about using money. Are there any other ways that you think you might use maths after you leave school? For example, do you think that you might use it in your job? If so, how might that be?
I might have to use it to work things out, like money, and time and how long things are if I'm making something.
***Q5*:** Why do you just love maths?
I just love to work out stuff.
How does it help your brain?
I am not sure.
***Q8 & 9**:* You said that Mum and Dad both like maths. What do they use maths for?
At their work
How did you work out that they like maths?
They always help me if I ask.
Do you think that having family like or dislike maths affects your feelings about maths?
No
***Q11**:* How would you feel if you were given problems that had several possible answers?
Ok it might be easier.
Would you like to have a chance to find a couple of answers to some questions?
Yes
What sorts of things do you try when you are given maths problems to solve?
I read it and think about it.
What do you think about the words that are used in problems?
What do you mean?
Do you have trouble with any of them?
Not usually, but some of the others near me do sometimes.
Why do you think they do?
Some of the words are a bit tricky because they can mean a couple of different things. You need to get used to that.
Can you think of some examples of those sorts of double-meaning words?
Err, no, not just now.
Do you think that you are a good problem solver?
Yes –OK.
Why is that?
I usually find a way to get an answer that's OK.
Thanks for your help.
That's OK

Appendix 26: Real-life Mathematics Journal Introduction



‘Maths In My Life’

This journal belongs to 4M.

It is their book for sharing thoughts on how they live with mathematics every day of their lives. It is true, we are surrounded by maths *all of the time!* We cannot escape maths. Just think about it for a few seconds. You walk at different speeds depending on where you are going and how much time you have, you talk at different speeds, depending on the situation and to whom you are talking, you drink quantities of liquid every day depending on the temperature and what you are doing, and so on. *It is never ending*. Even your heart beats at a particular speed in different situations.

Without mathematics we wouldn’t exist because the world would not exist!

The journal is designed for 4M to write about maths in their everyday lives. We don’t want to hear about school or homework maths. We want to hear about maths in their real lives, ***‘Real Life Maths’***.

4M, write an entry in any way that you like. It doesn’t have to have to be laid out like ordinary schoolwork. In fact, it would be nice to see you present your work in different, creative ways. Why not try a border around the page, perhaps a mathematical border like this one? Write your entry as a diary entry, a story, a poem, a song, or in some other way that you like and we can understand. Be prepared to share it with the class. If you want to ask a question, do so, but don’t write a maths problem. We can do that later. We might even decide to share it by having everybody solve it.

Here’s just one example of an idea to help your thinking and start you writing.

“On the weekend I went to Melbourne. My sister and I went to hand out brochures at my Dad’s Porsche race. We handed out 3,500 brochures. We earned $60 for it. When we got up to my Dad’s first race he came 11th. In his second race he came 10th and in his third he came 9th. We met a new guy called Doon. He is really funny. I am excited for next year.”

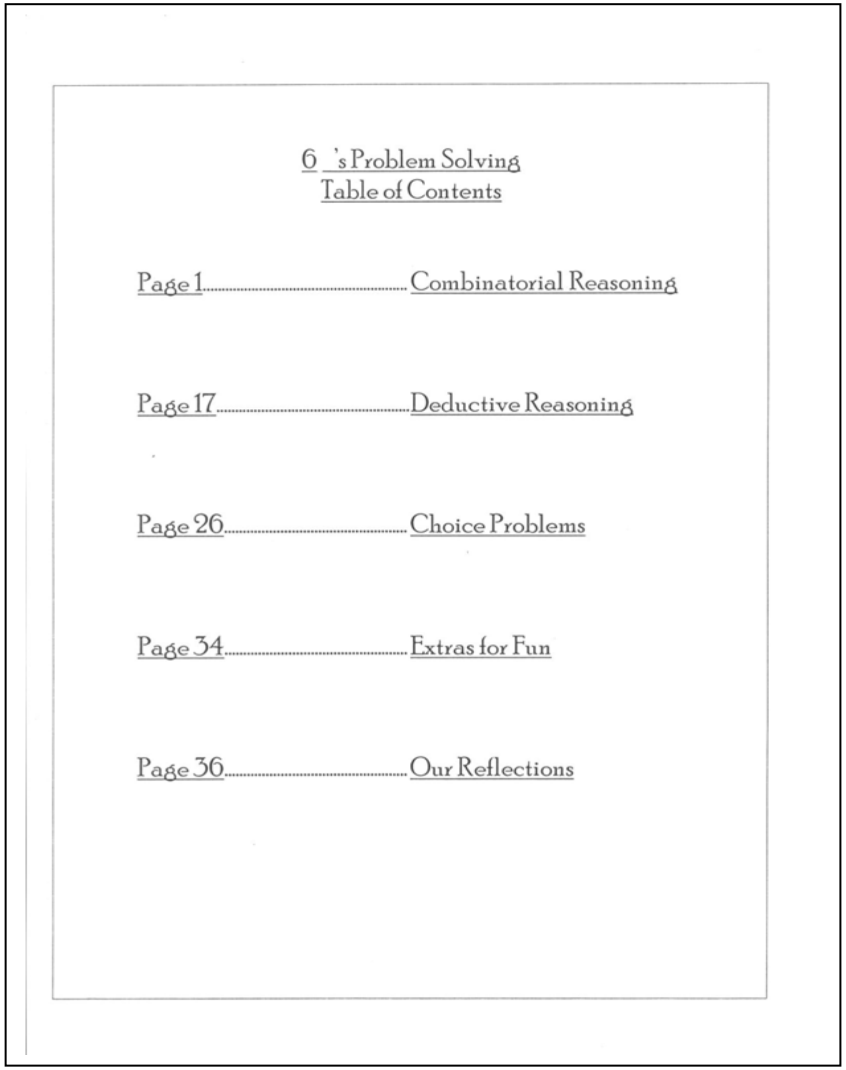
A really interesting journal entry!

There are lots of possible questions in there too!

4M, write in your journal about your thoughts on anything to do with life.

Maths can be great fun, especially when we see how it really is everywhere in our lives!

Appendix 27: Year 6 Problem Book Extracts



6 's Problem Solving
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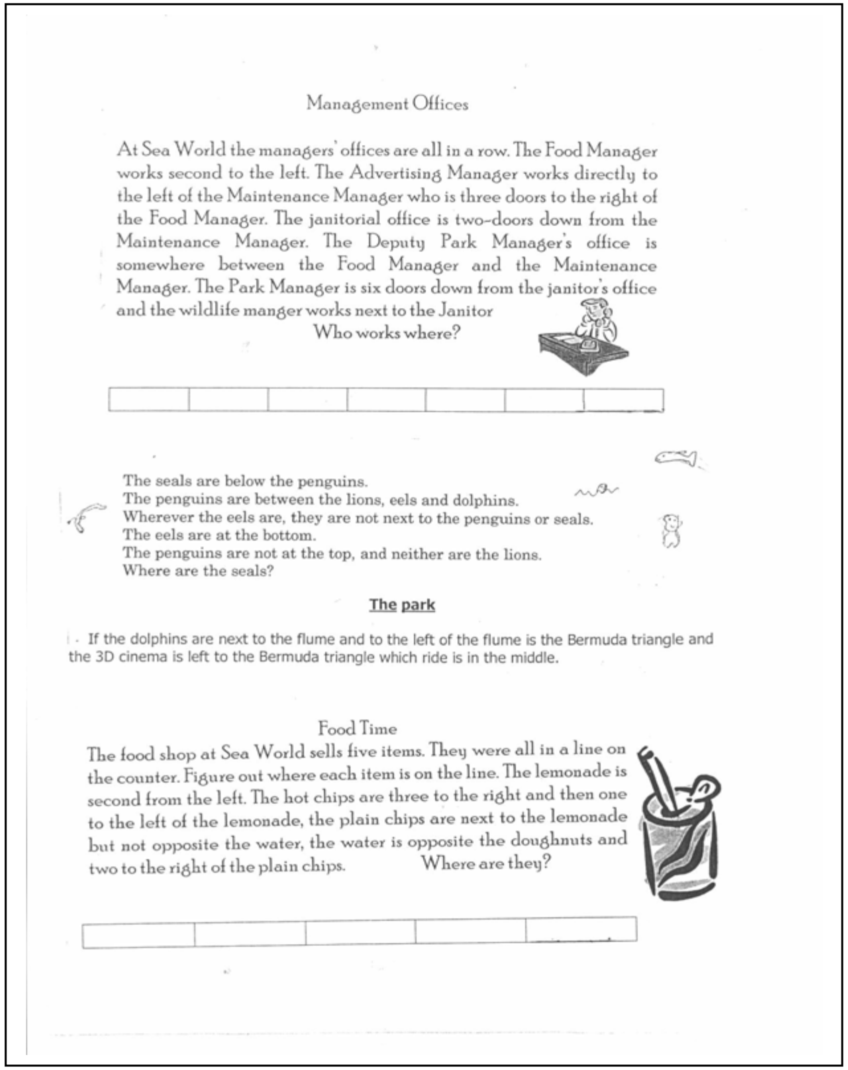


Management Offices

At Sea World the managers' offices are all in a row. The Food Manager works second to the left. The Advertising Manager works directly to the left of the Maintenance Manager who is three doors to the right of the Food Manager. The janitorial office is two-doors down from the Maintenance Manager. The Deputy Park Manager's office is somewhere between the Food Manager and the Maintenance Manager. The Park Manager is six doors down from the janitor's office and the wildlife manger works next to the Janitor

Who works where?

The seals are below the penguins.
The penguins are between the lions, eels and dolphins.
Wherever the eels are, they are not next to the penguins or seals.
The eels are at the bottom.
The penguins are not at the top, and neither are the lions.
Where are the seals?

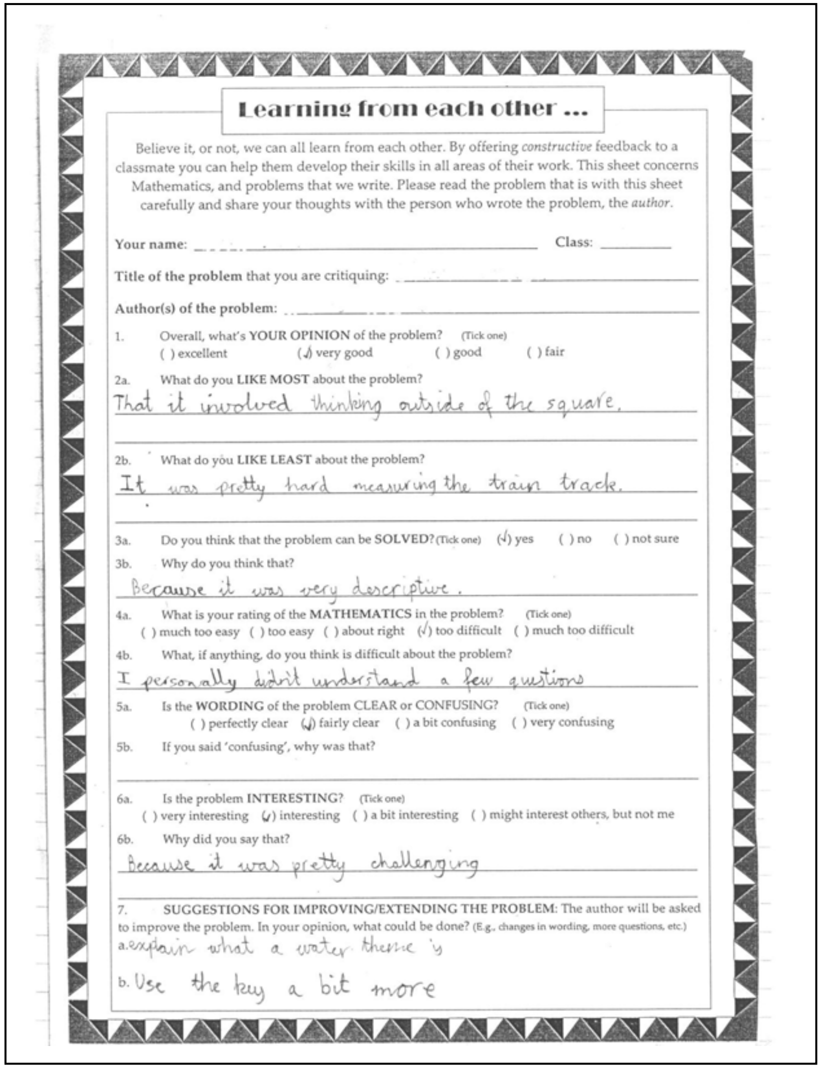
The park

If the dolphins are next to the flume and to the left of the flume is the Bermuda triangle and the 3D cinema is left to the Bermuda triangle which ride is in the middle.

Food Time

The food shop at Sea World sells five items. They were all in a line on the counter. Figure out where each item is on the line. The lemonade is second from the left. The hot chips are three to the right and then one to the left of the lemonade, the plain chips are next to the lemonade but not opposite the water, the water is opposite the doughnuts and two to the right of the plain chips. Where are they?

Appendix 28: *Learning From Each Other* - Peer Critiques of Problems



Learning from each other ...

Believe it, or not, we can all learn from each other. By offering *constructive* feedback to a classmate you can help them develop their skills in all areas of their work. This sheet concerns Mathematics, and problems that we write. Please read the problem that is with this sheet carefully and share your thoughts with the person who wrote the problem, the *author*.

Your name: ______ **Class:** ______

Title of the problem that you are critiquing: ______

Author(s) of the problem: ______

1. Overall, what's **YOUR OPINION** of the problem? (Tick one)
( ) excellent (✓) very good ( ) good ( ) fair

2a. What do you **LIKE MOST** about the problem?
That it involved thinking outside of the square.

2b. What do you **LIKE LEAST** about the problem?
It was pretty hard measuring the train track.

3a. Do you think that the problem can be **SOLVED**? (Tick one) (✓) yes ( ) no ( ) not sure

3b. Why do you think that?
Because it was very descriptive.

4a. What is your rating of the **MATHEMATICS** in the problem? (Tick one)
( ) much too easy ( ) too easy ( ) about right (✓) too difficult ( ) much too difficult

4b. What, if anything, do you think is difficult about the problem?
I personally didn't understand a few questions

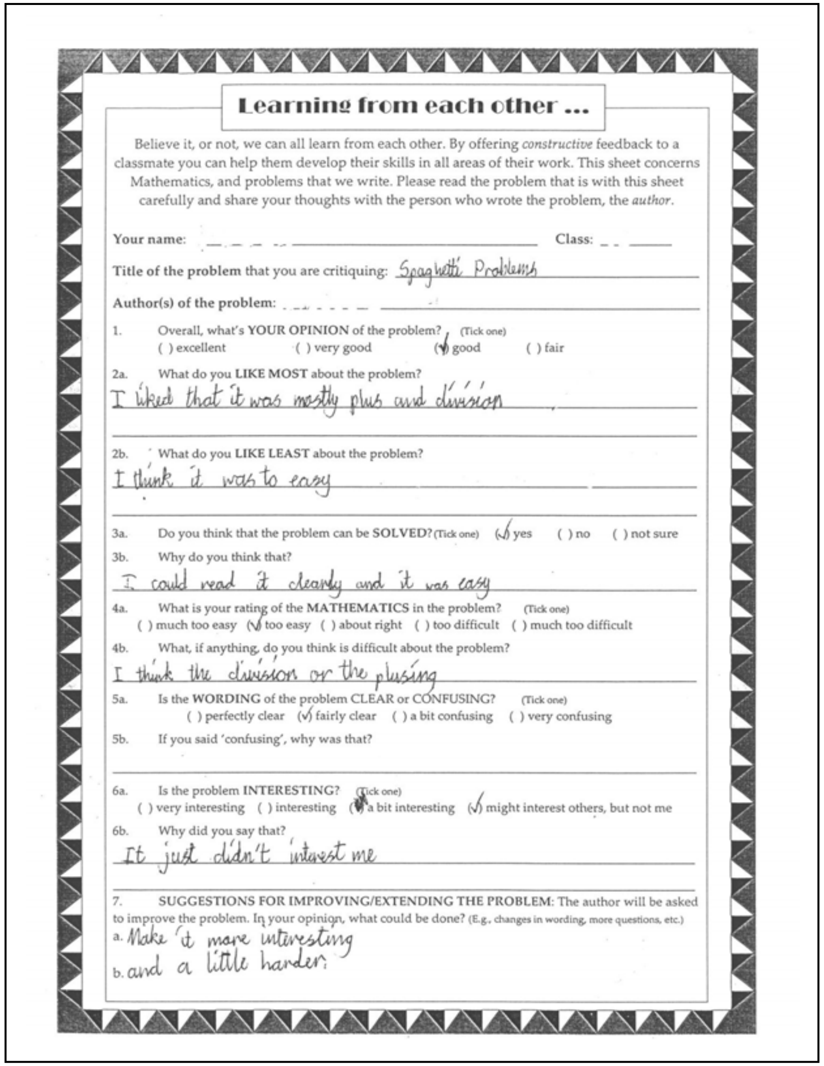
5a. Is the **WORDING** of the problem CLEAR or CONFUSING? (Tick one)
( ) perfectly clear (✓) fairly clear ( ) a bit confusing ( ) very confusing

5b. If you said 'confusing', why was that?

6a. Is the problem **INTERESTING**? (Tick one)
( ) very interesting (✓) interesting ( ) a bit interesting ( ) might interest others, but not me

6b. Why did you say that?
Because it was pretty challenging

7. **SUGGESTIONS FOR IMPROVING/EXTENDING THE PROBLEM:** The author will be asked to improve the problem. In your opinion, what could be done? (E.g., changes in wording, more questions, etc.)
a. explain what a water theme is
b. Use the key a bit more



Learning from each other ...

Believe it, or not, we can all learn from each other. By offering *constructive* feedback to a classmate you can help them develop their skills in all areas of their work. This sheet concerns Mathematics, and problems that we write. Please read the problem that is with this sheet carefully and share your thoughts with the person who wrote the problem, the *author*.

Your name: ______ **Class:** ______

Title of the problem that you are critiquing: Spaghetti Problems

Author(s) of the problem: ______

1. Overall, what's **YOUR OPINION** of the problem? (Tick one)
( ) excellent ( ) very good (✓) good ( ) fair

2a. What do you **LIKE MOST** about the problem?
I liked that it was mostly plus and division

2b. What do you **LIKE LEAST** about the problem?
I think it was to easy

3a. Do you think that the problem can be **SOLVED**? (Tick one) (✓) yes ( ) no ( ) not sure

3b. Why do you think that?
I could read it clearly and it was easy

4a. What is your rating of the **MATHEMATICS** in the problem? (Tick one)
( ) much too easy (✓) too easy ( ) about right ( ) too difficult ( ) much too difficult

4b. What, if anything, do you think is difficult about the problem?
I think the division or the plusing

5a. Is the **WORDING** of the problem CLEAR or CONFUSING? (Tick one)
( ) perfectly clear (✓) fairly clear ( ) a bit confusing ( ) very confusing

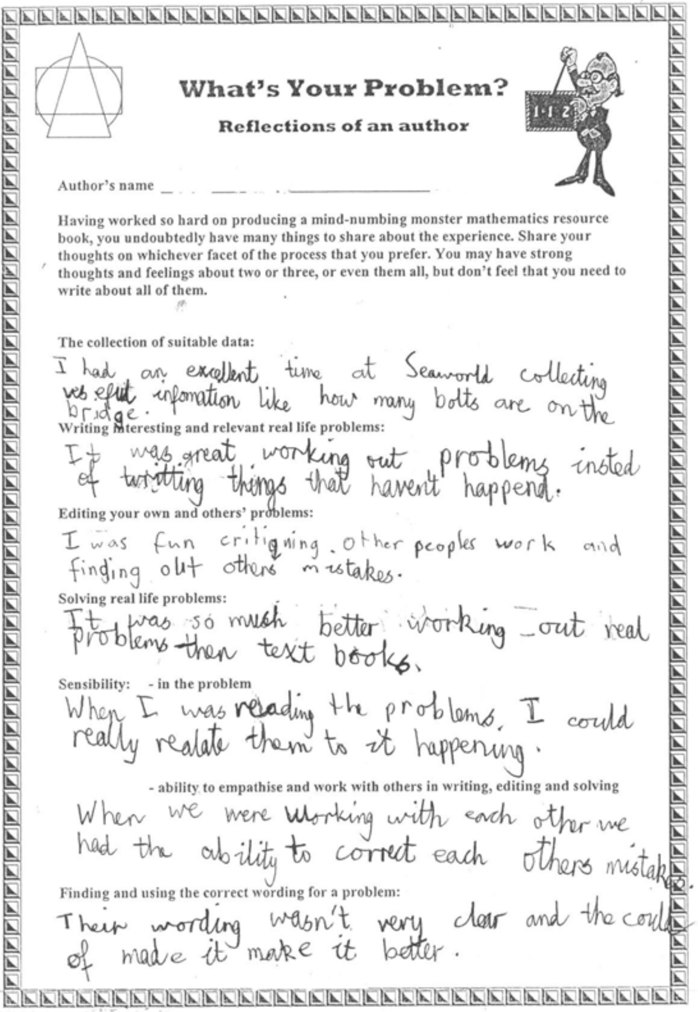
5b. If you said 'confusing', why was that?

6a. Is the problem **INTERESTING**? (Tick one)
( ) very interesting ( ) interesting (~~✓~~) a bit interesting (✓) might interest others, but not me

6b. Why did you say that?
It just didn't interest me

7. **SUGGESTIONS FOR IMPROVING/EXTENDING THE PROBLEM:** The author will be asked to improve the problem. In your opinion, what could be done? (E.g., changes in wording, more questions, etc.)
a. Make it more interesting
b. and a little harder.

Appendix 29: *What's Your Problem?* – Peer Critiques of Problems



What's Your Problem?

Reflections of an author

Author's name ______

Having worked so hard on producing a mind-numbing monster mathematics resource book, you undoubtedly have many things to share about the experience. Share your thoughts on whichever facet of the process that you prefer. You may have strong thoughts and feelings about two or three, or even them all, but don't feel that you need to write about all of them.

The collection of suitable data:
I had an excellent time at Seaworld collecting useful infomation like how many bolts are on the bridge.

Writing interesting and relevant real life problems:
It was great working out problems insted of writting things that haven't happend.

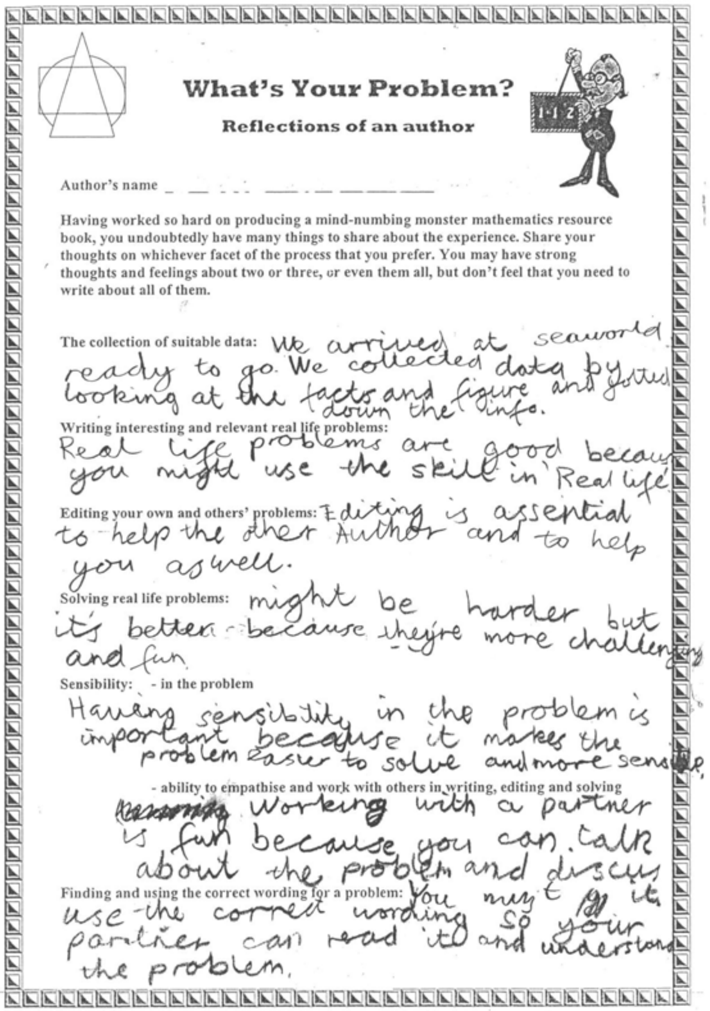
Editing your own and others' problems:
I was fun critiqning other peoples work and finding out others mistakes.

Solving real life problems:
It was so mush better working out real problems then text books.

Sensibility: - in the problem
When I was reading the problems, I could really realate them to it happening.

- ability to empathise and work with others in writing, editing and solving
When we were Working with each other we had the ability to correct each others mistakes.

Finding and using the correct wording for a problem:
Their wording wasn't very clear and the could of made it make it better.



What's Your Problem?

Reflections of an author

Author's name ______

Having worked so hard on producing a mind-numbing monster mathematics resource book, you undoubtedly have many things to share about the experience. Share your thoughts on whichever facet of the process that you prefer. You may have strong thoughts and feelings about two or three, or even them all, but don't feel that you need to write about all of them.

The collection of suitable data: We arrived at seaworld ready to go. We collected data by looking at the facts and figure and jotted down the info.

Writing interesting and relevant real life problems:
Real life problems are good because you might use the skill in Real life.

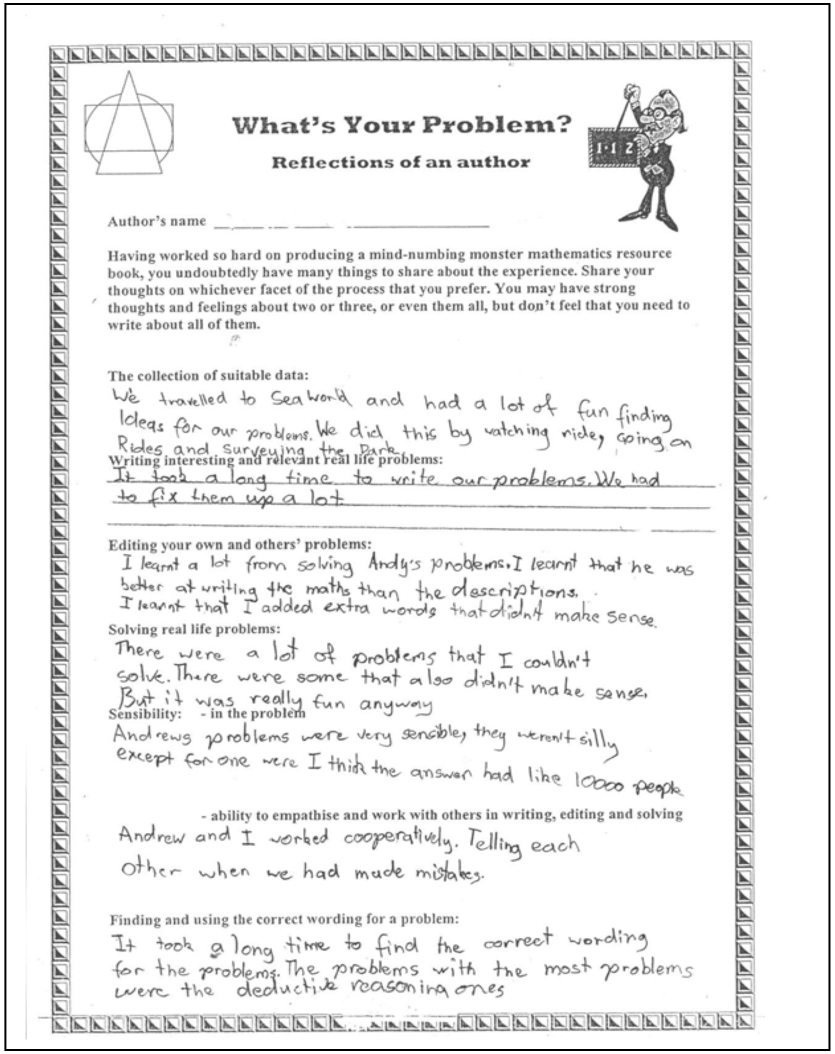
Editing your own and others' problems: Editing is assential to help the other Author and to help you aswell.

Solving real life problems: might be harder but it's better because theyre more challenging and fun.

Sensibility: - in the problem
Having sensibility in the problem is important because it makes the problem easier to solve and more sensible.

- ability to empathise and work with others in writing, editing and solving
Working with a partner is fun because you can talk about the problem and discuss

Finding and using the correct wording for a problem: You must [illegible] it use the correct wording so your partner can read it and understand the problem.



What's Your Problem?

Reflections of an author

Author's name ______

Having worked so hard on producing a mind-numbing monster mathematics resource book, you undoubtedly have many things to share about the experience. Share your thoughts on whichever facet of the process that you prefer. You may have strong thoughts and feelings about two or three, or even them all, but don't feel that you need to write about all of them.

The collection of suitable data:
We travelled to Sea World and had a lot of fun finding Ideas for our problems. We did this by watching ride, going on Rides and surveying the Park.

Writing interesting and relevant real life problems:
It took a long time to write our problems. We had to fix them up a lot

Editing your own and others' problems:
I learnt a lot from solving Andy's problems. I learnt that he was better at writing the maths than the descriptions.
I learnt that I added extra words that didn't make sense.

Solving real life problems:
There were a lot of problems that I couldn't solve. There were some that also didn't make sense. But it was really fun anyway

Sensibility: - in the problem
Andrews problems were very sencible, they weren't silly except for one were I think the answer had like 10000 people

- ability to empathise and work with others in writing, editing and solving
Andrew and I worked cooperatively. Telling each other when we had made mistakes.

Finding and using the correct wording for a problem:
It took a long time to find the correct wording for the problems. The problems with the most problems were the deductive reasoning ones

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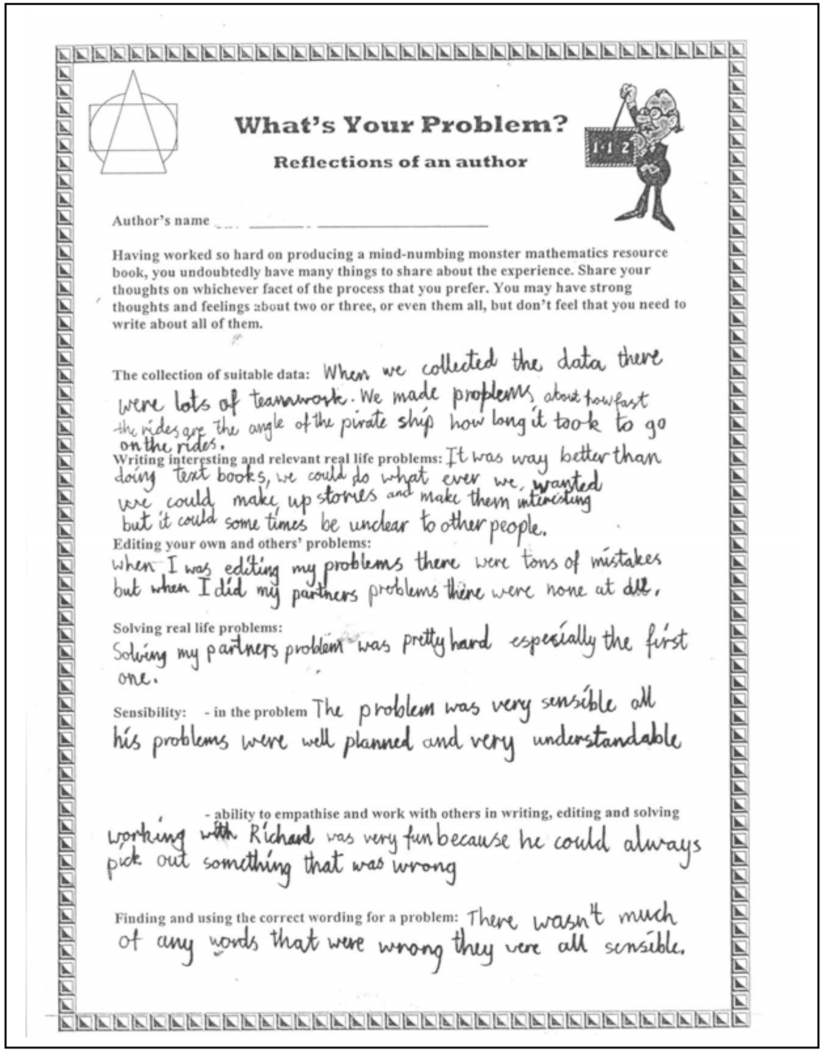

What's Your Problem?

Reflections of an author

Author's name ______

Having worked so hard on producing a mind-numbing monster mathematics resource book, you undoubtedly have many things to share about the experience. Share your thoughts on whichever facet of the process that you prefer. You may have strong thoughts and feelings about two or three, or even them all, but don't feel that you need to write about all of them.

The collection of suitable data: When we collected the data there were lots of teamwork. We made proplems about how fast the rides are the angle of the pirate ship how long it took to go on the rides.

Writing interesting and relevant real life problems: It was way better than doing text books, we could do what ever we wanted we could make up stories and make them interesting but it could some times be unclear to other people.

Editing your own and others' problems:
when I was editing my problems there were tons of mistakes but when I did my partners problems there were none at all.

Solving real life problems:
Solving my partners problem was pretty hard espesially the first one.

Sensibility: - in the problem The problem was very sensible all his problems were well planned and very understandable

- ability to empathise and work with others in writing, editing and solving
working with Richard was very fun because he could always pick out something that was wrong

Finding and using the correct wording for a problem: There wasn't much of any words that were wrong they were all sensible.

Appendix 30: First Teacher Interview Transcript (Teacher E)

Question 1. What were your main reasons for getting involved in our process portfolio project?
Well, I'm an experienced teacher who is probably a little set in my ways, particularly regard in maths and I think that I could change and learn quite a bit from the group. I'm doing my Masters, as you know, at the moment and the units I've been doing have made me think a lot about learning in general. I've just taught maths as best I can for many years and listening to you talk about the possibilities makes me think that there is a lot more that I could learn and do with my students. I've worried about assessment in English for a long time, I mean that I've been interested in making it more appropriate for a long time and changed a lot of bits and pieces, but maths is different as it has always seemed open and shut to me. You need to teach students the basic skills and get on with it using those skills…it's so sequential…and rather black and white in some ways. I'd like to think that I could learn a lot more about it from the group and really a make some big changes because I don't get a lot out of teaching it. It's just one of those mechanical things that you need to do in many ways. Your ideas on real-life are interesting too.

Question 2. Where would you see your strengths lying in teaching maths?
Most of my time has been with the older students, boys and girls, so I'd probably say I was best in upper primary maths working with older children, but I guess that means I could do a reasonable job with the smaller children. It's just that I've always had students that have many of the basics already taught to them so I just carry on developing their skills and knowledge….

Actually, I was looking for the part of the maths curriculum in which you would see your strengths lying?
Oh… well… I would say probably in number and operations mainly. You do so much of them over the years but I feel reasonably comfortable with chance and data too. Most of the work is linked to number and using those skills in operations though. I teach it all OK but I know that some is better than others as I feel a bit more comfortable with it.

Question 3. What are the best ways that you would see that the group could benefit from your strengths in our project?
Well, I guess my experience at teaching maths for a number of years, but while I'm happy to contribute in any way I can I am hoping to learn more than I teach, if you know what I mean. It's a chance to pick up some new ideas, some a bit radical maybe, judging by some of the things that you have said about teaching and learning in mathematics using real-life maths ideas. I thought that the group would probably learn a lot by pooling their ideas and sharing ideas they have from reading and considering issues. As I have done quite a bit of that so far in my Masters studies I'm open to all the learning that comes my way. Already I have managed to change a number of things that I do in my classroom and I'm really enjoying being able to do that. I think the students are really enjoying too. But most of those changes have been in my strength area of literacy. I could share some of those and perhaps we could adapt them to suit maths, who knows?

Question 4. Are there any weaknesses in your maths teaching skill armoury?
Probably plenty really…as I said I've been reasonably restricted in the way I've approached maths over the years and that means I've not really explored many possibilities. I'd like the opportunity to and improve my armoury as you say across the board really. I'm looking forward to the challenge. I've had a few this past year and enjoyed them, so let's see what it brings.

So, you would say that problem solving wasn't one of your strong suits?
Oh, I get by OK in problem solving but I use supplied problems generally. I'd like to develop my skills at creating my own. From what I gather the process portfolio will be great for doing that sort of thing. I could certainly get better in the problem solving area.

Question 5. How could I, or we, as a group, help you with those weaknesses?
As I say, the group sharing ideas, testing each others ideas and just generally sharing the chance to grow professionally together appeals to me. I've discovered that I am certainly a student as well as a teacher and I am ready to develop my maths skills as far and as wide as I can through our work together. The possibilities are endless really as far as I can see at this early time. I see you as a major contributor to the group early but once we get going in our classrooms we may well move up and develop a real equity across the group. I'm looking forward to it.

Question 6. Give me a picture of the assessment set-up you use with your maths class.
At present I use mostly testing, mostly end of topic tests, although since you started talking about open questions at Briefing I have introduced some and found that some boys really seem to like them. Others don't of course, because they're used to heading for one answer and that's it. They like to know when they've finished. Even some of the boys who don't like maths much say they like to stick to the questions that mean they have to head in a particular direction to get the only correct answer, they feel comfortable that way. Interesting, really. Most of my assessment is based on what students write, probably about 80% I'd say. We do plenty of discussion but I find that difficult to bring into the assessment picture in a formal way. I'm a believer in mental computation skills at this level, even if the senior school encourages them to use calculators for virtually everything. There's a certain buzz that they get from being able to do some things in their head. Mind you, I use the calculator for some things too.

You say you've started to use a few open questions, have you thought about using maths project work as a way of assessing students?
Thought about it, yes, lately in particular after reading that article you gave us, and a few things I've read as part of my study, but I couldn't claim to have used it as yet. I can see the possibilities though…and I shall be giving it a try shortly, with a bit of help, if you're available. That's why I've started to try out a few open ended questions here and there. I have to learn how to develop and understand them first I think, although I suppose we could do a bit of that together, but with Year 7 boys you need to be on top of your game. I've got some quite bright boys in the class, so I need to stay a bit ahead I think.

Question 7. Can you give me an approximate percentage breakdown of the various types of assessments you use? Say, what percentage of assessment would be written class tests, and so on, using groups of 5 or 10 percentage points roughly?
Well, as I said before I think that I probably have mainly written tests for assessment purposes…what did I say, about 80%, yes, that would be about right. Virtually all of it is closed…perhaps I could claim 10 % is now something like open.
Numerical to word questions?
That would probably be close to 50-50 with this particular group. They seem to like that mix, but mind you it's not easy finding good written problems.

Have you thought about writing many of them yourself to suit the students and the situation and topic?
Yes, I do write some, more now I guess than I used to, but it doesn't come easy to me really. I'm hoping that you can give me a bit of help along the way with that…what do you think?

Sure, not a problem. Would you say you use formative and summative types of assessment?
I do use both, but not much formative really. It's a bit senior schoolish I suppose. We use the Year 7 text of the Year 8 series so it really takes us along a path of working through a unit and testing, not the ideal in some ways, but that is the way we chose to take the Year 7 Transition programme this year, trying to help students assimilate into Year 8 more easily next year. Very little would be formative, perhaps less than a tenth, not much is it, I feel a bit guilty now.

Multi-choice?
No, nothing in that way. There is some available, but I'd rather have students working it out themselves fully instead of being able to get close and even guess. And good multi-choice

questions are hard to write, so I just used published word questions and a few I make up. The other Year 7 teachers do the same actually.

Question 8. What is your understanding at this early stage as to what process portfolios are?
Well, I have a bit of an inkling I guess. I understand them to be a variation of the showcase portfolio that we use in English at present. They are very handy actually, the showcase type, for using in discussions with parents and they give a lot of students a nice collection of work to take home and keep. They are a lot of work, so I guess that process portfolios are also a lot of work. I gather they show more of the process as against the finished item. That could prove useful in reporting to parents and tracking a student.

Question 9. How do you think that using process portfolios could help us improve maths teaching and learning?
As I said it could help in tracking students' progress when it comes to reporting and those sorts of things.

What about in teaching and learning though?
Oh, well, we would have some good records as far as the process students used to complete work I guess. Now that would suit your formative assessment quite well, wouldn't it, would it? It would help us see where we were missing the mark, or where the student was anyway. We could then change things to suit and make sure that we get the point across. It's going to be interesting to see how it fits into what we Year 7s are doing at present. I see fitting it in will be an interesting task. It sounds useful though …

Question 10. Are there one or two main things that you're looking for from our work together over the coming months?
Yes, I would like some help in developing problems that suit my class around the topics we work with. Of course, I'm keen to understand the process portfolio versus the showcase that we already have; that's why I wanted to be part of this. I just feel that it will offer me a much wider scope in maths, because as I said, I'm a bit worried that it's a bit narrow at present. Having done the learning that I've done, I see this as the next logical step, to put some of my learning into practice as part of the group's learning … quite exciting really. I'm looking forward to it all.
There is one other major thing for me…and that is using the rubric in maths assessments. I've used them in literacy activities like writing, but not in maths really. ***I'm a firm believer in their value in English and now am thinking that they could be really useful in maths, if we can get them right.*** *I see it as something that we could spend some considerable time on because as I say they are great value in English.*

We shall certainly be working on the rubric in maths assessments, so that will address that issue for you. Thanks for your time and for joining our group.

Appendix 31: Third Teacher Focus Group Interviews –Further Extracts

Teacher B

Question 1. Where do you believe that you are in the process of change in relation to:
involving students in task writing and rubric creation - *I have been very very lucky when I have been teaching in other places I have had mentors that are aware of doing that. I think it is very beneficial being involved with kids. It actually makes their life easier. Though the writing might be a little more difficult at the time – they take a bit more time. The end product and the process are easier as the kids know exactly where they are going.* ***Rather than bits and pieces, they actually have the whole road map; they know where they are going. Even though setting it up is more difficult the end product is far easier.*** *I am quite far down that road, because of that reason I try to involve it as much as I can.*

working collaboratively with colleagues - *I don't know about professional skill development there but I do work collaboratively with my colleagues as much as I can. The more that I can share with others the easier it is for me. I always try to work with somebody as it makes my life so much easier. It works both ways with ones strengths and weaknesses.*

Question 2. In relation to your students, how has the PD and spaced learning approach assisted you in:
which aspects of maths that students see as useful and therefore worth learning and knowing - ***This is the only way to go about it, if you don't discuss it you don't know.*** *You can't really mark what a child understands – if you don't discuss it, you don't know.*

Question 4. In regard to your students working on problem solving using the revised approach, i.e. task sheet and rubrics, did you notice any changes in:
motivation and commitment - *Definitely with the assignment* ***when we started to write our own rubric there was a lot more motivation because of the ownership factor.***

final products - *I would say the quality was starting to rise; there was definitely a sense a pride in their portfolio. They wanted to show it to their parents. They actually wanted to take it home to say, 'This is what I can do.' They were very happy with the final product. There was still – I am not sure if it because we teach boys – there was still I believe a lot of the final presentation was rushed.* ***Even again after group discussions and presentations you get more out of them. If they have to write it down again, I think it is because they are boys, they don't like writing and you get 'that'll do'.***

difficulties children experienced - *I think again because I was working with a group that struggled a lot I don't think that the difficulty got any less but the way that they were able to manage the difficulty improved. Originally there were some problems with hands in the air saying, 'We can't do this.' There was an attitude and it was we can deal with this. It became obvious that there is not always a black and white answer; you can search for it. Other people are having the same problems. 'We don't really know how to do this, but that is ok because other boys don't and through talking about it we will be able to find an answer.'* ***I suppose the biggest thing that I saw was the change that maths was not as intimidating, especially with a group of strugglers. Maths at the beginning of the year was very much too hard, I hate maths, I don't want to do it, I am no good at it, I have to do it because I am at school, the sooner this class is over the better; that changed a lot.***

Question 6. What changes has your new knowledge brought about in your:
recording and reporting - *I still have spread sheets. An example that comes up straight away -* ***a student did a test for me and he didn't perform very well at all, then he answered orally. At lunch break I actually wrote a paragraph about how he went orally as he was fine;*** *that was a different way of recording. You could use photos to record what they had done. I tend to have a check list with the portfolio.*

Teacher C

Question 1. Where do you believe that you are in the process of change in relation to:
involving students in task writing and rubric creation - *Last year I sat in with [Teacher B] when she showed the children how to create it themselves and then said, 'What are we going to call it?' She is really experienced at making them so we went with the flow with my class.* ***That is my next task to learn with the children to say, 'Well – if it is generated by them it is going to mean a lot more for them to be more reflective.'***

2. In relation to your students, how has the PD and spaced learning approach assisted you in:
gaining greater insight into the ways children interpret and solve problems - *Even the bright kids – and I am looking at the group that I have got. I can't do much about last year's kids. I am thinking they don't – they need to share more and you need to explain more and you need to do more, if it is not overhead transparencies, which I am quite happy to use if I get a projector. I think the boys need to be able to talk it out more. We need to write more tasks for the boys. I am astounded at their inability to understand written instruction. We assume they know an awful lot and they don't.* ***They put their own interpretation on it; they look for the easy way out in lots of ways.***

Teacher D

Question 2. In relation to your students, how has the PD and spaced learning approach assisted you in:
gaining deeper insight into the ways children assimilate and apply newly learned material - ***For me I found that reading their written responses has given me so much more information about them. Another example perhaps if they were to tell me orally how they were doing I find they are much more able to explain it verbally than written responses. I can then have something concrete on their understanding.***

Question 6. What changes has your new knowledge brought about in your:
recording of achievements and results – ***Well, I have to set something up. I would like to keep it consistent with the rubric or report card, have it in the same assessment pieces, just transfer it onto my own data base.***

Appendix 32: Study Log Notes - Withdrawal of Teacher A

☞ Notes of conversation with Teacher A

August 2/04

A asked that the conversation be informal and that it not be tape recorded but in light of what we were trying to achieve for all teachers was happy for notes to be made during and after the conversation.

A was put at rest and assured that as per the original letter of invitation, his withdrawal was without prejudice and would in no way effect existing working relationships within the school.

A - as to his feeling of inability to continue as part of the group:

Having problems with the level of expectations with Year 4, not used to this age student, has mainly had 11 and 12 year olds over his short career.
Realises that he is a strongly traditional teacher using conventional approaches, but does want to change – at some point.
Can't see way clear to change while learning the ropes of a new level – more comfortable learning under 'old' structure – then can change later.
[This is not an uncommon line amongst the more mature members of the school's staff. Teacher C has spoken of similar difficulties with the revised approach but has persisted as she is eager to find new ways and has received plenty of support form Teacher B.]
Agreed that he likes to maintain teacher control – his model of such is to be 'out the front' in a room set up to have students 'face the front'. Little or no group work occurs in the class.
Enormous problems understanding the open question concept – despite many examples generated and taught by TRW in the class over the months.
[Still has strong dichotomous view of mathematics!]
Plenty of support offered by some in the focus group, but the concept too different, too far removed from what he is used to for him to feel comfortable and offer contributions to the group. Feelings of inadequacy in comparison to some of the younger members who seems willing to ***'have a go at anything new with only limited background knowledge'*** – admires them for such an approach but can't adopt it himself.
Wants to learn to be a more reflective teacher – considers what he does, but not in a formal way in relation to himself, feels that he simply uses students as guides. Having trouble with the concept of reflection and the time it requires – doesn't feel comfortable guiding students in such except in a very basic way – feels that he needs to spend time learning from others but doesn't have that time at present.

A - as to his desire to continue to learn and contribute in a more minor manner:

Still has a lot to learn in relation to teaching and his year level.
Also wants to help out in any way he can where it fits into his program.
Keen to learn later and always willing to join conversations when he is available as he wants to learn about process portfolios.

Suggestions from A as to how his assimilation of process portfolios could be facilitated at some time in the future:

Plenty of time needs to be given somehow – for teachers to explore and experiment.
Would appreciate more detailed models and examples from which to learn – things that he could try with his students perhaps and use to develop his own material.

Appendix 33: Sixth Student Survey Questionnaire Responses Collated

(*Some* spelling corrections made for clarity)

[68 respondents]

Question 1: Please tell us what you think of the tasks that you have been asked to do for your mathematics portfolio.

PLUS	MINUS	INTERESTING
You can figure out real life choices We could learn with other people ***That we’re doing different stuff than what we do anywhere else*** Learning new things You put effort in It makes us get thinking It is fun working on our own and working with sponges instead of writing it down ***If you do it right can’t be wrong*** Great and creative games You have lots of fun and are able to think better in the hands on tasks but they have a balance between tests and funner activities You get to go outside and do hands on activities They were fun and easier to understand what I was doing Doesn’t make you get as bored as a maths test You don’t do many tests Challenging Teachers help One of the most important things in life Making Powerpoints You got to make your tent and can do whatever you want I liked the roman numerals and the tents and the paper strips because I was using the green hat They were at my level and below but I still learnt something You learn how to organize your portfolio I want to get better at it A time to look forward to	People who are good at maths have to do very easy things, while the not so good mathemations are taking 5 mins on a question ***Sometimes you get too much work to do in a small amount of time*** ***Not enough maths time*** The bad thing is that you don’t get graded on it That you weren’t able to compare yourself to the rest of the class Sometimes the teacher changes the subject You get told that you’ve done badly Not being able to understand something ***You only do revision*** We repeat the work sometimes It gets boring now and again Maths isn’t always good It is sometimes annoying There were none except we need more creative things None	Real life stuff There are many creative ways, some simple and easy Other classes don’t do as much as us Other people don’t like it The work is always fun You had fun stuff to do like you get to use clay You go through the work before answering the questions The fact that M---- chose clay or a sponge rather than making us do it all in our books Hands on activities Some of the things we do Working out questions and doing your best How there is more the 1 answer to most answers You have more information A way to do a question in a shorter time If I learn something new it would be interesting U can mark the work before the teacher If you do more work you are getting clever Assessing our work is interesting because I can learn how to improve my work Fascinating I didn’t know I was that good Problem solving ***The maths!***
Overall thrust: Student engagement Challenge in reality Enjoyment	**Overall thrust:** Grades wanted Nature of work – summative/revision	**Overall thrust:** Real life with more than one possible answer Self-assessment

Question 2: Tell us what you think about being able to assess your work before your teacher does.

PLUS	MINUS	INTERESTING
We can know what criteria we need to be better You won't be influenced by the teachers marks ***You can judge what you did*** They might judge it like you did Judging yourself and thinking positively You get to know what you think It is good You wont be embarrassed Honesty ***It helps us think about how we did the work*** You get a say in your work It is good so u can show … what u think of it and how much effort u put in it You can get a better idea what you think It allows us to go over your work to see flaws so next time it is better I like to see what he thinks of it after I know what I really want to do first before I see what he thinks You get to think what you want to think You see yours and the teacher thoughts It's confidential in our books Great because it helps the teacher and you get a choice YOUR say Simple to use Some boys might just copy the teacher if you do it after I think its better than the teacher So they don't see the unfinished work I like to say what I like about my work Overall it's a good thing	***You can get happy about your assessment but you can get upset about the teachers marks*** If we set our goals high and look it over and compare it and then see how pathetic it really is Sometimes I don't know what to think We can't compare our own score to the rest of the class Could have used time for something else Teacher reads each one SLOWLY Because I sometimes don't like teachers doing it for me ***No other teacher let us*** The teacher always corrects it It's a negative because I want to know what the teacher thinks first Most of the time you want to highlight between the columns Highlighter always runs out when doing it It's boring talking about it It takes a long time to get the rubric back	You can assess yourself It is a new way to assess yourself It is interesting marking your own work first – I hadn't done it before You can see the differences between the way you marked yourself and the way the teacher marks you Not many teachers let you have a say in your work Other classes don't do it I have never had a teacher do the same It tells us how we did Tells us how we can improve It gives you a chance or choice I think it's good cause maybe we think we're at year 6 standard but we might not be when our teacher marks it The boys got better at assessing their work as the year went on No other teacher lets us assess our own work first A waste of time Different It is interesting ***Everything***
Overall thrust: Judgement required Engagement in deep considered thought Students and teacher working together	**Overall thrust:** Possible let-down/disappointment Lack of comparative grades Unique	**Overall thrust:** Chance to improve Self assessors improve over times New - unique

Question 3: Tell us what you think about writing reflections after you've finished the tasks

PLUS	MINUS	INTERESTING
You get to reflect on the work and think what you could have done better Going back and telling yourself what you could've done to improve The reflection helped me get more focus on what I got wrong What you could improve You can see where you went wrong It reminds us of our mistakes It is good because you know where you can gain You can think of new tactics to figure out questions You can look back at it later Other people can see what you think about what you did I get to write about what I do I like being able to get a chance to say what I think It shows you can write down anything You don't feel put down cause you have had your say Because you learn from your mistakes Looking back and seeing how good you did I write down what I think was funnest about it I get to reflect everything I just did It's good because you get to think of the good and bad memory Easy to do, helping you, helping English It lets M----- know how we feel about the lesson Telling your teacher that could've done something better It is good fun because its like an exam but you already know the answers Helps you	You might have done nothing to reflect on You realise how bad you might have done ***It can be depressing looking back through really bad work*** Might be ashamed Being offended If other people lie I don't like writing for a long time Your hand gets sore from writing all of it They might not agree and you might be sad You might think that you did bad and get upset Looking back and seeing that it is not very good at all It could take a while We had to do it too many times It gets boring It took too long, especially on a Monday morning Waste of time, no point I don't like reflecting, reflecting is not fun Only the fact of more work Could be hard for some None	You can express your feelings You can show others what happened It makes some people think It is interesting the teacher knows what you think about your work and what you think before he does Because it's different than other work It makes me think what could I have done better It's sort of fun and it makes me think A new way of teaching Remembering the answer to a question Tells us how we're going It is interesting about the silly mistakes It is good to see how good you did Some of it was good but it is hard work I love writing reflections Can show it off ***I realised that maths is everywhere*** Different 20+ years – you can laugh at what happened Why do we have to reflect on maths?
Overall thrust: How work could have been improved Have your say Helpful	**Overall thrust:** Potential disagreement with teacher Potentially depressing Time and effort required	**Overall thrust:** Different Chance to think Mathematics is everywhere

Question 4: Tell us what you think about having a part in interviews with your parents using your maths portfolio.

PLUS	MINUS	INTERESTING
Telling your teacher what you want to change but if you are not there then your parents might now know what you want to change Because you get to show your parents what you think It lets our parents know what were doing in class and if where doing OK or where we compared to the rest of the class You can see what your parents think Hear what your parents say Parents might be happy Good because you know what your parents and teachers are saying Your parents know what you have done in the last term I think its really good cause we get to show our mums what we're doing Your mum sees the teacher ***It is good to communicate between teacher, parent and student*** ***That the parent and student get the information at once*** If it was just a student and teacher a student will not tell his parents Seeing it can add stuff in Good to show my work I feel comfortable because I know I've done what I can Getting to share your maths with your parents Your parents get to see what you think of what your teacher says You can disagree with what they think in the interview Because we can't tell them everything You get to hear about what work done Good cause you can understand what the teacher is starting to tell you Information spreads See what the teacher thinks You can show your portfolio Be proud of it	That we had to explain everything You have to answer a lot of questions You have to sit there for a long time ***You can't lie to mum*** You have to sit there and tell mum the truth ***Your parent knows everything you do at school*** The teacher might say something to your parents that you might not (have) wanted to tell them If you do something wrong they will find out Showing the bad work if it comes up It can be bad because if you did bad then they all know about it If we go bad we get in trouble Can be bad results and parents get angry Sometimes embarrassing Could talk more about it without child ***Waste of a child's time*** It's not interesting at all We could be out having fun You could be at home!	I got to be there It's normally just parent and teacher You have to tell your mum everything Showing mum my things Interesting to see what your mum thinks of it Cause you get to explain your work Your parents get to see your work To see how they reacted to my work The fact that they know what we are doing We get to see how our parents go at maths That parents should find out at home Your parents and teacher ask you questions ***You get to have a say and get more confident*** That you can speak to the teacher with your parents
Overall thrust: All hear what is said Parents see the teacher/know what's happening Students sharing with parents – pride in work	**Overall thrust:** Questions to answer Truth has to be told Time taken	**Overall thrust:** Normally just parent and teacher Sharing with parents in teacher presence Have your say – increase student confidence

Question 5: What's the best thing about working in a maths portfolio?

Going back and seeing what you have done
We can go back and see how we've changed
Getting to look back when you are having a problem
Making PowerPoints
Self assessments, hands on work and fun
There are no tests
It keeps maths work interesting
Its easy
You get to keep a record of all your work
You can have all your maths in one piece
That all my stuff doesn't get lost
Its easier than all separate sheets
There would be no sheets hanging around and more tidy
It is easy to find things in it
Nothing, Well, maybe the teachers
Maths!

Overall thrust: An organized record formed
Looking back for improvement and 'tactics'
Interesting tasks

Question 6: How do you think working in the maths portfolio could be improved?

We could do more rubrics and mark our own work
More varied activities
More detail to the work
More time to work
Not so much work
Work harder
By having more to put and fill it
Not having to copy everything off the board
More maths games to get people focus and learn at the same time
Yes. Very much so. More fun, simple yet hard, easy to understand and FUN!
By going to places and making it more interesting for the boys and girls at schools
We have had some interesting projects but we should have one per term
Putting in new subjects
Well we could have a separate portfolio for each subject
I don't see anything to change. It is fool proof
By not having one

Overall thrust: More - time allowed
- work and more detail in the tasks
- hands-on
Portfolios in more subjects

Appendix 33: Sixth Student Survey Questionnaire Responses Collated

(*Some* spelling corrections made for clarity)

[68 respondents]

Question 1: Please tell us what you think of the tasks that you have been asked to do for your mathematics portfolio.

PLUS	MINUS	INTERESTING
You can figure out real life choices We could learn with other people ***That we're doing different stuff than what we do anywhere else*** Learning new things You put effort in It makes us get thinking It is fun working on our own and working with sponges instead of writing it down ***If you do it right can't be wrong*** Great and creative games You have lots of fun and are able to think better in the hands on tasks but they have a balance between tests and funner activities You get to go outside and do hands on activities They were fun and easier to understand what I was doing Doesn't make you get as bored as a maths test You don't do many tests Challenging Teachers help One of the most important things in life Making Powerpoints You got to make your tent and can do whatever you want I liked the roman numerals and the tents and the paper strips because I was using the green hat They were at my level and below but I still learnt something You learn how to organize your portfolio I want to get better at it A time to look forward to	People who are good at maths have to do very easy things, while the not so good mathemations are taking 5 mins on a question ***Sometimes you get too much work to do in a small amount of time*** ***Not enough maths time*** The bad thing is that you don't get graded on it That you weren't able to compare yourself to the rest of the class Sometimes the teacher changes the subject You get told that you've done badly Not being able to understand something ***You only do revision*** We repeat the work sometimes It gets boring now and again Maths isn't always good It is sometimes annoying There were none except we need more creative things None	Real life stuff There are many creative ways, some simple and easy Other classes don't do as much as us Other people don't like it The work is always fun You had fun stuff to do like you get to use clay You go through the work before answering the questions The fact that M---- chose clay or a sponge rather than making us do it all in our books Hands on activities Some of the things we do Working out questions and doing your best How there is more the 1 answer to most answers You have more information A way to do a question in a shorter time If I learn something new it would be interesting U can mark the work before the teacher If you do more work you are getting clever Assessing our work is interesting because I can learn how to improve my work Fascinating I didn't know I was that good Problem solving ***The maths!***
Overall thrust: Student engagement Challenge in reality Enjoyment	**Overall thrust:** Grades wanted Nature of work – summative/revision	**Overall thrust:** Real life with more than one possible answer Self-assessment

Question 2: Tell us what you think about being able to assess your work before your teacher does.

PLUS	MINUS	INTERESTING
We can know what criteria we need to be better You won’t be influenced by the teachers marks ***You can judge what you did*** They might judge it like you did Judging yourself and thinking positively You get to know what you think It is good You wont be embarrassed Honesty ***It helps us think about how we did the work*** You get a say in your work It is good so u can show … what u think of it and how much effort u put in it You can get a better idea what you think It allows us to go over your work to see flaws so next time it is better I like to see what he thinks of it after I know what I really want to do first before I see what he thinks You get to think what you want to think You see yours and the teacher thoughts It’s confidential in our books Great because it helps the teacher and you get a choice YOUR say Simple to use Some boys might just copy the teacher if you do it after I think its better than the teacher So they don’t see the unfinished work I like to say what I like about my work Overall it’s a good thing	***You can get happy about your assessment but you can get upset about the teachers marks*** If we set our goals high and look it over and compare it and then see how pathetic it really is Sometimes I don’t know what to think We can’t compare our own score to the rest of the class Could have used time for something else Teacher reads each one SLOWLY Because I sometimes don’t like teachers doing it for me ***No other teacher let us*** The teacher always corrects it It’s a negative because I want to know what the teacher thinks first Most of the time you want to highlight between the columns Highlighter always runs out when doing it It’s boring talking about it It takes a long time to get the rubric back	You can assess yourself It is a new way to assess yourself It is interesting marking your own work first – I hadn’t done it before You can see the differences between the way you marked yourself and the way the teacher marks you Not many teachers let you have a say in your work Other classes don’t do it I have never had a teacher do the same It tells us how we did Tells us how we can improve It gives you a chance or choice I think it’s good cause maybe we think we’re at year 6 standard but we might not be when our teacher marks it The boys got better at assessing their work as the year went on No other teacher lets us assess our own work first A waste of time Different It is interesting ***Everything***
Overall thrust: Judgement required Engagement in deep considered thought Students and teacher working together	**Overall thrust:** Possible let-down/disappointment Lack of comparative grades Unique	**Overall thrust:** Chance to improve Self assessors improve over times New - unique

Question 3: Tell us what you think about writing reflections after you've finished the tasks

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Question 5: What’s the best thing about working in a maths portfolio?

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We can go back and see how we’ve changed
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Self assessments, hands on work and fun
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It keeps maths work interesting
Its easy
You get to keep a record of all your work
You can have all your maths in one piece
That all my stuff doesn’t get lost
Its easier than all separate sheets
There would be no sheets hanging around and more tidy
It is easy to find things in it
Nothing, Well, maybe the teachers
Maths!

Overall thrust: An organized record formed
Looking back for improvement and ‘tactics’
Interesting tasks

Question 6: How do you think working in the maths portfolio could be improved?

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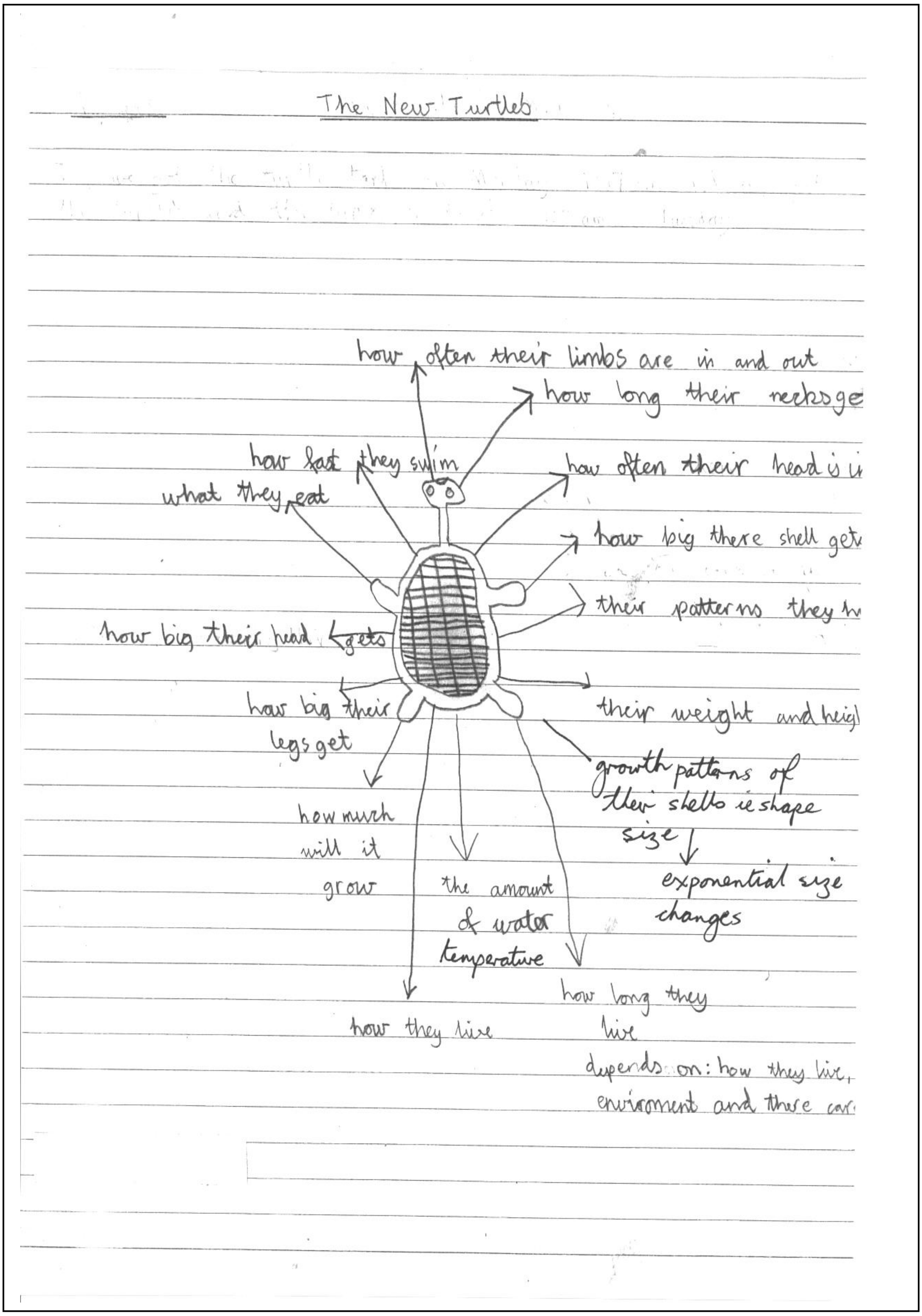
More detail to the work
More time to work
Not so much work
Work harder
By having more to put and fill it
Not having to copy everything off the board
More maths games to get people focus and learn at the same time
Yes. Very much so. More fun, simple yet hard, easy to understand and FUN!
By going to places and making it more interesting for the boys and girls at schools
We have had some interesting projects but we should have one per term
Putting in new subjects
Well we could have a separate portfolio for each subject
I don’t see anything to change. It is fool proof
By not having one

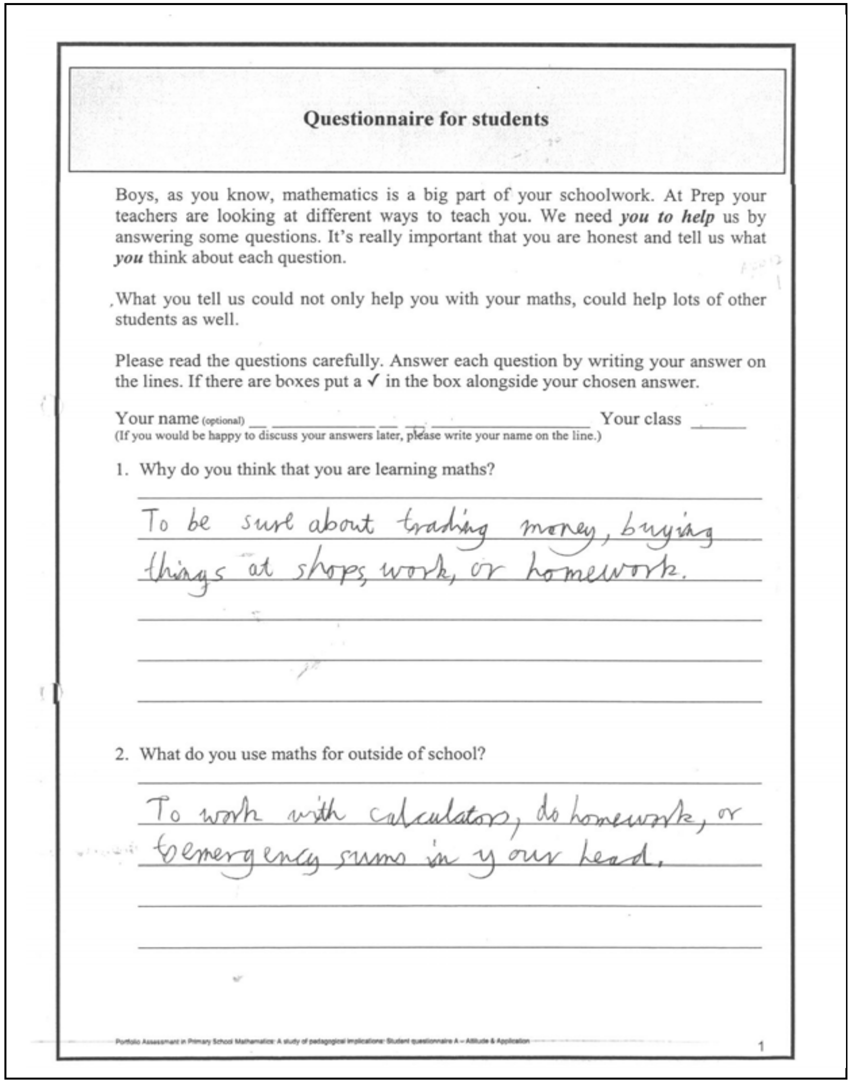
Overall thrust: More - time allowed
- work and more detail in the tasks
- hands-on

Portfolios in more subjects

Appendix 34: Real-Life Mathematics Journal – *The New Turtles*



Appendix 35: First Student Survey Questionnaire (Completed Example)



Questionnaire for students

Boys, as you know, mathematics is a big part of your schoolwork. At Prep your teachers are looking at different ways to teach you. We need ***you to help*** us by answering some questions. It's really important that you are honest and tell us what ***you*** think about each question.

What you tell us could not only help you with your maths, could help lots of other students as well.

Please read the questions carefully. Answer each question by writing your answer on the lines. If there are boxes put a ✓ in the box alongside your chosen answer.

Your name (optional) ____________ Your class ______
(If you would be happy to discuss your answers later, please write your name on the line.)

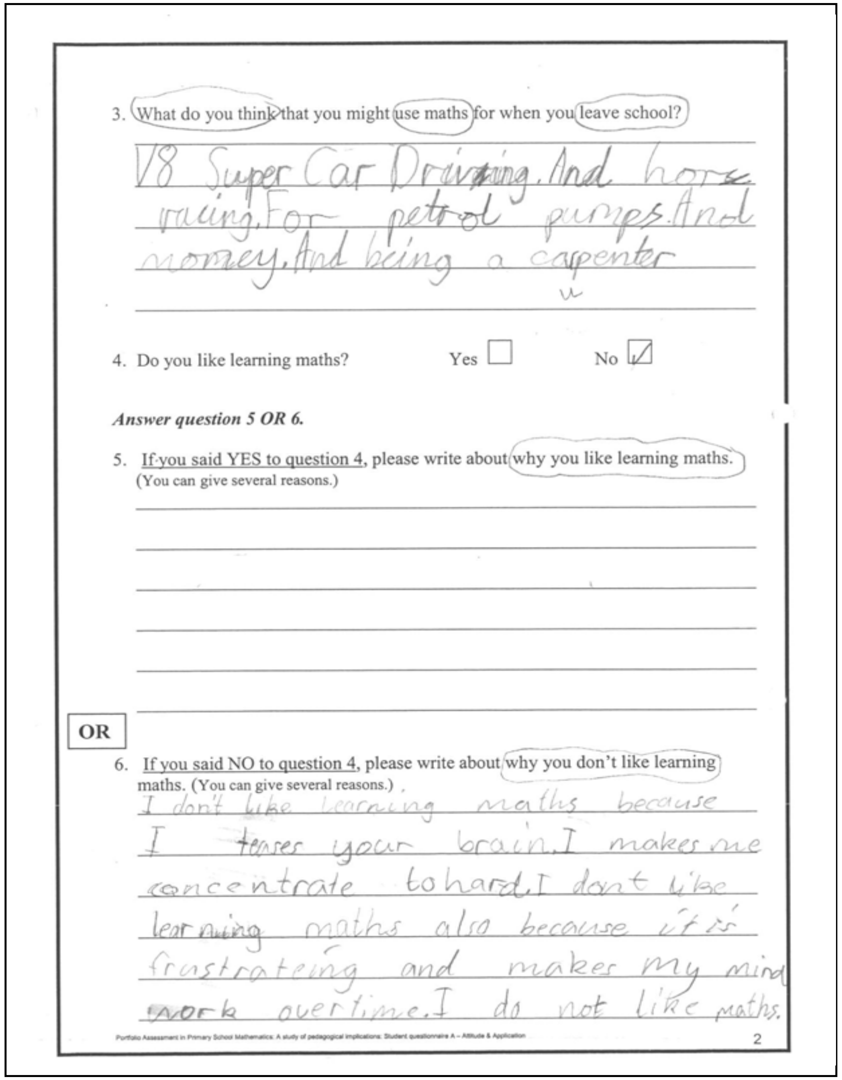
1. Why do you think that you are learning maths?

To be sure about trading money, buying things at shops, work, or homework.

2. What do you use maths for outside of school?

To work with calculators, do homework, or to emergency sums in your head.

Portfolio Assessment in Primary School Mathematics: A study of pedagogical implications: Student questionnaire A – Attitude & Application 1



3. What do you think that you might use maths for when you leave school?

V8 Super Car Driving. And horse racing. For petrol pumps. And money. And being a capenter

4. Do you like learning maths? Yes ☐ No ☑

Answer question 5 OR 6.

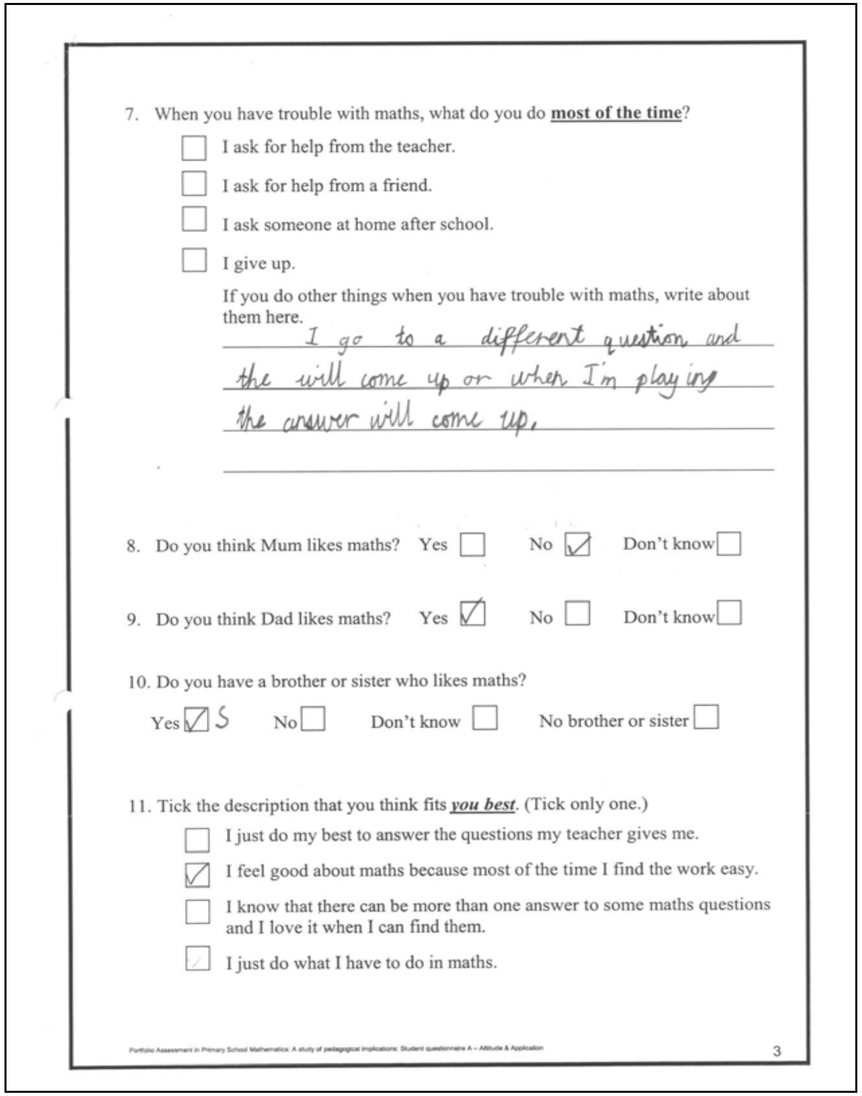
5. If you said YES to question 4, please write about why you like learning maths. (You can give several reasons.)

OR

6. If you said NO to question 4, please write about why you don't like learning maths. (You can give several reasons.)

I don't like learning maths because I teases your brain. I makes me concentrate to hard. I dont like learning maths also because it is frustrateing and makes my mind work overtime. I do not like maths.

Portfolio Assessment in Primary School Mathematics: A study of pedagogical implications: Student questionnaire A – Attitude & Application 2



7. When you have trouble with maths, what do you do **most of the time**?

☐ I ask for help from the teacher.
☐ I ask for help from a friend.
☐ I ask someone at home after school.
☐ I give up.

If you do other things when you have trouble with maths, write about them here.
I go to a different question and the will come up or when I'm playing the answer will come up.

8. Do you think Mum likes maths? Yes ☐ No ☑ Don't know ☐

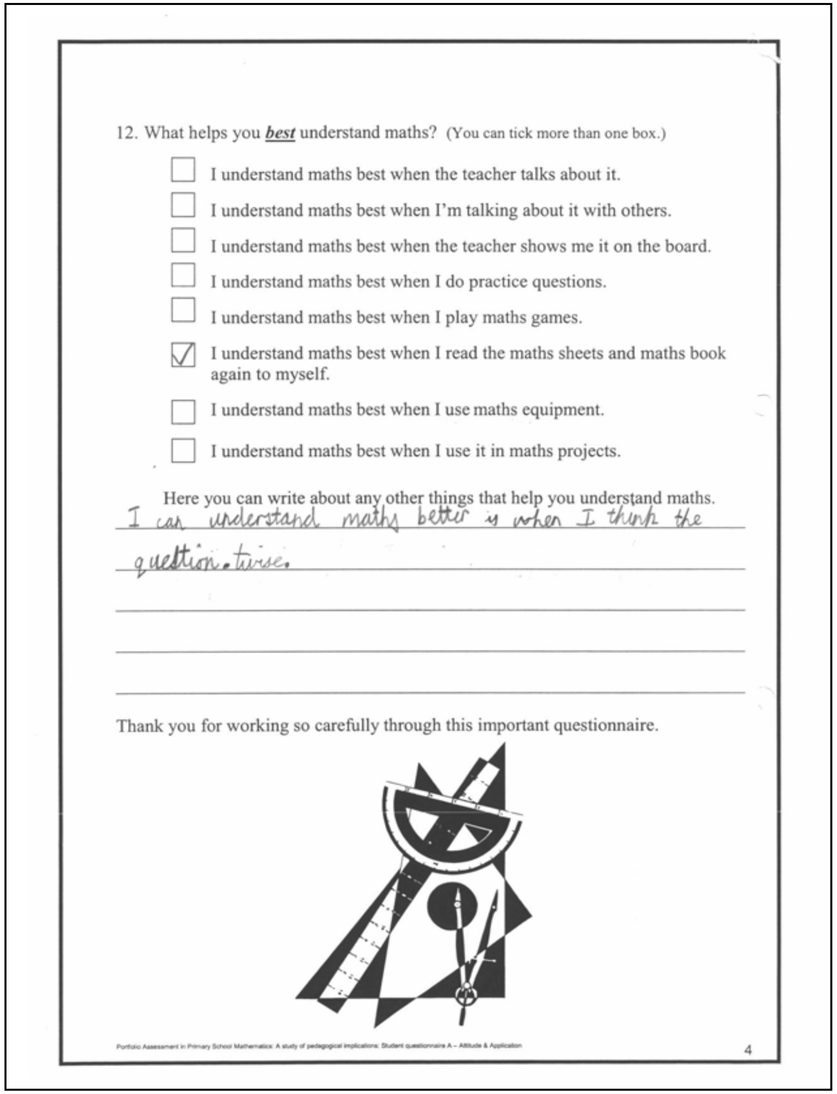
9. Do you think Dad likes maths? Yes ☑ No ☐ Don't know ☐

10. Do you have a brother or sister who likes maths?
Yes ☑ S No ☐ Don't know ☐ No brother or sister ☐

11. Tick the description that you think fits ***you best***. (Tick only one.)

☐ I just do my best to answer the questions my teacher gives me.
☑ I feel good about maths because most of the time I find the work easy.
☐ I know that there can be more than one answer to some maths questions and I love it when I can find them.
☐ I just do what I have to do in maths.

Portfolio Assessment in Primary School Mathematics: A study of pedagogical implications: Student questionnaire A – Attitude & Application 3



12. What helps you ***best*** understand maths? (You can tick more than one box.)

☐ I understand maths best when the teacher talks about it.
☐ I understand maths best when I'm talking about it with others.
☐ I understand maths best when the teacher shows me it on the board.
☐ I understand maths best when I do practice questions.
☐ I understand maths best when I play maths games.
☑ I understand maths best when I read the maths sheets and maths book again to myself.
☐ I understand maths best when I use maths equipment.
☐ I understand maths best when I use it in maths projects.

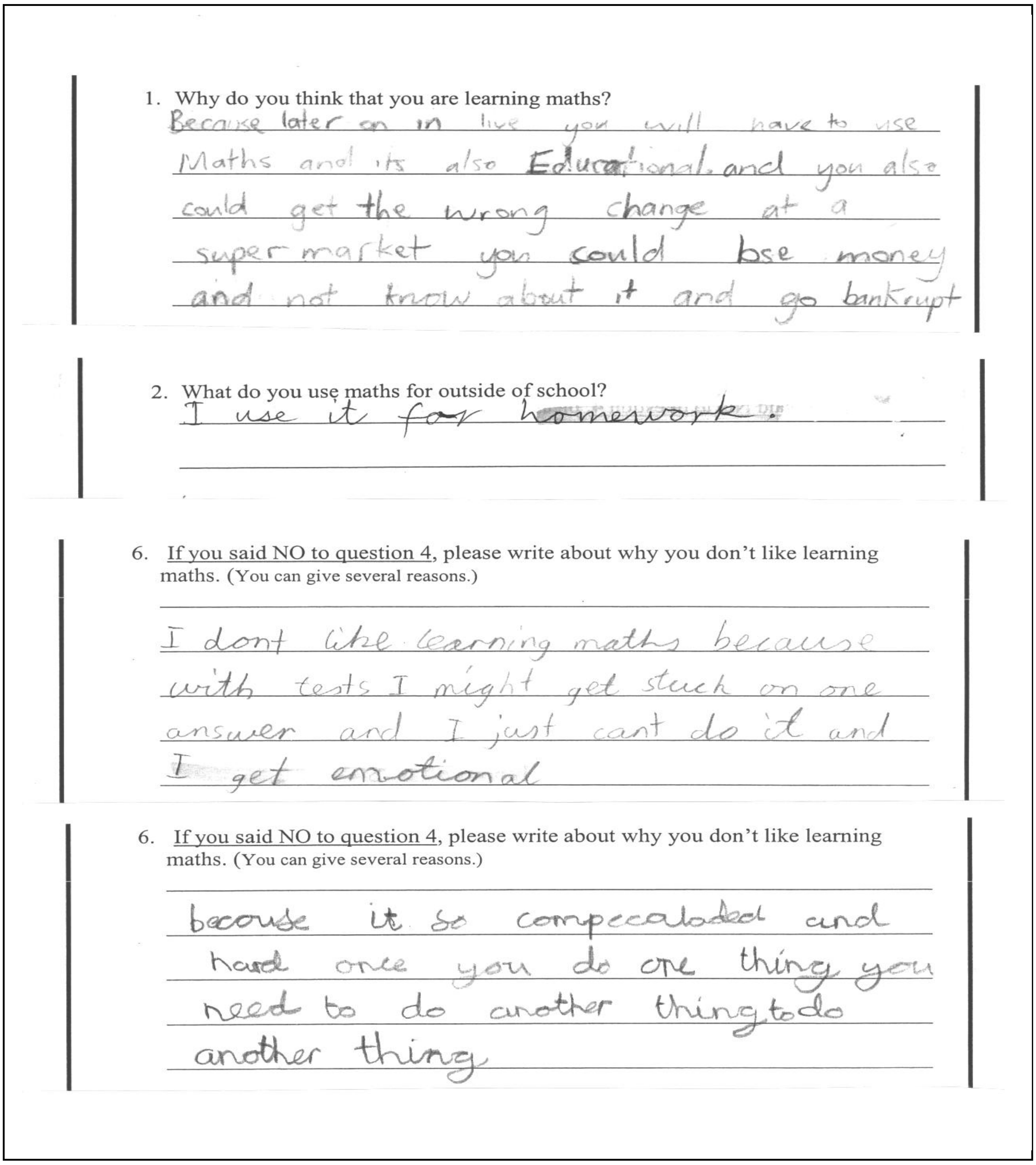
Here you can write about any other things that help you understand maths.
I can understand maths better is when I think the question twise.

Thank you for working so carefully through this important questionnaire.

Portfolio Assessment in Primary School Mathematics: A study of pedagogical implications: Student questionnaire A – Attitude & Application 4

Appendix 36: First Student Survey Questionnaire – Extracts of Responses

The following extracts have been taken from students' responses to questions within the first student survey questionnaire and are quoted within the text of Chapter Six.



1. Why do you think that you are learning maths?

Because later on in live you will have to use Maths and its also Educational. and you also could get the wrong change at a super market you could lose money and not know about it and go bankrupt

2. What do you use maths for outside of school?

I use it for homework.

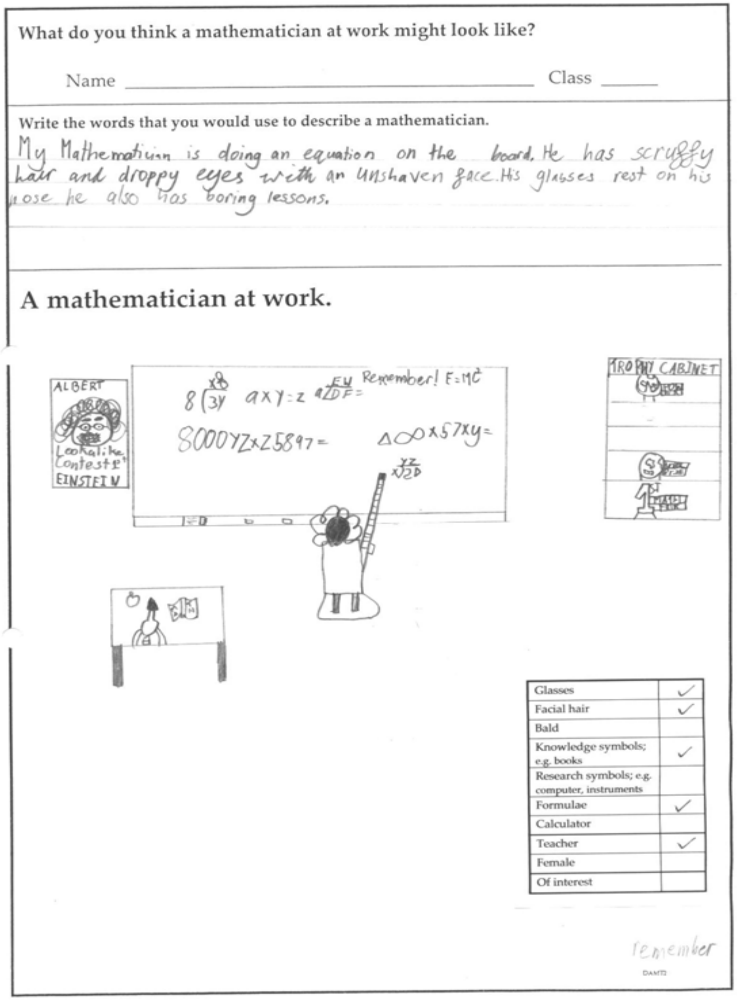
6. If you said NO to question 4, please write about why you don't like learning maths. (You can give several reasons.)

I dont like learning maths because with tests I might get stuck on one answer and I just cant do it and I get emotional

6. If you said NO to question 4, please write about why you don't like learning maths. (You can give several reasons.)

becouse it so compecaloded and hard once you do one thing you need to do another thing to do another thing

Appendix 37: Draw-A-Mathematician Tests (Examples)



What do you think a mathematician at work might look like?

Name ______________________ Class ______

Write the words that you would use to describe a mathematician.

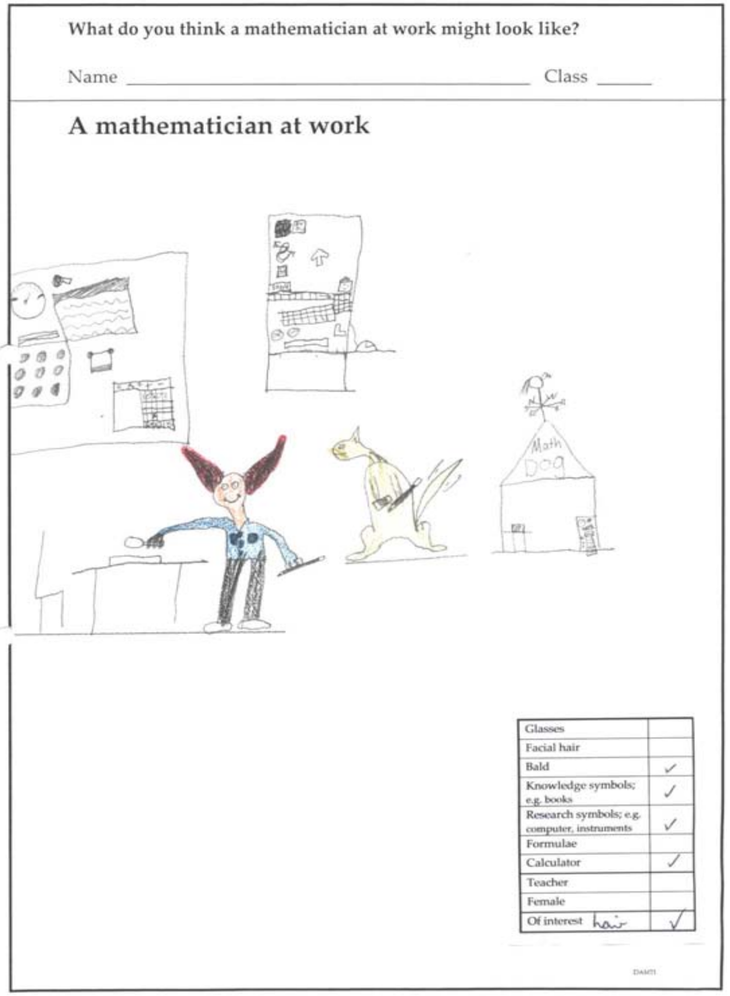
My Mathematician is doing an equation on the board. He has scruffy hair and droppy eyes with an unshaven face. His glasses rest on his nose he also has boring lessons.

A mathematician at work.

Glasses	✓
Facial hair	✓
Bald	
Knowledge symbols; e.g. books	✓
Research symbols; e.g. computer, instruments	
Formulae	✓
Calculator	
Teacher	✓
Female	
Of interest	

remember

DAMT2



What do you think a mathematician at work might look like?

Name ______________________ Class ______

A mathematician at work

Glasses	
Facial hair	
Bald	✓
Knowledge symbols; e.g. books	✓
Research symbols; e.g. computer, instruments	✓
Formulae	
Calculator	✓
Teacher	
Female	
Of interest hair	✓

DAMT1

Appendix 38: Student Interview Transcripts - Extracts

Student 5A

Thanks for doing such a great job with the maths questionnaire that we had you fill in a few weeks ago. Your answers were very interesting and I'd just like to ask you some more about what you think about maths. We'll only be a few minutes.

DAMT: Thanks for doing such an interesting drawing of a mathematician. I'd like to ask you a couple of questions about your mathematician, if I could.
Can a mathematician do almost anything?
Yes, they know everything about maths. That's why they are called a mathematician.

STUDENT SURVEY:
How does the teacher reading the question to you help you understand maths?
By showing it to me or writing on the board so I can understand.
Do you have any problems understanding the words that are used in maths questions?
Sometimes, yes I do.
Have you got any ideas why you might have that trouble?
It's just that sometimes you're not quite sure what the word means. You know some words can have two meanings.
What do you mean?
Well, ... operation can mean adding and it can mean a doctor cutting you open. There's others too.
So how do you get to know which meaning to use for those words?
You just do, practice them.
What sorts of things does your teacher write on the board to help you?
Shows me how to do it and doing examples, then I have a try myself.
When you say you would like harder work, what sorts of things are you talking about?
Like more harder fractions, like 12 over 1, no 52 over 6 plus 61 over 8, so bigger numbers bigger fractions.

QUESTIONNAIRE:
Q1: Why is maths "very important"?
It is important as when you grow up you need to know about money, every time you use maths. If you don't know you won't be able to go to university.
Q3: What sorts of tests do you think you might do at university where you would use maths?
A doctor
Q5: What do you mean when you use the word "smarter" to describe someone?
It helps your brain think more and you know more. You can learn more maths signs.

Student 7A

Thanks for doing such a great job with the maths questionnaire that we had you fill in a few weeks ago. Your answers were very interesting and I'd just like to ask you some more about what you think about maths. We'll only be a few minutes.

DAMT: Thanks for doing such an interesting drawing of a mathematician. I'd like to ask you a few questions about your mathematician, if I could.
What do you understand by the adjective "smart"?
I understand smart as being alert and switched on and knows what is happening.
You wrote about "tools". What did you mean?
Mathematicians use lots of tools, not only pencils and rubbers but inside their heads which could be named as tools.

Student 6 A

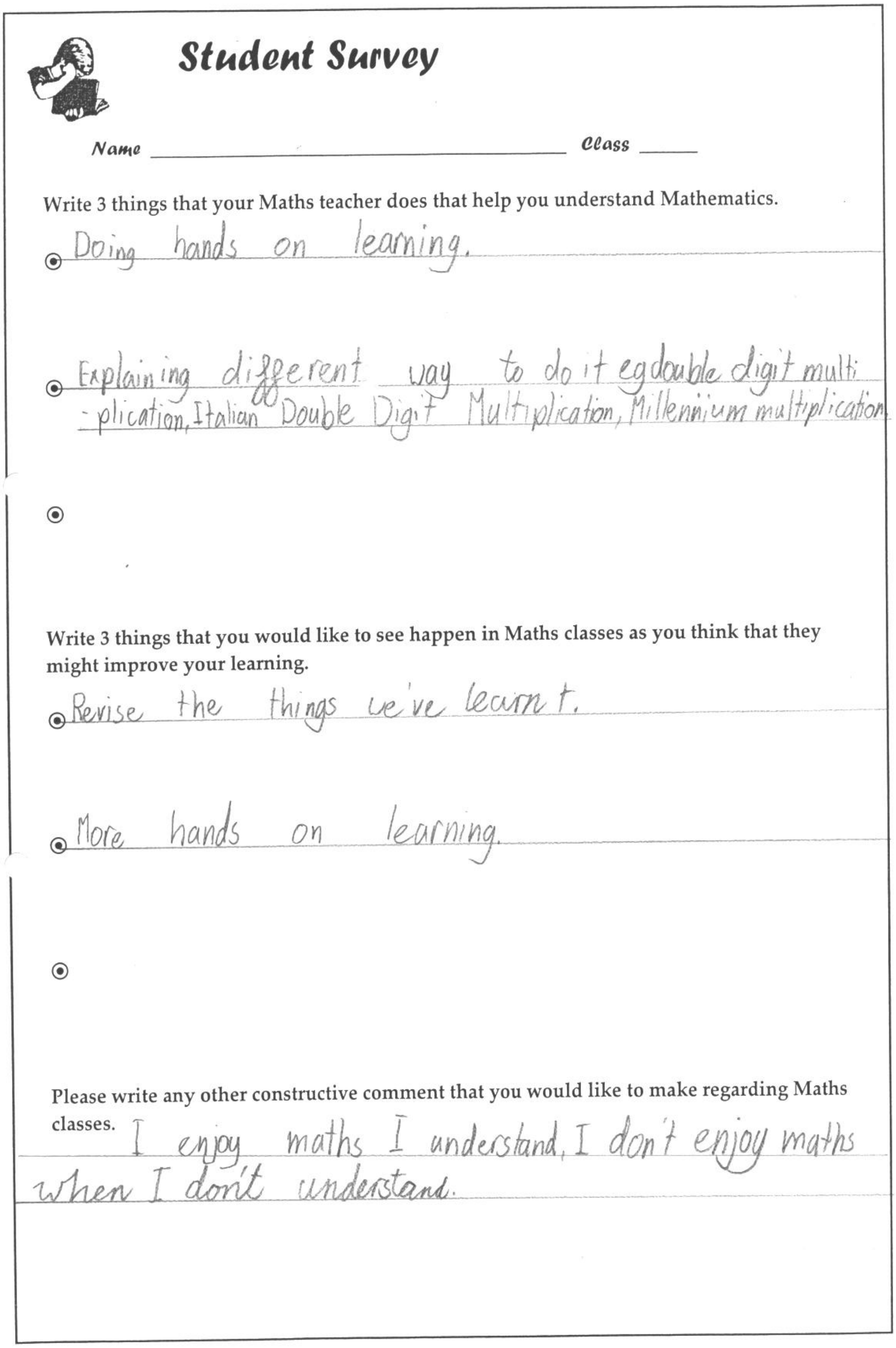
Thanks for doing such a great job with the maths questionnaire that we had you fill in a few weeks ago. Your answers were very interesting and I'd just like to ask you some more about what you think about maths. We'll only be a few minutes.

DAMT: Thanks for doing such an interesting drawing of a mathematician. I'd like to ask you a couple of questions about your mathematician, if I could. Do you think that you could describe your mathematician for me?
If someone asks me what a mathematician would be like, I would say Albert Einstein, or his theory of creativity. This mathematician looks like Albert Einstein inspired by him and he is doing an equation on the board that is extremely hard.
Do you think all mathematicians would probably be teachers in schools?
No. Some of them may be want to put their maths into helping countries with food or weapons.
Would most of them be men and scruffy?
No. You can have female mathematicians.
Would they be scruffy looking?
No. They would have short hair and little glasses.
Why do you think that all of their lessons would be boring?
Because with maths most people would consider it to be the most boring subject. If a subject is harder you don't enjoy it as much. I know a lot of people who are better at English than Maths.
Why do you think that they might be better at English than Maths?
I'm not really sure, but it could have something to do with the language. Maths language can be a bit confusing sometimes.
Where do you think that confusion comes from?
Could be from words having so many meanings. You need to get used to that. I just practise a bit.
Do you think maths is boring all of the time?
At times, but I really enjoyed doing circles with a piece of string and getting the circumference.

QUESTIONNAIRE:
Q1:What does physics entail?
Periodic table working on – just kind of different things when mixed. I am moving onto chemistry. Physics is really looking into things, nuclear reactors and stuff.
What would it be used for?
Power, water, nature
Do you have any interest in physics?
I don't know too much about it, but my Mum is really smart and she likes physics and chemistry. And my friend likes chemistry.
Q2: You seem to have lots of uses for maths outside of school. So, do you think that it is worth learning how to do and use maths?
Yes, because in business my Dad if he wants to look at shares, stock prices, working with money and stuff and bills. And tuckshop to add the money up.
Q3: What do you think that you might use maths for after you leave school?
Just business, law all those jobs.
Q6: You said that when you have trouble with maths you have to recite it over and over again. What sorts of things do you have to recite?
How to do long division, equations, tables and just how to do long division. That's what I have most trouble with.
Can you think of any other ways to learn those things, other than reciting them?
Hands on learning and just putting them into a fun way.
Do you think that reciting things helps you understand them?
Depends if it is short and quick like tables it is easy, and the equations are hard to figure out.
How could we make maths better, more enjoyable for you to learn?

Putting it into more fun ways, fake money, decimals. Some people don't realise that decimals have a lot to do with money. At the shop I add up how much my lollies are.
***Q7**:* You say that you understand the maths when the teacher explains it and shows you on the board (Q12), so why do you say that when you have trouble you ask for help at home?
Because Mum, I don't know it is easier when someone is close to your heart, I find it easier listening to Mum. I know more about her at school. She was a nerd at school and that is not a bad thing because when you are older it helps.
***Q8**:* As you say that Mum likes maths, is it her that you ask for help?
Yes and Dad helps sometimes too.
***Q9**:* What makes you feel that Dad doesn't
No, Dad doesn't mind maths. He helped with my tables, but Mum is smarter. I asked what interest was and he explained.
Does he use it in his job at all?
Sometimes
Do you think that having family like or dislike maths effects your feelings about maths?
Yes, It helps me. If my whole family was against maths I would have a lot lower score
***Q11**:*When the teacher gives you work, do you just like to get the job done?
I would rather understand it and get it wrong than just get the job done and not know how and why and stuff.
Do you think that maths problems could have more than one acceptable answer?
Sometimes there is an open-ended question. Like there are many different answers on maths mental. You could have 6 x 8. That is not open-ended. There is only one answer.
An open-ended question is sometimes when we have maths projects. We had lots of those. There are different ways to figure things out like an area. Different boys did it different ways.
How would you feel if you were given problems that had several possible answers?
I like it because there are different ways to figure it out and with questions like with one answer they are harder because you have only one way to figure out the answer. With an open-ended question there is lots of different ways to figure it out.
Would you like to have a chance to find a couple of answers to some questions?
I try to understand it a bit better, and once I understand it helps me get it done.
Do you think that you are a good problem solver?
I am an all right problem solver sometimes. If I were in the mood I would do better. If I am tired or don't want to do it I don't do as well.
***Q12**:* What are some of the "fun different ways of doing maths" that help you understand maths?
If we have like MAB blocks and working decimals we had fake money before us and we could take $10 or 57cents take away just anything and then you could just find the decimal as cents and then when you add the numbers its more dollars.
Thanks for your help. It's been a very interesting chat.
That's fine.

Appendix 39: Second Student Survey (Example)



Student Survey

Name ______________________ **Class** ______

Write 3 things that your Maths teacher does that help you understand Mathematics.

- Doing hands on learning.
- Explaining different way to do it eg double digit multi-plication, Italian Double Digit Multiplication, Millennium multiplication
-

Write 3 things that you would like to see happen in Maths classes as you think that they might improve your learning.

- Revise the things we've learnt.
- More hands on learning.
-

Please write any other constructive comment that you would like to make regarding Maths classes. I enjoy maths I understand, I don't enjoy maths when I don't understand.

Appendix 40: Task Sheet for Blaster Laser Skirmish (A Journal-based Task)

Blaster Laser Skirmish

You are to establish a new ***Blaster Laser Skirmish*** park. You have borrowed $75 000 from the bank at 5% interest per year for 10 years.

Items that you will need for the park include:

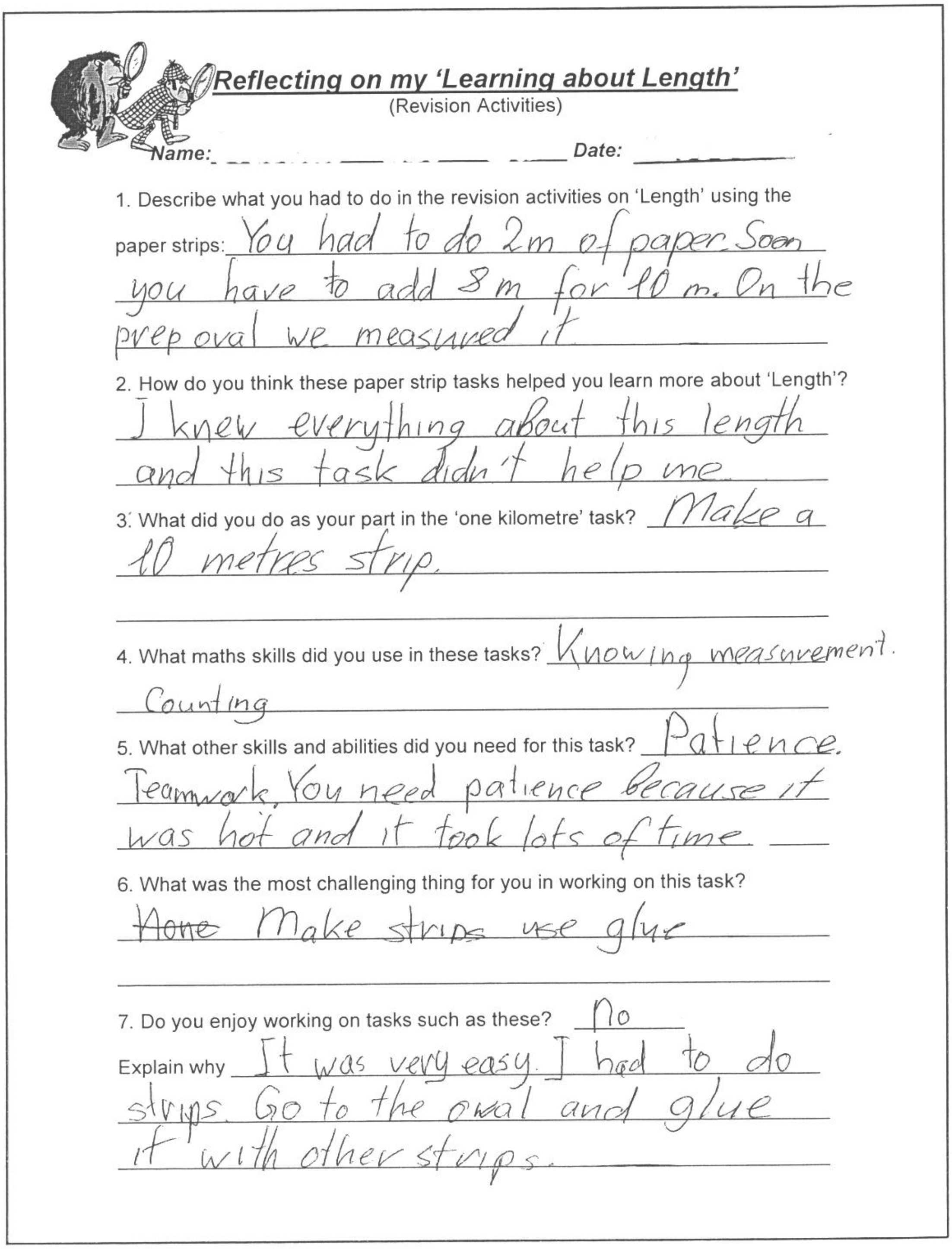
Uniforms	$47.50 each	
Laser guns	$2 450 each	($2 200 each if ordered in batches of 5)
Packs of ammo	$3.75 a pack of 10 ($2.80 if ordered in batches of 100)	
Helmets	$15.75 each	($13.50 each if ordered in batches of 10)

You will need to build a Headquarters at a cost of $14 550.
It will cost you $11 575 a year to rent the land for the park. (You have started with a 5 year lease.)

Tasks:

1. Work out a shopping list to fit your budget in setting up the park. State reasons as to why you need the quantities that you order. (Your list must be properly set out with prices and a total, so that it is easily read and understood by the supplier.)
2. Work out the prices that will need to be charged to operate the park. (You will need to estimate how many people come and play Blaster Laser Skirmish each week.)
3. Carefully design the layout of the block of land that you are to use for your park.
4. Design an advertising campaign to launch the park in a BIG way! (Give reasons for the things that you would use, such as radio ads, TV ads, banners at the roadside by the park, flyers to put in letter boxes – but remember they all cost money!)
5. How much do you think that you and your friend who operate the park would be able to take as your pay. Give your reasons using words and figures for the amounts.
6. Having completed tasks 1-5, write down some criteria that you think somebody judging your work should use. Careful planning, logical thought and setting out or presentation, could be some, but there a plenty more!
7. Once you've finished tasks 1-6, you might like to go further by looking at other aspects of operating such a park at a profit.

Appendix 41: Journal Task Guided Reflection – *Learning about Length*



Reflecting on my 'Learning about Length'

(Revision Activities)

Name: ____________ Date: ________

1. Describe what you had to do in the revision activities on 'Length' using the paper strips: You had to do 2m of paper. Soon you have to add 8m for 10 m. On the prep oval we measured it.

2. How do you think these paper strip tasks helped you learn more about 'Length'? I knew everything about this length and this task didn't help me.

3. What did you do as your part in the 'one kilometre' task? Make a 10 metres strip.

4. What maths skills did you use in these tasks? Knowing measurement. Counting

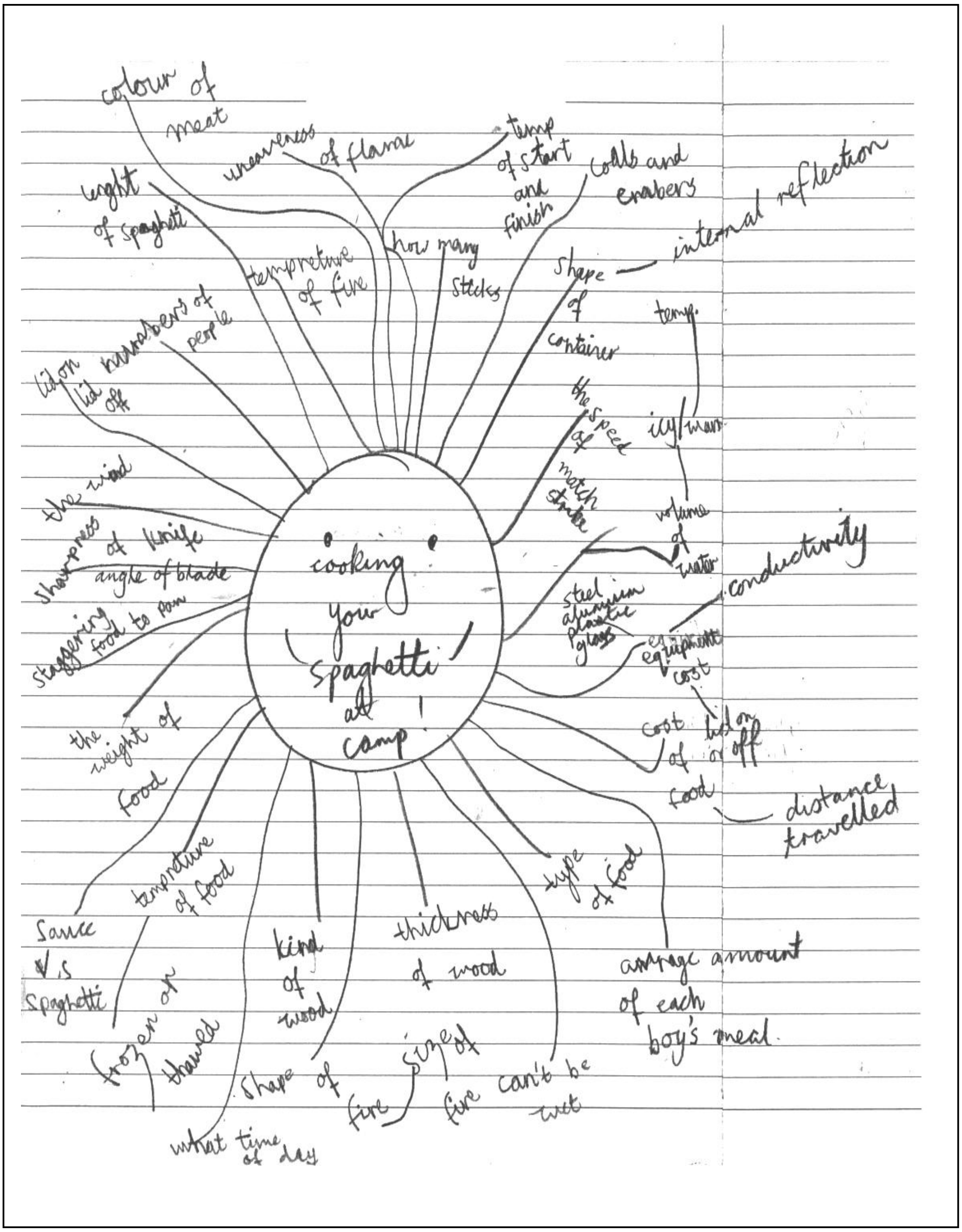
5. What other skills and abilities did you need for this task? Patience. Teamwork. You need patience because it was hot and it took lots of time.

6. What was the most challenging thing for you in working on this task? ~~None~~ Make strips use glue

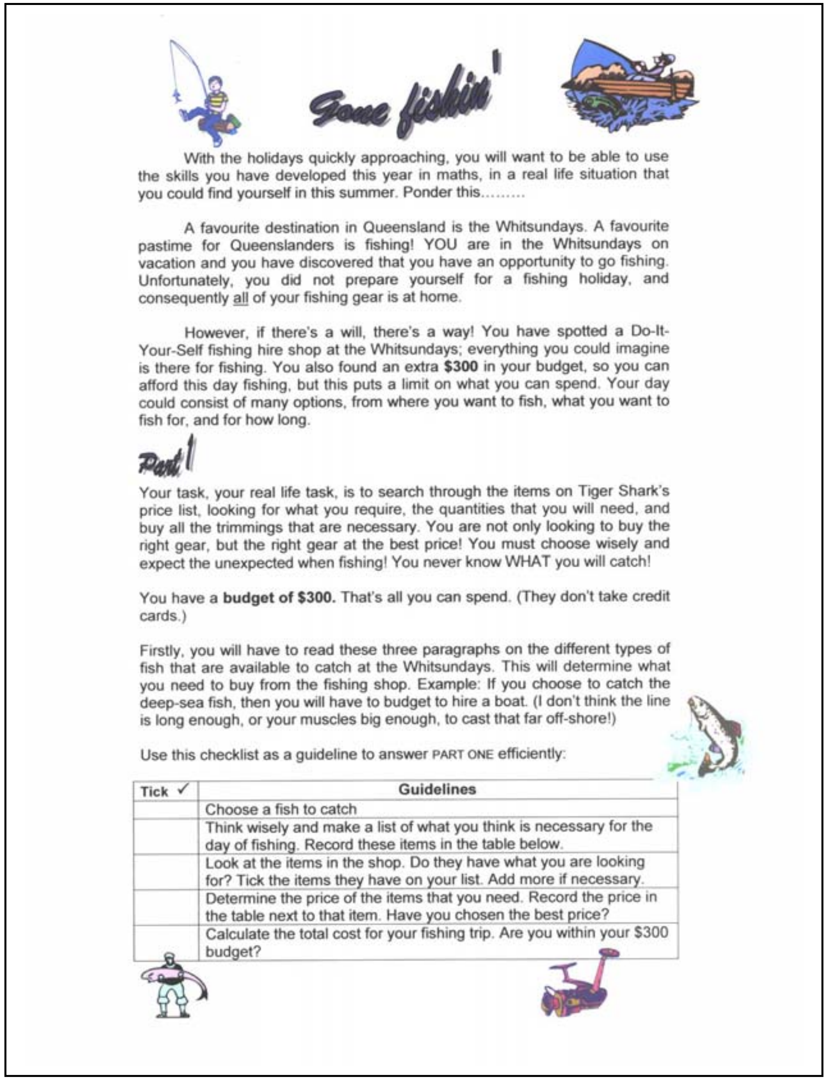
7. Do you enjoy working on tasks such as these? No

Explain why It was very easy. I had to do strips. Go to the owal and glue it with other strips.

Appendix 42: Real-life Mathematics Journal – *Cooking Your Spaghetti*



Appendix 43: Year 6 Task – *Gone Fishin'*



Gone fishin'

With the holidays quickly approaching, you will want to be able to use the skills you have developed this year in maths, in a real life situation that you could find yourself in this summer. Ponder this………

A favourite destination in Queensland is the Whitsundays. A favourite pastime for Queenslanders is fishing! YOU are in the Whitsundays on vacation and you have discovered that you have an opportunity to go fishing. Unfortunately, you did not prepare yourself for a fishing holiday, and consequently all of your fishing gear is at home.

However, if there's a will, there's a way! You have spotted a Do-It-Your-Self fishing hire shop at the Whitsundays; everything you could imagine is there for fishing. You also found an extra **$300** in your budget, so you can afford this day fishing, but this puts a limit on what you can spend. Your day could consist of many options, from where you want to fish, what you want to fish for, and for how long.

Part 1

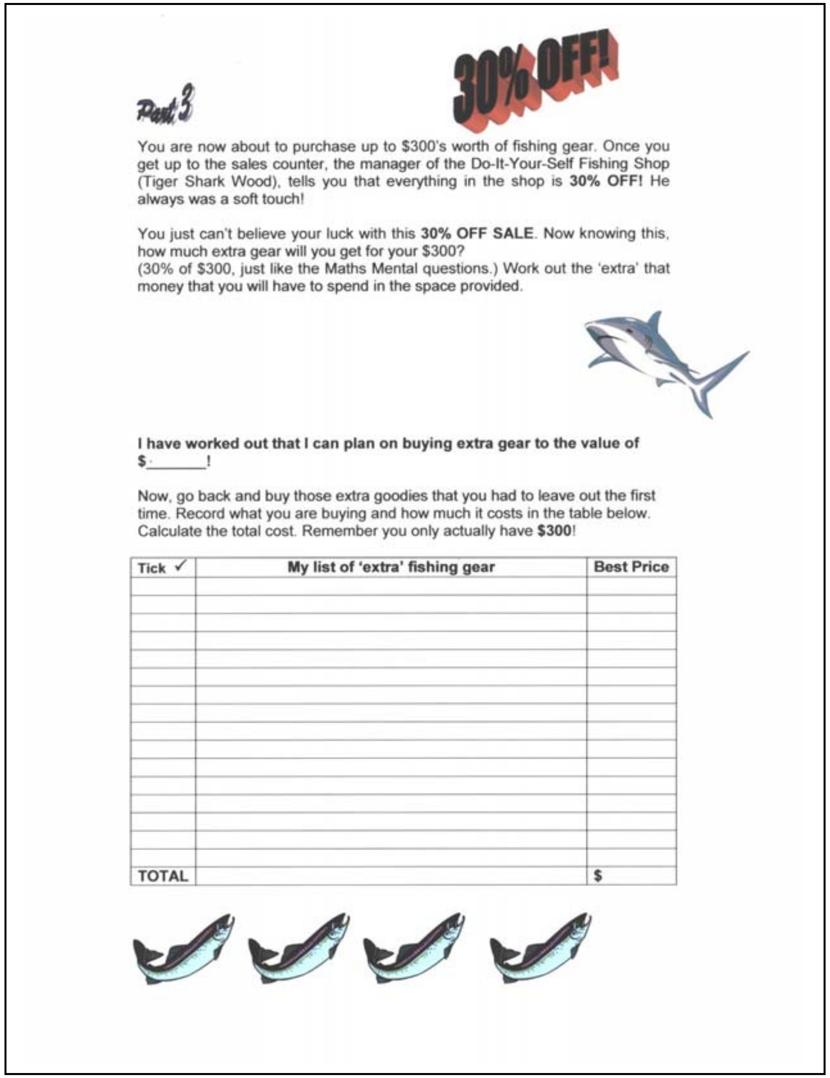
Your task, your real life task, is to search through the items on Tiger Shark's price list, looking for what you require, the quantities that you will need, and buy all the trimmings that are necessary. You are not only looking to buy the right gear, but the right gear at the best price! You must choose wisely and expect the unexpected when fishing! You never know WHAT you will catch!

You have a **budget of $300.** That's all you can spend. (They don't take credit cards.)

Firstly, you will have to read these three paragraphs on the different types of fish that are available to catch at the Whitsundays. This will determine what you need to buy from the fishing shop. Example: If you choose to catch the deep-sea fish, then you will have to budget to hire a boat. (I don't think the line is long enough, or your muscles big enough, to cast that far off-shore!)

Use this checklist as a guideline to answer PART ONE efficiently:

Tick ✓	**Guidelines**
	Choose a fish to catch
	Think wisely and make a list of what you think is necessary for the day of fishing. Record these items in the table below.
	Look at the items in the shop. Do they have what you are looking for? Tick the items they have on your list. Add more if necessary.
	Determine the price of the items that you need. Record the price in the table next to that item. Have you chosen the best price?
	Calculate the total cost for your fishing trip. Are you within your $300 budget?



Part 3

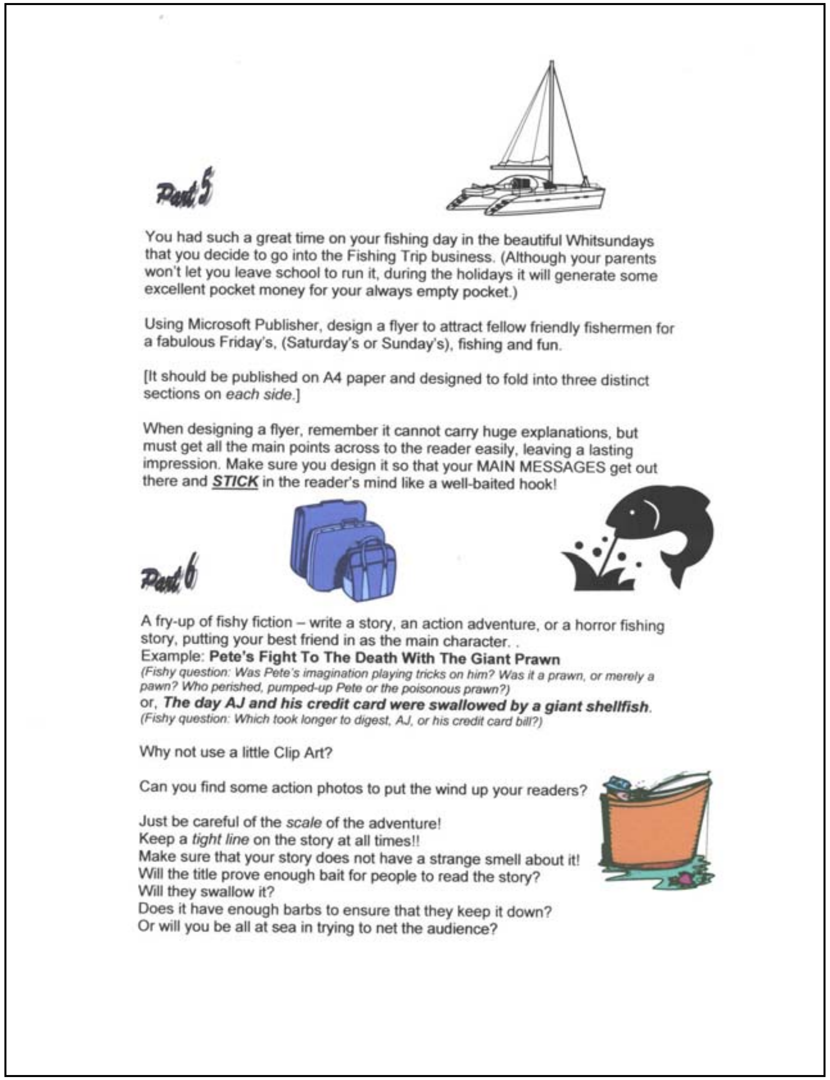
You are now about to purchase up to $300's worth of fishing gear. Once you get up to the sales counter, the manager of the Do-It-Your-Self Fishing Shop (Tiger Shark Wood), tells you that everything in the shop is **30% OFF!** He always was a soft touch!

You just can't believe your luck with this **30% OFF SALE**. Now knowing this, how much extra gear will you get for your $300?
(30% of $300, just like the Maths Mental questions.) Work out the 'extra' that money that you will have to spend in the space provided.

I have worked out that I can plan on buying extra gear to the value of $_______!

Now, go back and buy those extra goodies that you had to leave out the first time. Record what you are buying and how much it costs in the table below. Calculate the total cost. Remember you only actually have **$300**!

Tick ✓	**My list of 'extra' fishing gear**	**Best Price**
TOTAL		$



Part 5

You had such a great time on your fishing day in the beautiful Whitsundays that you decide to go into the Fishing Trip business. (Although your parents won't let you leave school to run it, during the holidays it will generate some excellent pocket money for your always empty pocket.)

Using Microsoft Publisher, design a flyer to attract fellow friendly fishermen for a fabulous Friday's, (Saturday's or Sunday's), fishing and fun.

[It should be published on A4 paper and designed to fold into three distinct sections on *each side*.]

When designing a flyer, remember it cannot carry huge explanations, but must get all the main points across to the reader easily, leaving a lasting impression. Make sure you design it so that your MAIN MESSAGES get out there and ***STICK*** in the reader's mind like a well-baited hook!

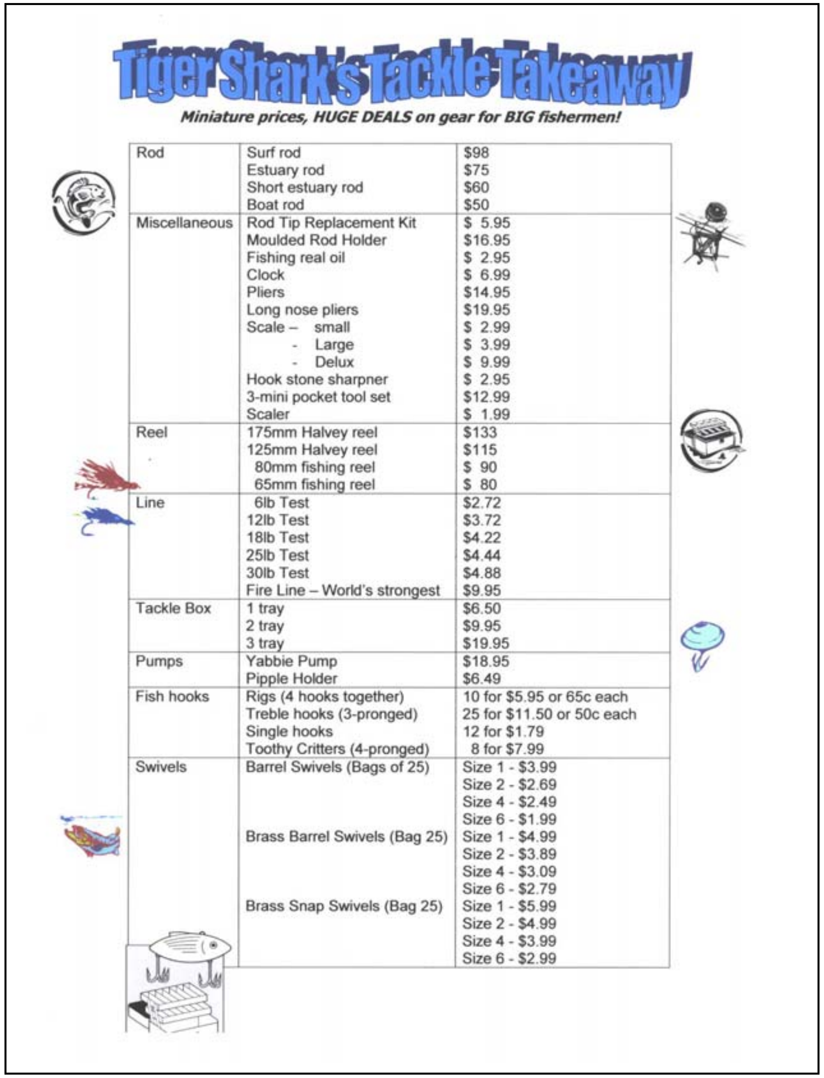
Part 6

A fry-up of fishy fiction – write a story, an action adventure, or a horror fishing story, putting your best friend in as the main character. .
Example: **Pete's Fight To The Death With The Giant Prawn**
(Fishy question: Was Pete's imagination playing tricks on him? Was it a prawn, or merely a pawn? Who perished, pumped-up Pete or the poisonous prawn?)
or, ***The day AJ and his credit card were swallowed by a giant shellfish***.
(Fishy question: Which took longer to digest, AJ, or his credit card bill?)

Why not use a little Clip Art?

Can you find some action photos to put the wind up your readers?

Just be careful of the *scale* of the adventure!
Keep a *tight line* on the story at all times!!
Make sure that your story does not have a strange smell about it!
Will the title prove enough bait for people to read the story?
Will they swallow it?
Does it have enough barbs to ensure that they keep it down?
Or will you be all at sea in trying to net the audience?



Tiger Shark's Tackle Takeaway

Miniature prices, HUGE DEALS on gear for BIG fishermen!

Rod	Surf rod	$98
	Estuary rod	$75
	Short estuary rod	$60
	Boat rod	$50
Miscellaneous	Rod Tip Replacement Kit	$ 5.95
	Moulded Rod Holder	$16.95
	Fishing real oil	$ 2.95
	Clock	$ 6.99
	Pliers	$14.95
	Long nose pliers	$19.95
	Scale – small	$ 2.99
	- Large	$ 3.99
	- Delux	$ 9.99
	Hook stone sharpner	$ 2.95
	3-mini pocket tool set	$12.99
	Scaler	$ 1.99
Reel	175mm Halvey reel	$133
	125mm Halvey reel	$115
	80mm fishing reel	$ 90
	65mm fishing reel	$ 80
Line	6lb Test	$2.72
	12lb Test	$3.72
	18lb Test	$4.22
	25lb Test	$4.44
	30lb Test	$4.88
	Fire Line – World's strongest	$9.95
Tackle Box	1 tray	$6.50
	2 tray	$9.95
	3 tray	$19.95
Pumps	Yabbie Pump	$18.95
	Pipple Holder	$6.49
Fish hooks	Rigs (4 hooks together)	10 for $5.95 or 65c each
	Treble hooks (3-pronged)	25 for $11.50 or 50c each
	Single hooks	12 for $1.79
	Toothy Critters (4-pronged)	8 for $7.99
Swivels	Barrel Swivels (Bags of 25)	Size 1 - $3.99
		Size 2 - $2.69
		Size 4 - $2.49
		Size 6 - $1.99
	Brass Barrel Swivels (Bag 25)	Size 1 - $4.99
		Size 2 - $3.89
		Size 4 - $3.09
		Size 6 - $2.79
	Brass Snap Swivels (Bag 25)	Size 1 - $5.99
		Size 2 - $4.99
		Size 4 - $3.99
		Size 6 - $2.99

Year 5 Mathematics Conference

A two day event centred on the Mathematics of problem formulation, critiquing, investigation and possible solution.
Some of the work can be based on student Maths Journal entries.
All of it will be rooted in '**authentic**' Maths – *Real Life Mathematics*.

Authentic problems have a 'personal' frame of reference, often have no agreed-on solutions or prescribed strategies for solution, may have the potential to change attitudes or beliefs, and are targeted at a real audience, serving a purpose.

Group structure: (3 classes split into 4 groups: **a**, **b**, **c**, **d**)

Teacher		**(C)**	**(E)**	**(L)**	**(W)**
Day 1	*0845 - 0900*	*Housekeeping*	*Housekeeping*	*Housekeeping*	
	0900 - 1100	Workshop C1**a**	Workshop E1**b**	Workshop L1**c**	Workshop W1**d**
	1145 - 1315	Workshop C1**b**	Workshop E1**c**	Workshop L1**d**	Workshop W1**a**
	1345 - 1515	Workshop C1**c**	Workshop E1**d**	Workshop L1**a**	Workshop W1**b**
	1515 - 1530	Plenary session – Review the day			
Day 2	*0845 – 0900*	*Housekeeping*	*Housekeeping*	*Housekeeping*	
	0900 – 1100	Workshop C2**c**	Workshop E2**d**	Workshop L1**a**	Workshop W2**b**
	1145 – 1315	Workshop C2**a**	Workshop E2**b**	Workshop L1**c**	Workshop W2**d**
	1345 - 1500	Workshop C2**b**	Workshop E2**c**	Workshop L1**d**	Workshop W2**a**
	1500 - 1530	Plenary session – Review the two days			

Specialist timetable: The timetable is modified to shift Specialist teaching lessons from the nominated two days.

Appendix 45: Study Log Notes - Mathematics Conference Feedback

☞ **Mathematics Conference** – feedback

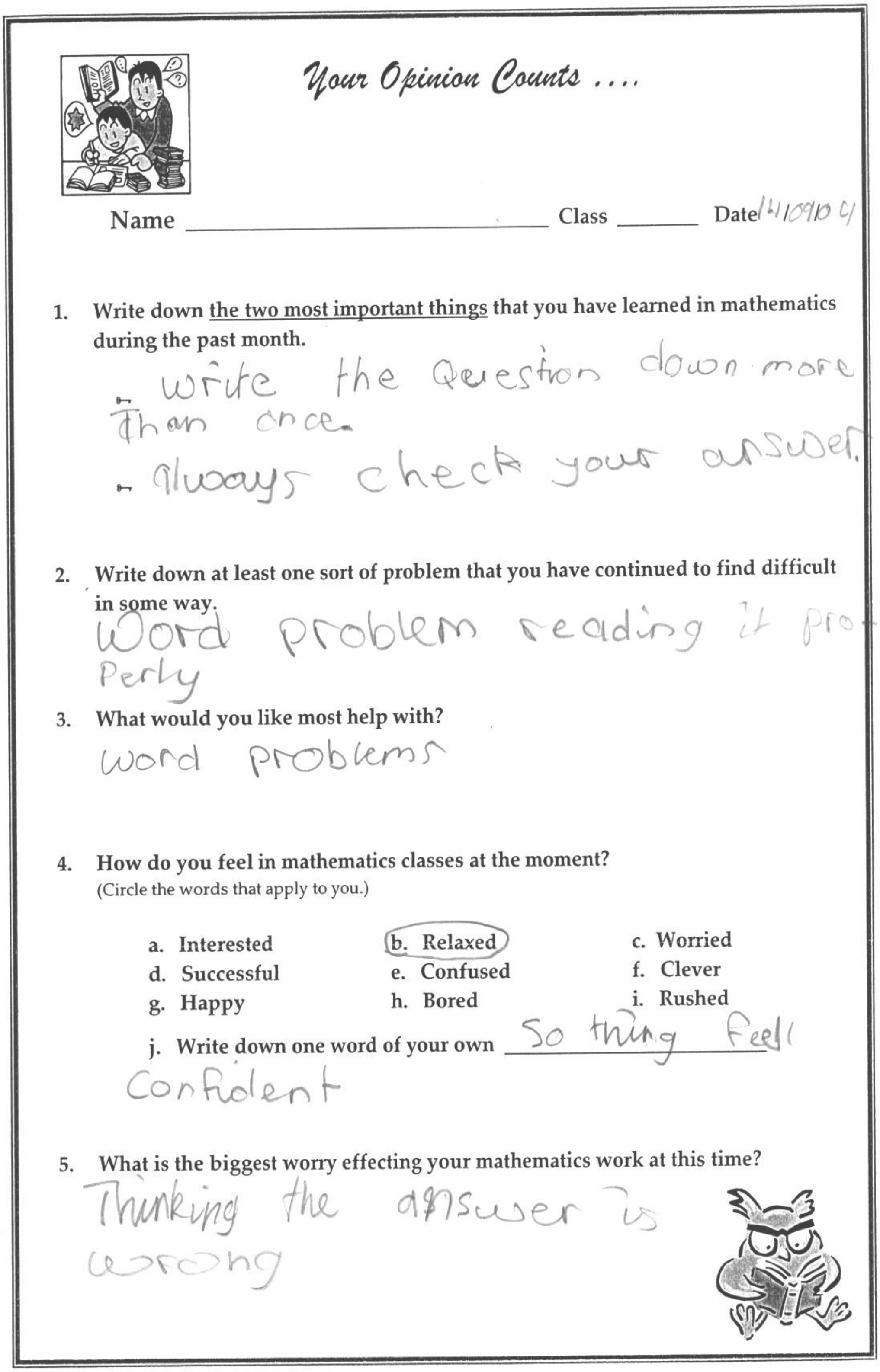
The conference ran smoothly – lots of enthusiasm from teachers and boys – a real buzz actually. The schedule worked well with boys having been primed well before the event by teachers discussing the concept on several occasions.
There was a tendency for teachers to plan a little too much for their sessions which meant that the 'homework' was probably a little too much of an ask – but boys were so keen that that was overlooked by most. It does need attention for next time.
There was good use of the practical side of maths across the workshops.

Teachers: "I thoroughly enjoyed the sessions as the boys were really motivated."
"I learnt a few things as we went along. The boys discovered some great things about angles." "I was really impressed with the quality of the ideas and solutions and arguments that they developed."
"They're really seeing how other things can be used now – PowerPoint had a starring role with some short presentations."
"We could run this over three days next time because there was certainly plenty left in the topics that we all chose."
"Once we got the session underway there wasn't that much for me to do – just circulate and make a bit of input here and there, or ask a question."
"Boy, were they into it! I'd love to see that everyday in the classroom."
"Their group skills developed really quickly actually. I guess that surprised me a bit."
"Perhaps we could run a similar set-up for staff on our next PD day."
"The concept worried me a bit in the early stages, but once I got into the planning with BB I could see where it was going and felt so much more comfortable. I loved it!"

Students: "That was the best!"
"I'm not a maths nut, but I enjoyed that because we were doing different things – not just sitting at our desks working."
"I like maths more now!" "I really liked the way we got a chance to try things out."
"We should do that more often." "I really like the group stuff we did, all that sharing ideas and fun stuff." "It was a bit noisy sometimes."
"I know so much about measurement now!" "We got a lot of homework!"
"The teachers seemed a bit different in some ways. They sort of treated us like high school kids. It was great." "You should have seen what my group in design made – it was awesome."
"I really liked being able to spend lots of time on one thing – we did some really good stuff." "It was great that the things we were doing were sort of real."

It was clear that the boys enjoyed the prolonged exposure to a small number of topics at a different/more in-depth level. Very few expressed any real reservations about the concept and what they had been asked to do. Overall, I was impressed by the way everybody embraced the idea and really put the time and effort in. Considering that this was the first time that anything like this had ever been tried here, it was a real success. Apart from thinking about using it for PD days with staff, we could do a lot more with the concept across other subjects. It is certainly a concept worth exploring with staff and one that we will keep going after this study finishes. Idea: KLA conferences each term – concentrating on Maths, Science, SOSE and English across the four terms. Integrated conferences with more of the KLAs could then follow if early experiences successful??

Appendix 46: Third Student Survey – *Your Opinion Counts* (Example)



Your Opinion Counts ....

Name ______________ Class _______ Date 14/09/04

1. Write down the two most important things that you have learned in mathematics during the past month.

- write the Qeestion down more Than once.
- always check your answer.

2. Write down at least one sort of problem that you have continued to find difficult in some way.

Word problem reading it properly

3. What would you like most help with?

word problems

4. How do you feel in mathematics classes at the moment?
(Circle the words that apply to you.)

a. Interested
[✓ b. Relaxed]
c. Worried
d. Successful
e. Confused
f. Clever
g. Happy
h. Bored
i. Rushed

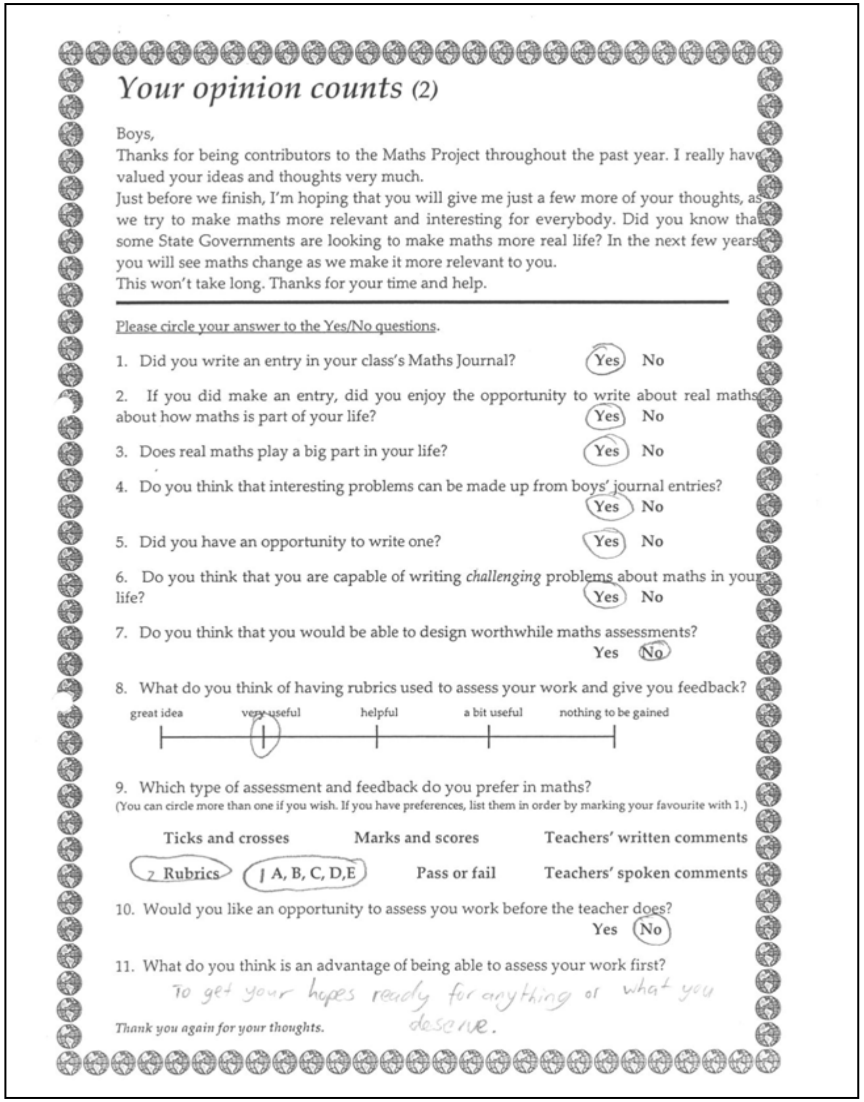
j. Write down one word of your own So thing Feell Confident

5. What is the biggest worry effecting your mathematics work at this time?

Thinking the answer is wrong

Adapted from: Clarke, D.J. (1992). Activating Assessment Alternatives. *Arithmetic Teacher*, Feb 1992, p.24-29.

Appendix 47: Fourth Student Survey – *Your Opinion Counts 2* (Examples)



Your opinion counts (2)

Boys,

Thanks for being contributors to the Maths Project throughout the past year. I really have valued your ideas and thoughts very much.

Just before we finish, I'm hoping that you will give me just a few more of your thoughts, as we try to make maths more relevant and interesting for everybody. Did you know that some State Governments are looking to make maths more real life? In the next few years you will see maths change as we make it more relevant to you.

This won't take long. Thanks for your time and help.

Please circle your answer to the Yes/No questions.

1. Did you write an entry in your class's Maths Journal? [✓ Yes] No
2. If you did make an entry, did you enjoy the opportunity to write about real maths about how maths is part of your life? [✓ Yes] No
3. Does real maths play a big part in your life? [✓ Yes] No
4. Do you think that interesting problems can be made up from boys' journal entries? [✓ Yes] No
5. Did you have an opportunity to write one? [✓ Yes] No
6. Do you think that you are capable of writing *challenging* problems about maths in your life? [✓ Yes] No
7. Do you think that you would be able to design worthwhile maths assessments? Yes [✓ No]
8. What do you think of having rubrics used to assess your work and give you feedback?

great idea [✓ very useful] helpful a bit useful nothing to be gained

9. Which type of assessment and feedback do you prefer in maths?

(You can circle more than one if you wish. If you have preferences, list them in order by marking your favourite with 1.)

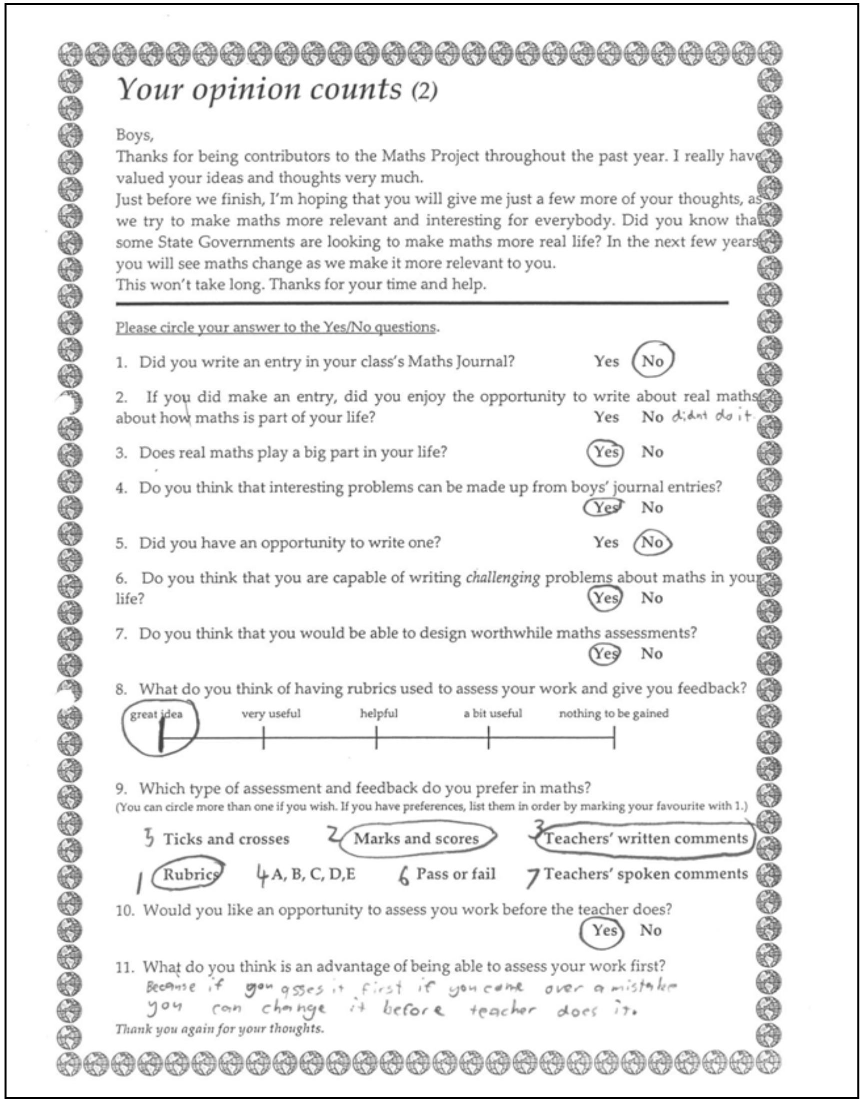
Ticks and crosses Marks and scores Teachers' written comments

[✓ 2 Rubrics] [✓ 1 A, B, C, D,E] Pass or fail Teachers' spoken comments

10. Would you like an opportunity to assess you work before the teacher does? Yes [✓ No]
11. What do you think is an advantage of being able to assess your work first?

To get your hopes ready for anything or what you deserve.

Thank you again for your thoughts.



Your opinion counts (2)

Boys,

Thanks for being contributors to the Maths Project throughout the past year. I really have valued your ideas and thoughts very much.

Just before we finish, I'm hoping that you will give me just a few more of your thoughts, as we try to make maths more relevant and interesting for everybody. Did you know that some State Governments are looking to make maths more real life? In the next few years you will see maths change as we make it more relevant to you.

This won't take long. Thanks for your time and help.

Please circle your answer to the Yes/No questions.

1. Did you write an entry in your class's Maths Journal? Yes [✓ No]
2. If you did make an entry, did you enjoy the opportunity to write about real maths about how maths is part of your life? Yes No didnt do it.
3. Does real maths play a big part in your life? [✓ Yes] No
4. Do you think that interesting problems can be made up from boys' journal entries? [✓ Yes] No
5. Did you have an opportunity to write one? Yes [✓ No]
6. Do you think that you are capable of writing *challenging* problems about maths in your life? [✓ Yes] No
7. Do you think that you would be able to design worthwhile maths assessments? [✓ Yes] No
8. What do you think of having rubrics used to assess your work and give you feedback?

[✓ great idea] very useful helpful a bit useful nothing to be gained

9. Which type of assessment and feedback do you prefer in maths?

(You can circle more than one if you wish. If you have preferences, list them in order by marking your favourite with 1.)

5 Ticks and crosses [✓ 2 Marks and scores] [✓ 3 Teachers' written comments]

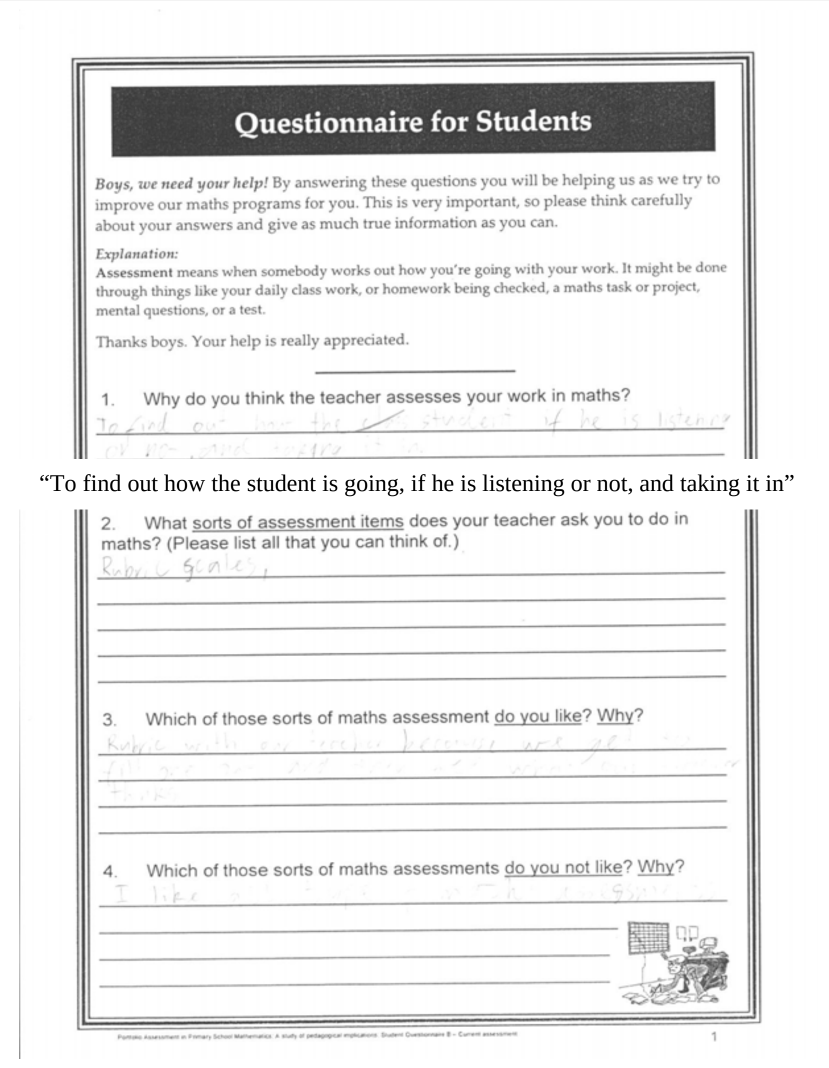
[✓ 1 Rubrics] 4 A, B, C, D,E 6 Pass or fail 7 Teachers' spoken comments

10. Would you like an opportunity to assess you work before the teacher does? [✓ Yes] No
11. What do you think is an advantage of being able to assess your work first?

Because if you asses it first if you come over a mistake you can change it before teacher does it.

Thank you again for your thoughts.

Appendix 48: Fifth Student Survey (Examples)



Questionnaire for Students

Boys, we need your help! By answering these questions you will be helping us as we try to improve our maths programs for you. This is very important, so please think carefully about your answers and give as much true information as you can.

Explanation:
Assessment means when somebody works out how you're going with your work. It might be done through things like your daily class work, or homework being checked, a maths task or project, mental questions, or a test.

Thanks boys. Your help is really appreciated.

1. Why do you think the teacher assesses your work in maths?
To find out how the ~~class~~ student if he is listening or no, and taking it in.

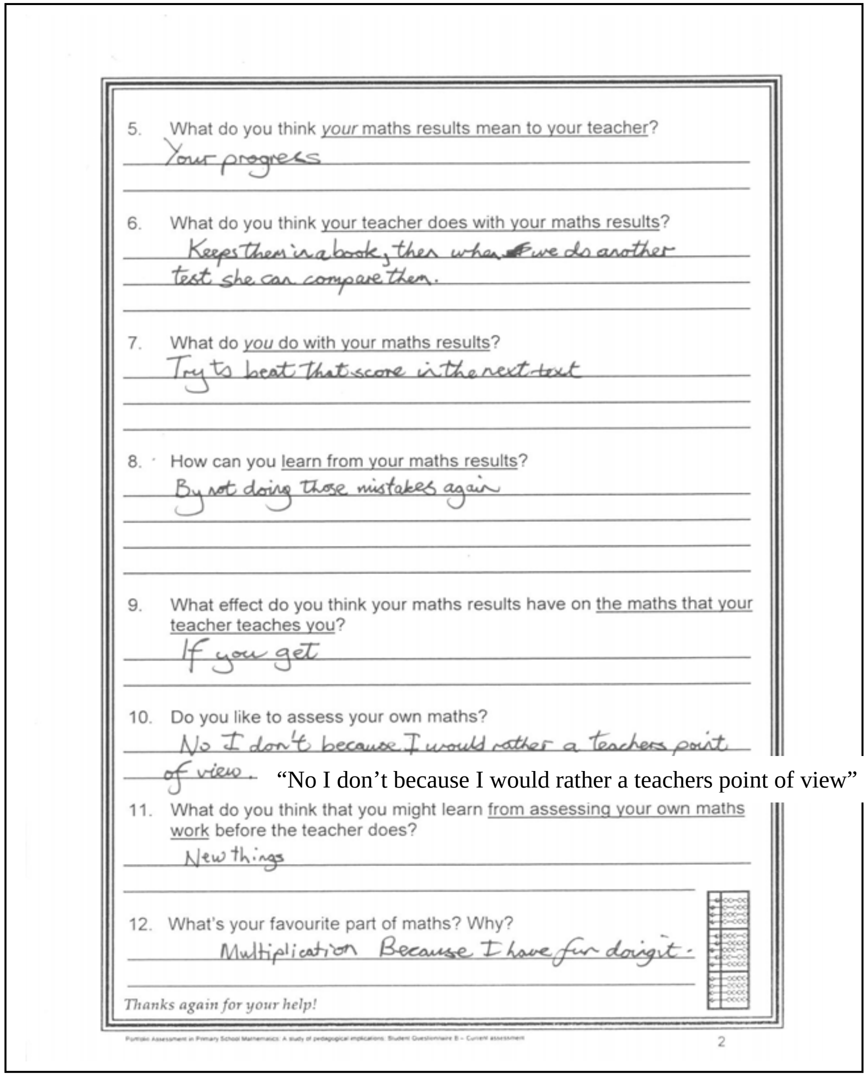
"To find out how the student is going, if he is listening or not, and taking it in"

2. What sorts of assessment items does your teacher ask you to do in maths? (Please list all that you can think of.)
Rubric scales,

3. Which of those sorts of maths assessment do you like? Why?
Rubric with our teacher because we get to fill one in and then [illegible] what our teacher thinks

4. Which of those sorts of maths assessments do you not like? Why?
I like all types of maths assessments

1



5. What do you think *your* maths results mean to your teacher?
Your progress

6. What do you think your teacher does with your maths results?
Keeps them in a book, then when ~~I~~ we do another test she can compare them.

7. What do *you* do with your maths results?
Try to beat that score in the next text

8. How can you learn from your maths results?
By not doing those mistakes again

9. What effect do you think your maths results have on the maths that your teacher teaches you?
If you get

10. Do you like to assess your own maths?
No I don't because I would rather a teachers point of view.

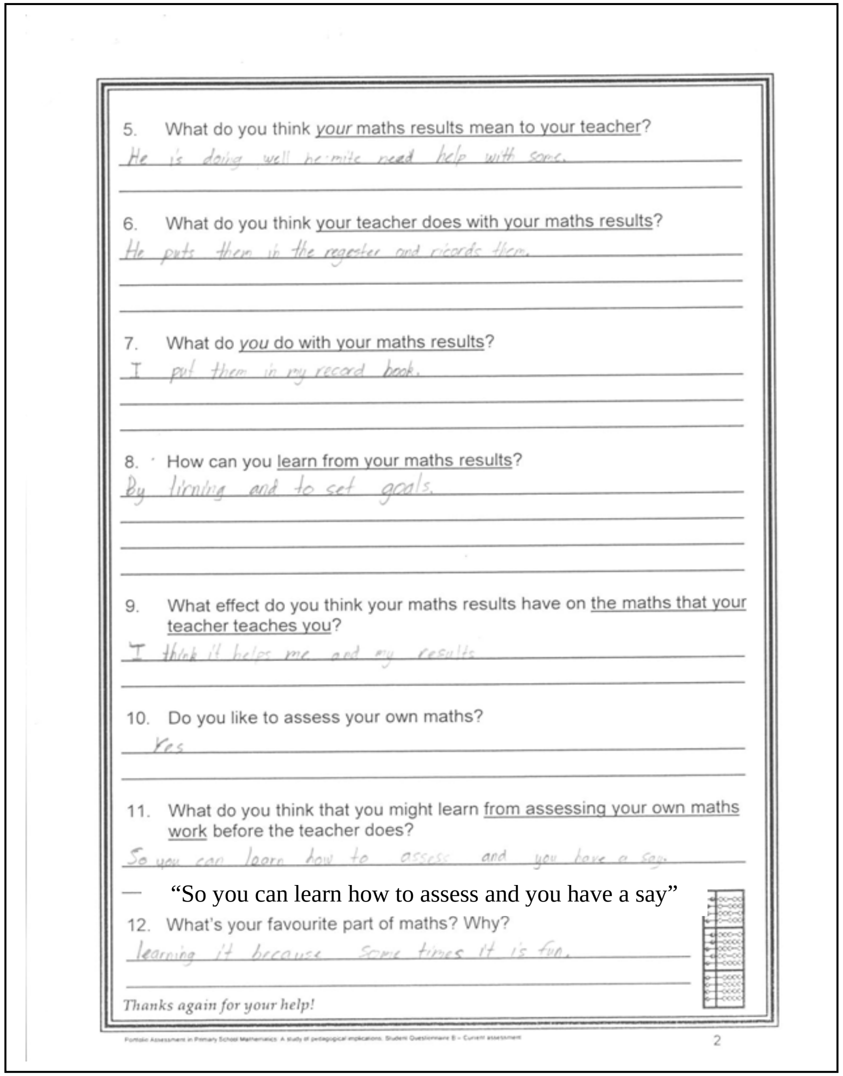
"No I don't because I would rather a teachers point of view"

11. What do you think that you might learn from assessing your own maths work before the teacher does?
New things

12. What's your favourite part of maths? Why?
Multiplication Because I have fun doingit.

Thanks again for your help!

2



5. What do you think *your* maths results mean to your teacher?
He is doing well he mite need help with some.

6. What do you think your teacher does with your maths results?
He puts them in the regester and records them.

7. What do *you* do with your maths results?
I put them in my record book.

8. How can you learn from your maths results?
By lirning and to set goals.

9. What effect do you think your maths results have on the maths that your teacher teaches you?
I think it helps me and my results

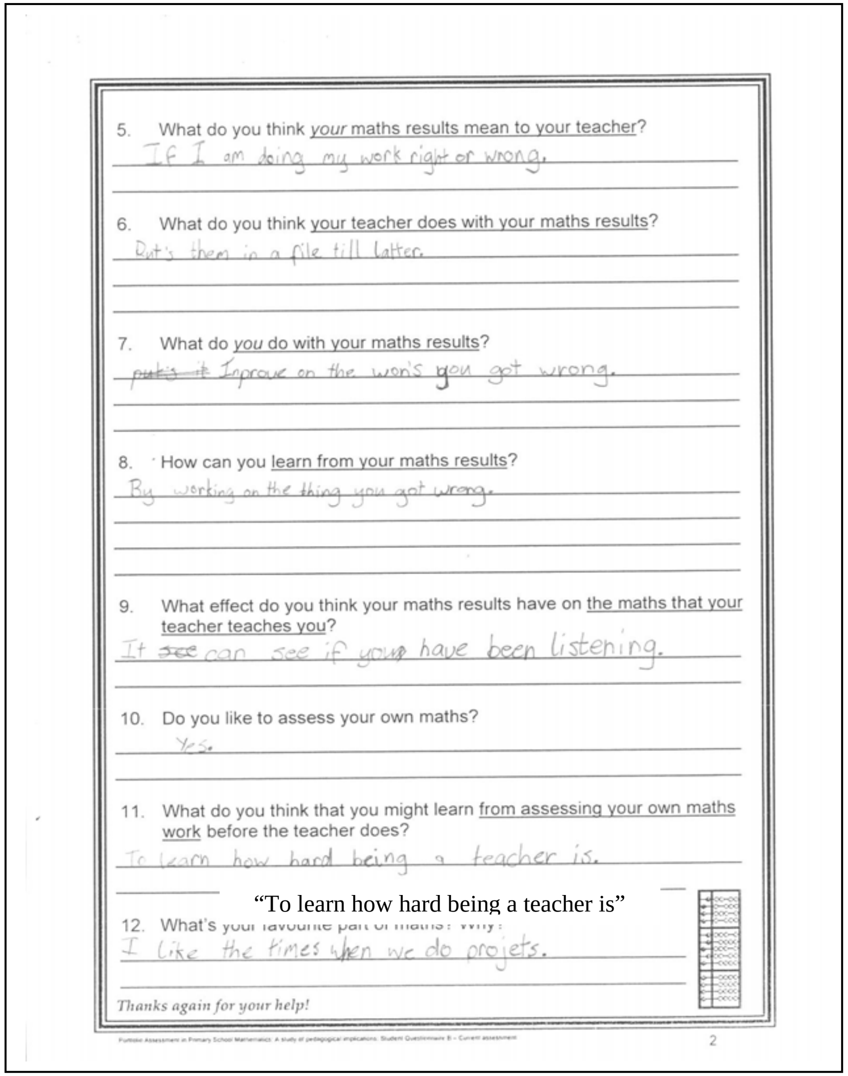
10. Do you like to assess your own maths?
Yes

11. What do you think that you might learn from assessing your own maths work before the teacher does?
So you can learn how to assess and you have a say.

“So you can learn how to assess and you have a say”

12. What's your favourite part of maths? Why?
learning it because some times it is fun.

Thanks again for your help!



5. What do you think *your* maths results mean to your teacher?
If I am doing my work right or wrong.

6. What do you think your teacher does with your maths results?
Put's them in a file till latter.

7. What do *you* do with your maths results?
~~puts it~~ Inprove on the won's you got wrong.

8. How can you learn from your maths results?
By working on the thing you got wrong.

9. What effect do you think your maths results have on the maths that your teacher teaches you?
It ~~see~~ can see if you~~r~~ have been listening.

10. Do you like to assess your own maths?
Yes.

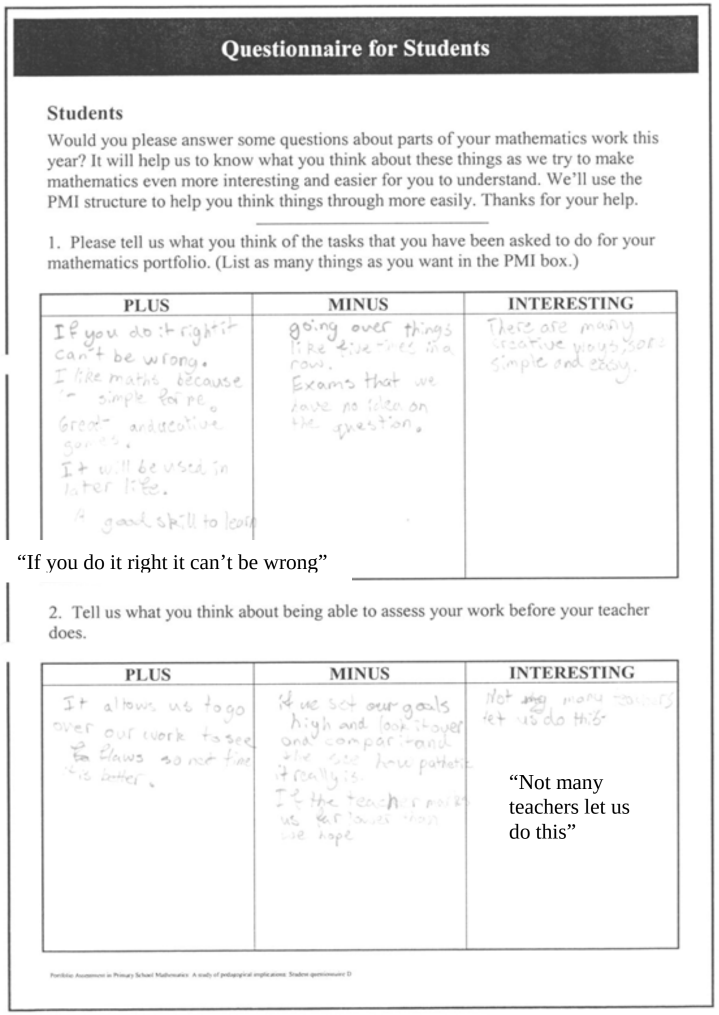
11. What do you think that you might learn from assessing your own maths work before the teacher does?
To learn how hard being a teacher is.

“To learn how hard being a teacher is”

12. What's your favourite part of maths? Why?
I like the times when we do projets.

Thanks again for your help!

Appendix 49: Sixth Student Survey (Completed Example)



Questionnaire for Students

Students

Would you please answer some questions about parts of your mathematics work this year? It will help us to know what you think about these things as we try to make mathematics even more interesting and easier for you to understand. We'll use the PMI structure to help you think things through more easily. Thanks for your help.

1. Please tell us what you think of the tasks that you have been asked to do for your mathematics portfolio. (List as many things as you want in the PMI box.)

PLUS	MINUS	INTERESTING
If you do it right it can't be wrong. I like maths because it simple for me. Great and creative games. It will be used in later life. A good skill to learn	going over things like five times in a row. Exams that we have no idea on the question.	There are many creative ways, some simple and easy.

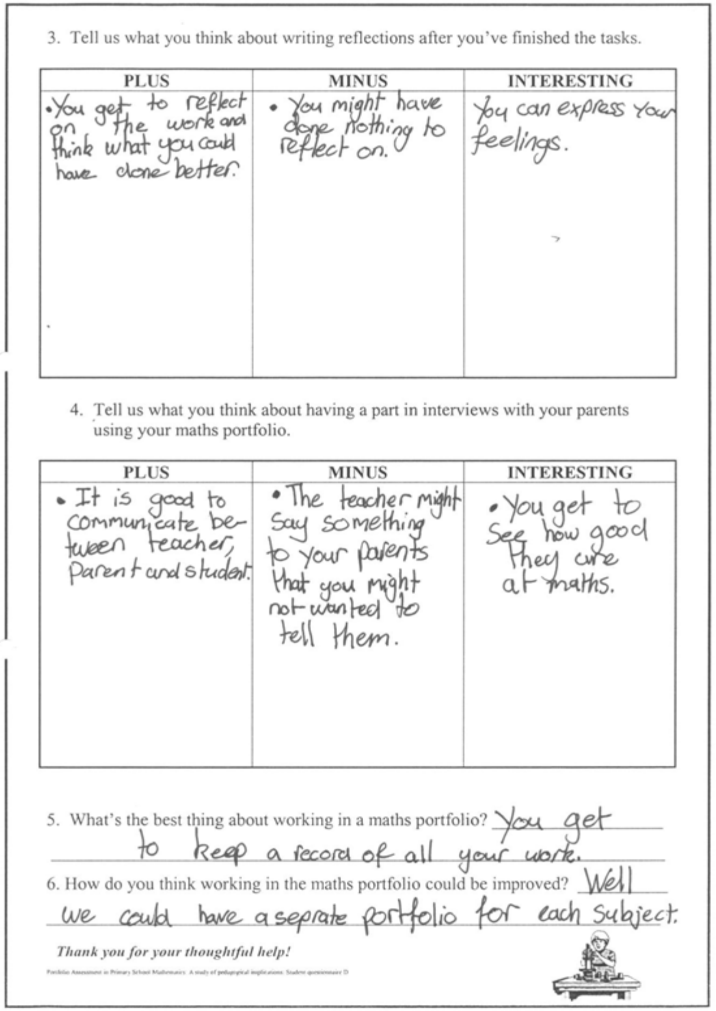
"If you do it right it can't be wrong"

2. Tell us what you think about being able to assess your work before your teacher does.

PLUS	MINUS	INTERESTING
It allows us to go over our work to see ~~to~~ flaws so not fine it is better.	If we set our goals high and look it over and compar it and the see how pathetic it really is. If the teacher marks us far lower than we hope	Not ~~my~~ many teachers let us do this.

"Not many teachers let us do this"

Portfolio Assessment in Primary School Mathematics: A study of pedagogical implications: Student questionnaire D



3. Tell us what you think about writing reflections after you've finished the tasks.

PLUS	MINUS	INTERESTING
•You get to reflect on the work and think what you could have done better.	• You might have done nothing to reflect on.	You can express Your feelings.

4. Tell us what you think about having a part in interviews with your parents using your maths portfolio.

PLUS	MINUS	INTERESTING
• It is good to communicate between teacher, Parent and student.	• The teacher might Say something to your parents that you might not wanted to tell them.	• You get to See how good they are at maths.

5. What's the best thing about working in a maths portfolio? You get to keep a record of all your work.

6. How do you think working in the maths portfolio could be improved? Well we could have a seprate portfolio for each subject.

Thank you for your thoughtful help!

Portfolio Assessment in Primary School Mathematics: A study of pedagogical implications: Student questionnaire D

Appendix 50: Parent Questionnaire Explanatory Letter

10 October 2004

Assessment of Primary School Mathematics

Dear Parents of

You will remember that way back at the start of the year I asked you to allow your sons to complete a questionnaire for me on the subject of Mathematics. The boys did an excellent job and provided a lot of useful information. Overall, the process revealed a great deal of worthwhile data as to our boys' perceptions and problems with Maths. We have already been able to integrate much of that information into our work as we develop something of a different way of looking at problem solving with various groups, from setting the tasks to assessing and reporting on the final products/outcomes.

Well, now I need to ask a large favour of *you*, and I'm hoping that your response will be as overwhelmingly supportive as it was earlier. We are very interested in your point of view in relation to Maths, so I have prepared a *short* questionnaire seeking your opinion on a variety of issues. If you could spare a few minutes, complete the enclosed questionnaire and return it to the Prep Office by Monday 18 October via your son it would be appreciated immensely. If there is any comment that you would like to write or something that you would like to share in relations to Maths to which we haven't referred, please feel free to add it to the final page, or where you think it fits. Your thoughts *will* prove invaluable!

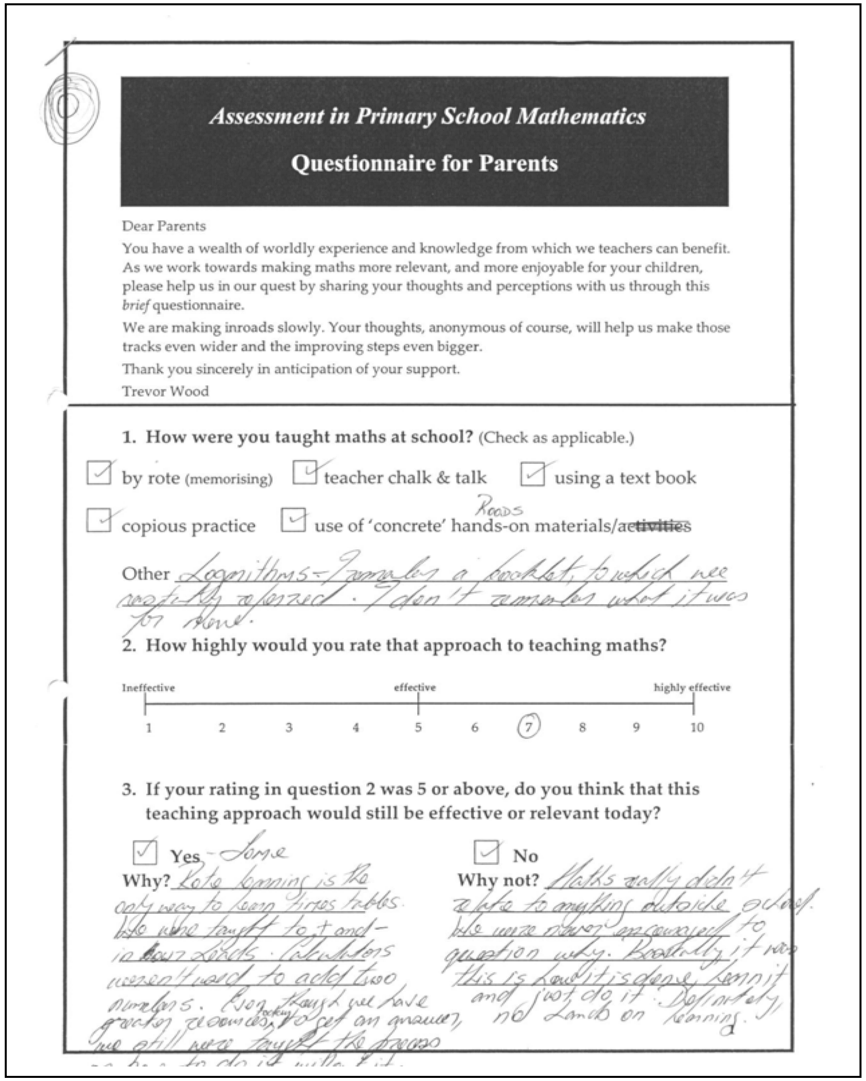
I know that I am asking for your time, but I would appreciate just a few minutes and the group of teachers with whom I am working believe that through this work we are well on the way to making Maths problem solving more relevant ('real'), more creative (heaven forbid!), and more enjoyable, as well as attempting to ensure that you gain a clearer, more comprehensive picture of how your son is progressing in the long run.

We hope that you can find that few minutes to share your thoughts and wisdom. Sincere thanks in anticipation.

Yours sincerely

Trevor Wood

Appendix 51: Parent Questionnaire (Completed Examples)



Assessment in Primary School Mathematics

Questionnaire for Parents

Dear Parents

You have a wealth of worldly experience and knowledge from which we teachers can benefit. As we work towards making maths more relevant, and more enjoyable for your children, please help us in our quest by sharing your thoughts and perceptions with us through this *brief* questionnaire.

We are making inroads slowly. Your thoughts, anonymous of course, will help us make those tracks even wider and the improving steps even bigger.

Thank you sincerely in anticipation of your support.

Trevor Wood

1. How were you taught maths at school? (Check as applicable.)

☑ by rote (memorising) ☑ teacher chalk & talk ☑ using a text book

☑ copious practice ☑ use of 'concrete' hands-on materials/ac~~tivities~~ RODS

Other Logarithms – Formulas a booklet, to which we regularly referred. I don't remember what it was for now.

2. How highly would you rate that approach to teaching maths?

Ineffective — effective — highly effective

1 2 3 4 5 6 [✓ 7] 8 9 10

3. If your rating in question 2 was 5 or above, do you think that this teaching approach would still be effective or relevant today?

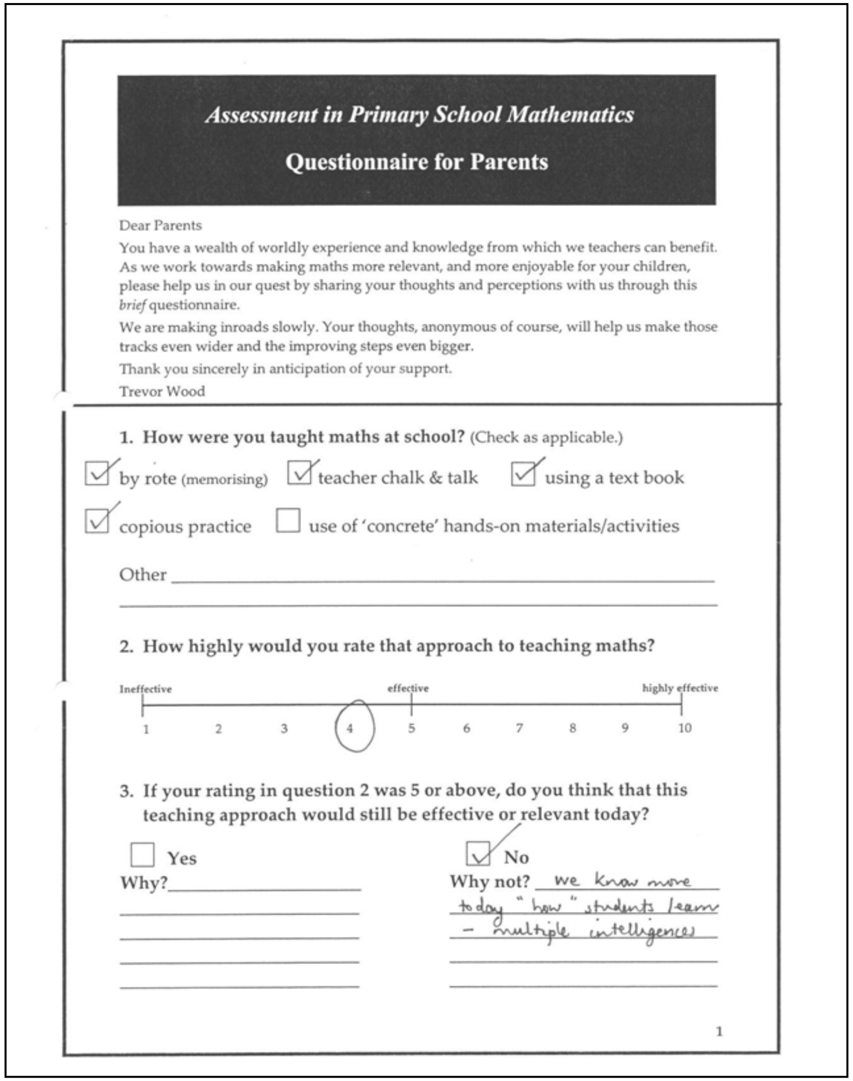
☑ **Yes** - Some

Why? Rote learning is the only way to learn times tables. We were taught to + and − in our heads. Calculators weren't used to add two numbers. Even though we have greater resources (technology) to get an answer, we still were taught the process on how to do it without it.

☑ **No**

Why not? Maths really didn't relate to anything outside school. We were never encouraged to question why. Basically it was this is how it is done, learn it and just do it. Definitely no hands on learning.

1



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Trevor Wood

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☑ by rote (memorising) ☑ teacher chalk & talk ☑ using a text book

☑ copious practice ☐ use of 'concrete' hands-on materials/activities

Other

2. How highly would you rate that approach to teaching maths?

Ineffective — effective — highly effective

1 2 3 [✓ 4] 5 6 7 8 9 10

3. If your rating in question 2 was 5 or above, do you think that this teaching approach would still be effective or relevant today?

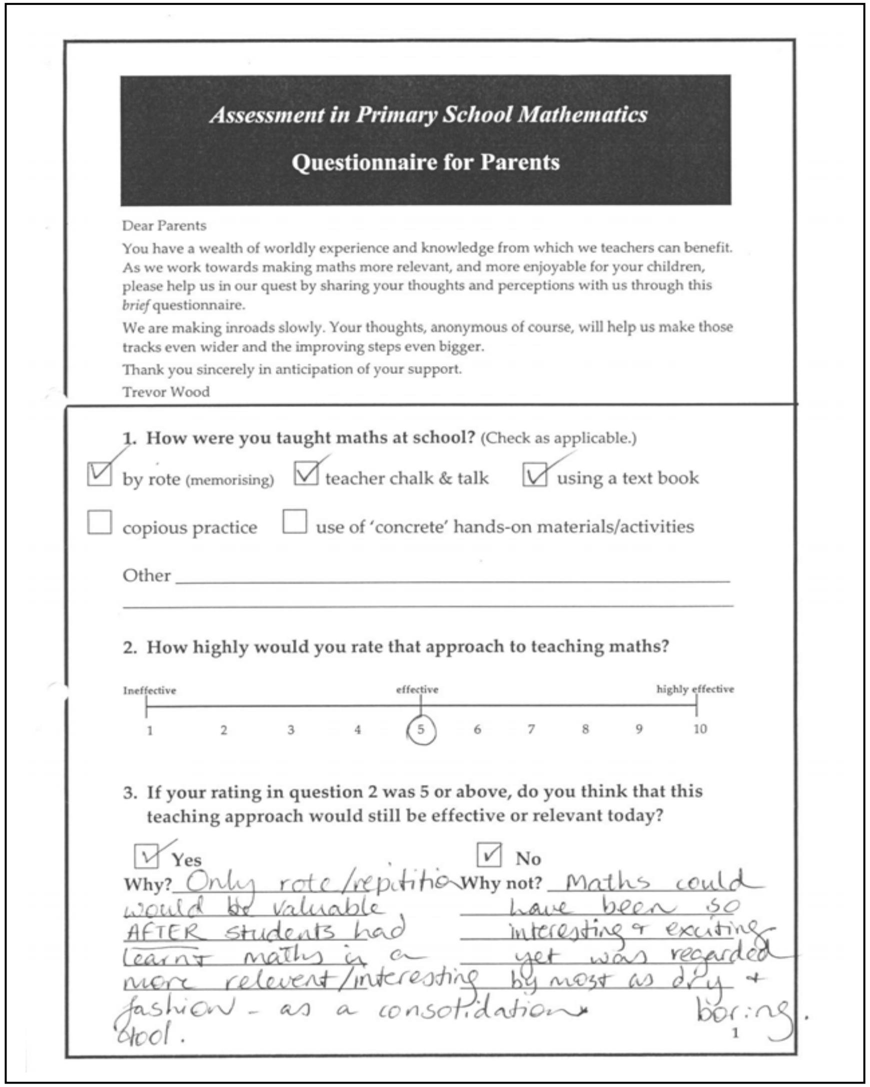
☐ **Yes**

Why?

☑ **No**

Why not? We know more today "how" students learn – multiple intelligences

1



Assessment in Primary School Mathematics

Questionnaire for Parents

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We are making inroads slowly. Your thoughts, anonymous of course, will help us make those tracks even wider and the improving steps even bigger.

Thank you sincerely in anticipation of your support.

Trevor Wood

1. How were you taught maths at school? (Check as applicable.)

☑ by rote (memorising) ☑ teacher chalk & talk ☑ using a text book

☐ copious practice ☐ use of 'concrete' hands-on materials/activities

Other ______

2. How highly would you rate that approach to teaching maths?

Ineffective — effective — highly effective

1 2 3 4 [✓ 5] 6 7 8 9 10

3. If your rating in question 2 was 5 or above, do you think that this teaching approach would still be effective or relevant today?

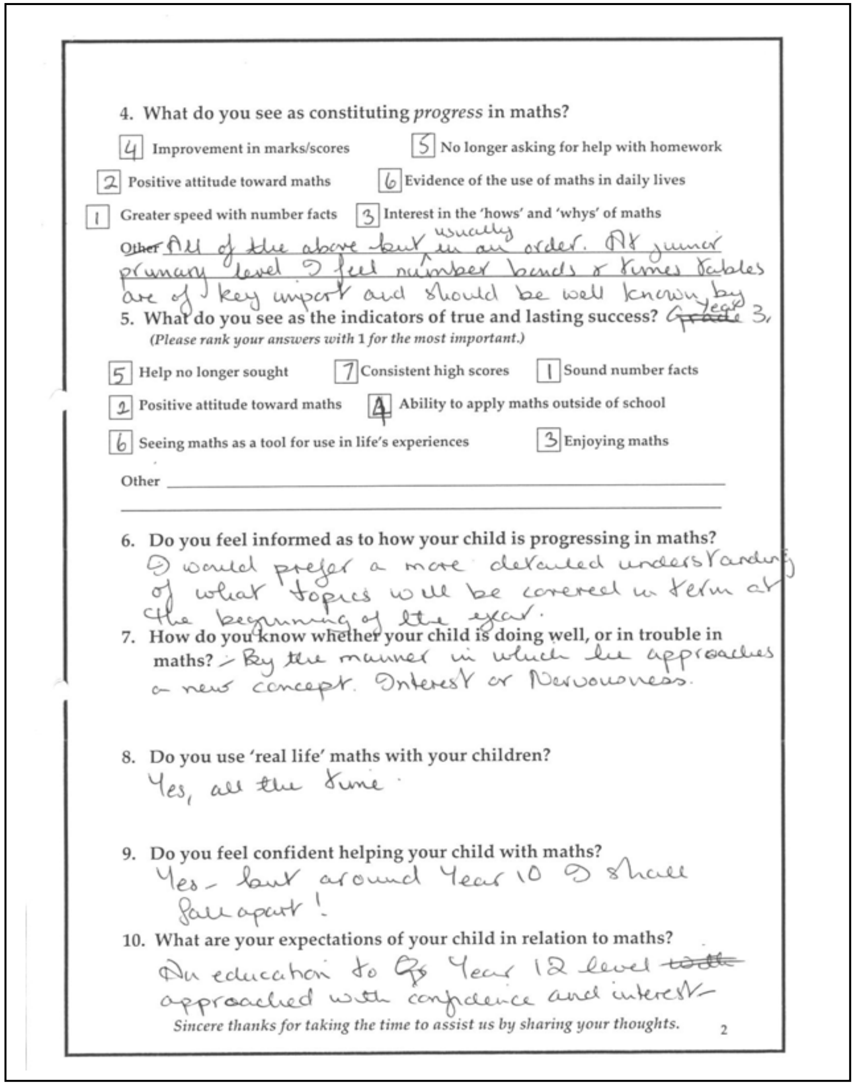
☑ Yes

Why? Only rote/repitition would be valuable AFTER students had learnt maths in a more relevent/interesting fashion - as a consolidation tool.

☑ No

Why not? Maths could have been so interesting & exciting yet was regarded by most as dry + boring.

1



4. What do you see as constituting *progress* in maths?

4 Improvement in marks/scores

5 No longer asking for help with homework

2 Positive attitude toward maths

6 Evidence of the use of maths in daily lives

1 Greater speed with number facts

3 Interest in the 'hows' and 'whys' of maths

~~Other~~ All of the above but usually in an order. At junior primary level I feel number bonds & times tables are of key import and should be well known by ~~Grade~~ Year 3,

5. What do you see as the indicators of true and lasting success?

(Please rank your answers with 1 for the most important.)

5 Help no longer sought

7 Consistent high scores

1 Sound number facts

2 Positive attitude toward maths

4 Ability to apply maths outside of school

6 Seeing maths as a tool for use in life's experiences

3 Enjoying maths

Other ______

6. Do you feel informed as to how your child is progressing in maths?

I would prefer a more detailed understanding of what topics will be covered in term at the beginning of the year.

7. How do you know whether your child is doing well, or in trouble in maths? - By the manner in which he approaches a new concept. Interest or Nervousness.

8. Do you use 'real life' maths with your children?

Yes, all the time.

9. Do you feel confident helping your child with maths?

Yes - but around Year 10 I shall fall apart!

10. What are your expectations of your child in relation to maths?

An education to Year 12 level ~~to the~~ approached with confidence and interest -

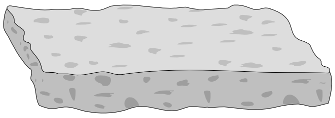
Sincere thanks for taking the time to assist us by sharing your thoughts.

2

Appendix 52: Mathematics News Sheet – *The Latest Addition*

Year 7's **The Latest Addition** October 2005

The newssheet that keeps you up to date with what's happening in mathematics!



SPACE IN SPONGES?

How does a sponge manage to absorb so much water? How much water can a sponge absorb? How much air space is there in a sponge? This month Year 7 are looking at that question.

Students have been given the task of discovering a method of measuring the space in a sponge. Sponges are readily available for them to try their ideas.

How accurate can that measurement be? Try your hand at measuring the space in a sponge!

GOING MENTAL!

Speedy short cuts to make life easy!

When multiplying by 25, divide the number by four and call the answer hundreds.

E.g. 48 X 25: 48 ÷ 4 = 12, so it's 1200.
23 X 25: 23 ÷ 4 = 5¾, so it's 575.

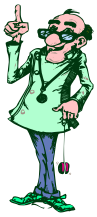
What about a similar short cut for multiplying by 20? ***Can you think of one?***

PARENT & MATHS INSIGHTS

If you would like an insight into what Year 7 is doing in maths this term, why not come along to this term's workshop session? All are welcome and no previous insight is needed.

Where: **Year 7 classrooms**
When: **Wednesday October 5, 6–7pm**

What to bring: *Just yourself and an interest in mathematics.*



See you there!

SIMPLE INTEREST SIMPLIFIED

Simple Interest is called 'simple' not because all of the calculations are simple, but because it can all be done in one line. The complicated interest is called Compound Interest, but that will be learned in a later year.

Here's the question: You borrowed $2 500 for 4 years and paid 8% per year simple interest. How much will you repay in total?

The interest calculation formula is simply:
Principal (amount) X (Interest) Rate X Time (years)
It's written as:

$$\frac{P}{1} \times \frac{R}{100} \times \frac{T}{1}$$

So we have:

$$\frac{2500}{1} \times \frac{8}{100} \times \frac{4}{1}$$

We use our knowledge of cancelling down fractions:
(Remember what you do to one you must do to the other)

$$\frac{\cancel{2500}}{1} \times \frac{8}{\cancel{100}} \times \frac{4}{1}$$

$$= 25 \times 8 \times 4$$

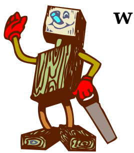
$$= \$800$$

(You could use our short cut from GOING MENTAL!)

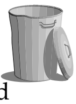
So, if you borrowed $2 500 and paid $800 interest over the 4 years, you will have to pay back a total of

$3 300

THIS MONTH IN MATHS



we will be working with:



Volume
Simple Interest and
Measurement

How many number facts can you do in 3 minutes?

Look out for next month's problem with Buzz the Blowfly!

Appendix 53: Parent Interview Schedule

	Monday 30/8	Tuesday 31/8	Wednesday 1/9	Thursday 2/9	Friday 3/9
0745	▨	▨ **JP (4, 2, 5&7, F)**		**KM (4, 2, 2&5, F)**	▨
0815	▨	**GP (5, 2, 5&3, M)**		**LL (6, 1, 6, F)**	▨
0900	▨			**KB (7,2, 5&6, F)**	▨
0930	▨				▨
1000	▨			▨	▨
1030	▨			▨	▨
1100				▨	▨
1130					▨
1200					
1230					**RM (11, 2, 10&7, F)**
1300		**KR (9, 2, 8&5, F)**			
1330				**KW (3, 2, 4&5, F)**	
1400	**1415 PF (7, 2, 4&6, M)**	**JH (5, 1, 4, M)**			
1430				**PH (10, 2, 9&6, F)**	**CM (5, 3, 1&4, F)**
1500	**SR (2, 1, 4, F)**	**ER (8, 2, 7&5, F)**	**TW (5, 2, 9&5, F)**		**AE (<1, 1 , 7, F)**
1530	**JB (<1, 1, 4, F)**		**DN (13, 2, 12&7, F)**	▨ **BB (2, 1, 4, F)**	**TP (1, 2, 3&5, F)**
1600	**SF (1, 1, 7, F)**		▨ **JR (<1, 1, 7, F)**		
1630	**VM (3, 1, 6, F)**				

Code
(Time parent at this school in years, number of students at this school , year level of student/s, sex of participant parent)
Shaded = appointment cancelled

0830 Tuesday 7/9 TS (<1, 1, 6, F)
0900 Tuesday 7/9 BD (8, 2, 5&6, M)

Appendix 54: Parent Interview Transcript (Parent J)

Parent J (Mother)

Good morning J. Thanks for giving me the time. As I said in my letter at the start of the year, I am looking into various aspects of assessment and reporting. I would like to ask you a few questions regarding reporting so that I can gain a more complete picture of the effectiveness of our current reporting system and future possible directions.

What does the school's current form of reporting tell you about your son's progress?

I know that he is in the top percentile in the class and that others try to keep up with him. I really don't get much from the Record Book. If I have a problem I go to the teacher direct. He has done maths with Ms B and she has been able to get through to him.

If you miss some of the maths building blocks you don't get it later on.

Are you happy with the current form?

I don't get a lot from the report; I am a more face-to-face person.

I think it is quite general. It is politically correct; sometimes I get concerned about that.

Is there anything that it does not tell you that you would like to be told?

Perhaps some marks and scores would help. I'm not sure actually.

Is there any other way that you currently use to obtain that information?

Well, really as I said, ***I get most of what I want to know from face-to-face with the teacher.***

How would you prefer to receive that information?

Face-to-face is OK really.

Do you see your son's schoolwork very often?

No, as I said maths is a concern for me. The homework is his responsibility. If he has a question he has to ask me. I want them to complete their own homework. If he is struggling I lend a hand – it is usually maths. I cannot see the point of him writing out a maths problem; it just takes time.

What do you think of the idea of a portfolio of your son's schoolwork that you can view?

Yes, definitely.

If we had a maths portfolio this is what we would be looking at. Some students have begun working with it, with others to have it introduced over the coming weeks. The student is given a task sheet which clearly explains what he is to do. Along with that he is given a double rubric, like this, so that he can see how he is to be assessed. Task and assessment are explained at the time. Using one side of the rubric, the student has to assess himself when he has finished the task. Then he hands it in and the teacher assesses it. What do you think of the concept?

If he knows what is expected of him he will give 150%, *but if he doesn't know he flounders.*

All he wants to do is to do everything to please the adult or teacher. It would be excellent for my son; once he knows he is off.

Would you find formal interview opportunities to check on your son's progress through reviewing his portfolio with his teacher useful?

Yes, I use the formal slot even though I am a regular visitor to the class.

In relation to the assessment and reporting of student progress, is there anything that we haven't covered that you would like to raise about reporting?

I am here a lot. If our son has an issue I am here.

Thanks very much for your time and support J.

Appendix 55: Parent Interview Transcript Extracts

Parent A (Mother)

Would you find formal interview opportunities to check on your son's progress through reviewing his portfolio with his teacher useful?

Certainly. As I said I do take advantage of the interview opportunities offered. A portfolio would add to interview opportunities.

Parent C (Father)

If we had a maths portfolio this is what we would be looking at. Some students have begun working with it, with others to have it introduced over the coming weeks. The student is given a task sheet which clearly explains what he is to do. Along with that he is given a double rubric, like this, so that he can see how he is to be assessed. Task and assessment are explained at the time. Using one side of the rubric, the student has to assess himself when he has finished the task. Then he hands it in and the teacher assesses it. What do you think of the concept?

Do the children understand the concept? If I was Year 7 and I was asked to assess myself I would probably assess myself higher. I see this as not only a maths but also a comprehension problem. If the student weren't good at English they may struggle. The problem the boys have is not the inability to do maths but to be able to read the question and understand what is required. ***It's very thought provoking and good for the mind as well.*** *If they can relate to their own experiences that would be terrific.*

About how often would you have a formal progress interview with your son's teacher?

I only have them rarely because of work commitments. My wife sees the boys' teachers reasonably regularly for brief chats sometimes, but formally only about once a year.

In relation to the assessment and reporting of student progress, is there anything that we haven't covered that you would like to raise about reporting?

No, the semester report is very comprehensive. We look ***very quickly at the ratings, but more at the comments****. Not really. We don't know how they are going day-to-day, apart from what they tell us.*

Parent E (Father)

Good afternoon E. … What does the school's current form of reporting tell you about your son's progress**?**

It gives me a basis idea of what is going on. The most effective form of reporting is feedback through the Record Book. It is an excellent form of feedback. Of course the semester reports I find they are very 'new agey' and difficult to know what is going on. I personally don't like the format that the school reports are in – maybe they are politically correct and maybe it is a new way, but I like the old style, that is an A is an A and an F is an F. …

I was under a British system and A, B, was the norm. There were A+ and A-; you really got a feel of how you were going. I could tell my progress. I find it very hard to decipher the current system. A more precise scale would be better, how I interpret it; it is very open and open to interpretation.

The semester reports don't tell me a great deal. We ***gain the most information by approaching the teacher verbally.*** *What is written down is kind of nice, but we really get the meat and gristle of our son's progress by verbal contact. The maths assessment – benchmark is quite good. They tell you where your son went right or wrong. It helps us focus on where the weaknesses are in our son's understanding. J___ understands it all if it is put to him in a way he does understand and we are* *working hard on that. Anything in writing is very difficult to interpret where his weaknesses are.*

Would you find formal interview opportunities to check on your son's progress through reviewing his portfolio with his teacher useful?

Absolutely critical.

Parent F (Father)

Do you see your son's schoolwork very often?

Probably only the work that does come home. It would be a matter of me making the time to come into his classroom. ***If he brought home more work I would certainly have a look at it.***

If we had a maths portfolio … What do you think of the concept?

That sounds really good. It would teach ongoing logic. Schooling is about training your mind for use farther down the track. It would make him ***take responsibility for his learning****. It would be excellent.*

Parent G (Mother)

If we had a maths portfolio … What do you think of the concept?

I think it would be great – it would be interesting how the student would mark themselves. I would be very interested to see how it develops.

I feel very positive about that*. I think the opportunity to go over at home would be great. I would certainly be interested.*

Parent K (Mother)

If we had a maths portfolio … What do you think of the concept?

The self assessment would be very valuable. ***I am for that. It would give us a greater insight into the boys' thinking in lots of ways. I like the idea****.*

Parent N (Mother)

If we had a maths portfolio … What do you think of the concept?

*Very thorough****.*** ***I like the idea of self assessing, reflecting on his work****. It would make him think. Even if he didn't get a good mark I think the experience would be good. He would always feel he has achieved something. I really think it is good. They would take responsibility for their learning.*

Parent P (Father)

If we had a maths portfolio … What do you think of the concept?

That is the sort of maths I like*. It is the sort of maths that you would use every day; it is excellent.*

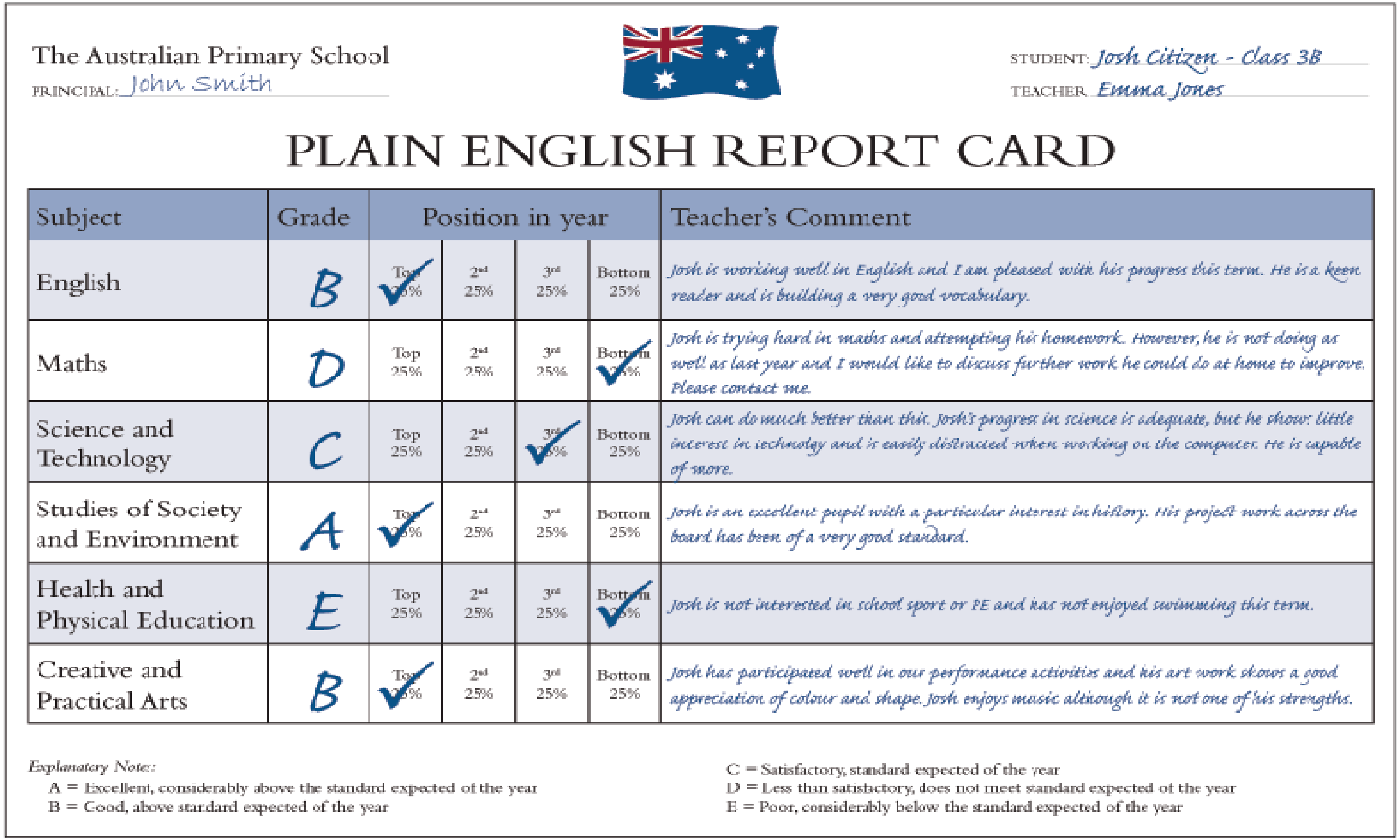
It would be good if he self assessed; he is very confident and would mark himself up. I think this is one of the most important things to learn. It's life Maths – it's very important.

Parent Q (Mother)

If we had a maths portfolio … What do you think of the concept?

It would give him a sense of responsibility. ***My son would say that is the very best I could do. I am working way beyond my limits****. I think it is a terrific set up.*

Appendix 56: Plain English Report Card (Government Exemplar)



The Australian Primary School
PRINCIPAL: John Smith

STUDENT: Josh Citizen - Class 3B
TEACHER: Emma Jones

PLAIN ENGLISH REPORT CARD

Subject	Grade	Position in year				Teacher's Comment
English	B	✓ Top 25%	2nd 25%	3rd 25%	Bottom 25%	Josh is working well in English and I am pleased with his progress this term. He is a keen reader and is building a very good vocabulary.
Maths	D	Top 25%	2nd 25%	3rd 25%	✓ Bottom 25%	Josh is trying hard in maths and attempting his homework. However, he is not doing as well as last year and I would like to discuss further work he could do at home to improve. Please contact me.
Science and Technology	C	Top 25%	2nd 25%	✓ 3rd 25%	Bottom 25%	Josh can do much better than this. Josh's progress in science is adequate, but he shows little interest in technology and is easily distracted when working on the computer. He is capable of more.
Studies of Society and Environment	A	✓ Top 25%	2nd 25%	3rd 25%	Bottom 25%	Josh is an excellent pupil with a particular interest in history. His project work across the board has been of a very good standard.
Health and Physical Education	E	Top 25%	2nd 25%	3rd 25%	✓ Bottom 25%	Josh is not interested in school sport or PE and has not enjoyed swimming this term.
Creative and Practical Arts	B	✓ Top 25%	2nd 25%	3rd 25%	Bottom 25%	Josh has participated well in our performance activities and his art work shows a good appreciation of colour and shape. Josh enjoys music although it is not one of his strengths.

Explanatory Note:
A = Excellent, considerably above the standard expected of the year
B = Good, above standard expected of the year
C = Satisfactory, standard expected of the year
D = Less than satisfactory, does not meet standard expected of the year
E = Poor, considerably below the standard expected of the year

Appendix 57: Three Way Interviews (Parent-Teacher-Student) Notes

Teacher D

14 boys made interviews with their parents in 6_. Most were at the end of Term 3 and some at the beginning of Term 4.

The interview *agenda* was conducted in basically the same way for each:

- Open ended questions posed to the boys, about what they enjoyed in 6_, specialist classes, social friends and anything they would like to see changed in class
- The *triangular team* was re-established, to promote communication between student-parent-teacher
- A quick overview from the check-list of his accomplishments
- Student then proceeded to explain and present the portfolio to their parents – questions were asked along the way
- Examples were produced to show progression from January to present
- Behaviour Log was produced and indicated if there were any patterns
- General discussion about maths – including home, homework, home help and attitudes.

The boys explained the assessment parts, with a recap of what they had to do in various, or single chosen tasks.
The boys then explained the concept of the *Rubric* to their parents as they perceived it. I just filled in the gaps.

Questions were then asked to the parents as to what were their feelings toward the Maths portfolio?

Parent quotes:

1. ***It really shows what they have to do!***
2. It's very clear and set out in a way that even *I* can understand.
3. It's nice the boys get a say in how they think they went.
4. ***The words make it easy to see what they have to do to get to the next level.***
5. If my boy is competent, is that good? Why is he not in the performing beyond?
6. ***At least I can see he's honest in his assessment, as your's matches.***
7. This is the same set up that I see in my University assignments for my own assessment.
8. He certainly enjoys having a big sister who likes maths.
9. I like the feedback this gives but some comparison done properly doesn't hurt I don't think. He does have to live in a competitive world out there.
10. My son can really understand this feedback better then a 'tick-mark'.
11. Well, I help him whenever he gets stuck at this stage. He doesn't really go looking for help from his older brothers and sisters.
12. When looking at work 6 months ago, it's clear as to where he was performing and you don't have to look too much further than the actual rubric to judge his work – it's all there.
13. I think that a positive home is really important. Even if I do struggle with some of the things that he asks I try to be positive.
14. This is a good idea!
15. No, I'm not a fan of just marks and comparison to others.
16. The other two children don't seem to like maths much, but he certainly does. He says that it makes him get smarter and I agree.
17. I like how some in some areas it shows his strengths and in others it shows what he needs work on, like organisation.

18. The words are very good. I can understand this as a parent. I even feel that I am getting smarter in maths.
19. By putting in the performing beyond column, it gives them something extra to strive for. They can be satisfied with competent, but the motivation is there to do even better, as in that last column.
20. My son really likes to assess his own work. Finally, he gets a say!
21. ________ really gets involved in the whole process and loves to share it at home now. We hear all about the tasks. Even his brother joins in sometimes.
22. If he's not going so well, how can I help him get to the competent column?
23. ***My son feels interested in what he's doing as he knows it means something if there is a rubric attached. It's almost like he feels more anxious to get the work done.***
24. I believe it is possible for a child to become smarter and my son seems to be at least in mathematics and I think that working this way has something to do with it.
25. His little brother likes to get involved in his projects.
26. The rubric lets him know exactly what is expected.

Overall: Very supportive parents – they really appreciated the chance to see all sides of the story, a chance for their sons to get involved from the beginning with writing tasks right through to self-assessing. They were all supportive of the need for students to understand maths, not just be able to remember facts parrot fashion. The boys seemed to enjoy the chance to have mum and dad in an interview that they were big parts of. They really got involved. Parents liked to see all of the information – tasks sheets and rubrics as it helped them not only find out what was happening in the class but it helped them remember stuff from many years ago and that helped them help their children at times. It really was a very positive time and all made some sort of comment about the positive attitudes to maths at home that was coming out or getting stronger.

I will be recommending this process to other staff members!

Teacher E

Purpose
Throughout this year students have created a collection of work samples, or learning artefacts in their process portfolios to provide tangible evidence of their learning and progress. All parts of the problem solving tasks as well as tests have been included and displayed. Teacher observations and interactions with students and a review of regular class performance were then added to validate my judgements about individual student progress in formal semester reporting to parents.

Procedure
There are a range of assessment pieces presented in the portfolios:

- Embedded assessment tasks including the work sample and double assessment rubric
- Student self-reflective questionnaires and comments about particular topics/units of study taken at various levels along the learning sequence
- Tests with checklist rubrics and student reflective comments about progress
- Test with numerical scores

Before portfolio interviews students took their portfolios home to show their parents. Students have the opportunity to explain and discuss the learning asks and the processes for assessment. In particular students can explain the rubric assessment process to educate their parents on embedded assessment procedure.

In previewing the portfolio prior to the interview, parents can focus their questions and discussion at interview on issues and information arising from their viewing of the portfolio, making interview time more focused and purposeful.

Parent feedback on portfolios
My overriding comment would have to be about the relaxed nature of the discussions.

Parents seemed to like having specific things there to talk about and the fact that they had seen them and discussed before the interview. Overall the interviews were very positive, and comfortable for all concerned.

The boys did an excellent job explaining things to their parents. In fact in some cases I had a problem getting any comment in for a while. Their preparation was terrific! (We had done preparation in class and discussed it quite a bit.)

Parents liked the information provided by the assessment rubrics because they were able to clearly see the purpose of the tasks and the outcomes expected.

Parents were very interested in reading their child's self-reflection because these gave them greater insight into student perceptions about their own performance. Several commented on the trust that seemed to be building within their sons in relation to their learning and being able to make comment on their performance before the teacher.

Several parents were intrigued by questions about their attitude to maths and their sons seeking help from them. As a whole the group were very supportive of the maths that was being done and willing to help at home in any way they could, although several mothers did say it was time their sons were starting to become self-reliant. The group was reasonably evenly split when it came to actually liking maths but the few fathers who were able to attend all said that they enjoyed maths. Some said that they asked to help their sons. Siblings liking of maths proved an interesting question. Some parents didn't really know how strongly their children felt about a number of things about school, including maths. Others talked of having older children who liked maths and who this particular child would ask for help. They said that a positive attitude was important, as in any subject, and that having an older child who liked maths did seem to have an effect on the younger – besides it gave the parent a chance to hand the homework question on.
Parents commented on the real nature of much of the work in comparison to the maths they learned at school. They often added that their child seemed to enjoy working with problems that had real application, even if they struggled a bit. They were getting not only a greater insight into the maths being done because they were getting more involved than they had been for years, but into their son's strengths and weaknesses as well. Parents were getting to feel comfortable with maths much more because they were learning things that they had forgotten. Many said that their renewed interest in school maths seemed to have a positive effect on their son's attitude, even the very good boys.

Parents liked the range of information in the portfolios because they got to see how their child performed in tests compared with other tasks and how these together provided a picture of overall student progress. There was virtually no mention of comparisons across the class or year level. The strong theme of parents learning through their child's working in the way they were was worth comment too.

From my point of view we have achieved a great deal so far. We need to keep going and now get others really involved.