Science and Mathematics Education Centre

Perceived Effects of Embedding a Learning Strategy Course in a Year 8 Science Program

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Abstract

A year long learning strategy course was designed and embedded in a Year 8 science curriculum. The Science Learning Strategy (SLS) program aimed to improve student ability to apply learning strategies to science, increase student achievement in science and to augment students' feelings of control over their science learning, so that their perceived competence was maximised. Achievement of these aims was monitored by collecting perceptions from students, parents and the teacher/researcher via a range of devices including questionnaires, work samples and interviews.

The program overall was regarded as successfully achieving all three aims by 22 of the 24 students. The other two students found that only some aspects of the course were helpful, and felt they had learned little from the program.

Thirty three percent of parents attributed positive changes in their daughter's study and learning strategies to participation in the SLS program (the remainder were unsure, or did not know of any changes). In relation to perception of academic performance, 38% of the parents interviewed believed that the SLS had a positive effect on their daughter's achievement in science. Several of these parents reported very positive effects on performance. The remainder were not sure or did not know if there had been any positive effects. No parents mentioned that the SLS program had caused a drop in science performance. The proportion of parents believing their daughters blamed disappointing results on factors they couldn't control dropped from 45% at the start of the year, to 22% by the end of the SLS program. After the intervention, 33% of parents reported that their daughters had come to believe that their science performance was affected by many factors, most of which they could control.

The teacher/researcher observed strong improvement in student ability to apply learning strategies to science as a result of participation in the program. Students were also observed by the teacher/researcher, to have been assisted by the intervention to realise that their science performance was governed not only by their natural ability, but also by factors such as studying behaviour and affective influences. In particular, the

program appeared to the teacher/researcher to have helped students realise that they had control over their use of learning strategies, and that this control could influence their science performance. However, the teacher/researcher found that no statistically significant changes in science achievement resulted from student participation in the SLS course.

The other objective of the research was to investigate the extent to which learning strategy education was valued and implemented by Western Australian science teachers. The 218 returned surveys revealed that most respondents recognised the need to teach these skills during science lessons. Seventy six percent of respondents considered the delivery of learning strategy instruction in the lower school science classroom to be as important, or more important, than teaching subject processes and content. Sixty seven percent recognised that improving study strategies can improve confidence and/or motivation.

Many teachers, however, had not been able to convert these views into consistent classroom practice. A moderate proportion of teachers reported teaching a variety of learning strategies; 74% of the respondents agreed that learning strategy instruction could improve performance in science. Only one teacher specifically mentioned incorporating the teaching of learning strategies with instruction in science process and content.

As a future outcome of this project, the teacher/researcher will encourage other teachers to embed learning strategy instruction within the science curriculum, so that their students come to feel more in control of their learning and can learn more effectively.

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This work is dedicated to my father who taught me about persistence and patience.

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Chapter 1
Introduction

1.1 Background to the research project

In the process of tutoring high school students in science subjects over a number of years, it became apparent to the researcher that many students had problems managing and synthesising the large amount of conceptual material covered at school. Interacting with students on a one-to one basis in this setting provided an opportunity to gain insights into the way in which students' confidence, motivation and performance in science subjects appeared to improve with tuition in learning strategies such as paraphrasing, summarising and concept mapping. Students also benefited from assistance with time planning, test preparation and completion strategies and goal clarification (McGlynn, 1997).

Subsequently, four week learning strategy courses were incorporated into the researcher's lower school science programs and student perceptions of the courses were monitored in a study that was a precursor to the current investigation. Students consistently found value in the learning strategy courses (McGlynn, 1997). For example, 38% of students in an *advanced* stream Year 9 class described the learning strategy work as being very useful and perceived that their marks had improved as a result. Another 43% of the students in this class chose to describe the work as quite useful and believed that their marks may have improved because of it. Fifty two percent of class members indicated that they would attempt to use the techniques in other subjects.

Learning strategy tuition has become commonplace in the American tertiary sector since the late 1960s when many students with poor academic preparation entered college (Gall, Gall, Jacobsen, & Bullock, 1990). However, at the high school level, Gall *et al*. (1990) comment that efforts to teach learning strategies “have been neither systematic nor sustained” (p. 8). Mayer (1996) described studying competence as part of the ‘hidden curriculum’ at secondary level and comments that teachers at all levels believe that students already possess a repertoire of appropriate studying behaviours.

It is difficult to believe that many high school educators may still hold the belief that they have no role in teaching their students *how* to learn and possibly still assume that students will inherently possess the skills to manage the ever increasing quantity of process skills and content knowledge to which they are exposed.

High school teachers may feel that learning strategy instruction is yet another add-on which they have neither the time nor the energy to absorb. Armbruster and Anderson (1981) counter with the points that teachers have a responsibility to teach learning strategies and that teachers “need not sacrifice content matter because teaching students to study will facilitate teaching the content” (p.155). Vermunt (1996) makes the unequivocal point that

> instruction does not lead to learning automatically. The learning activities that students employ determine to a large extent the quality of the learning outcomes they achieve. Therefore, teaching should be directed at encouraging students to use high-quality learning activities. (p. 25)

In a publication called *Learning to Learn*, Adult Education Resource and Information Service Information Sheet (2000), teachers are advised to

> make a conscious effort to model and verbalize their own use of relevant learning strategies, integrate previous learning, select materials that lend themselves to meta-cognitive strategies, share their thinking strategies and encourage students to verbalize and share their learning strategies. (p. 1)

There are many techniques that are encompassed by the phrase 'learning strategies'. Broadly, the term refers to strategies that assist the student to effectively acquire, store, manage, integrate, retrieve and apply information. Schumaker and Deshler (1992) described a learning strategy as an individual's way of organising and using a particular set of skills in order to learn content or accomplish other tasks more effectively and efficiently in school as well as in nonacademic settings.

Some specific examples of learning strategies include time management, effective note taking, effective test taking, goal setting, motivation, listening skills and concentration techniques, using diagrammatic aids (such as concept maps or mind maps) and summarization techniques (Gall *et al*., 1990; Weinstein & Mayer, 1986). In researching the literature in this area, it is apparent that research on *learning strategies* also may be located by the search term *study skills*. Is there a consequential difference between these terms? McKeachie (1988) has suggested that the term study strategy be employed when students choose appropriately from a repertoire of well-developed skills. Hadwin and Winne (1996) reserve the term learning strategy for occasions when “students define their own short-term (local) goals and overall (global) goals for studying and select and coordinate alternative study tactics they expect will be helpful in achieving those goals” (p. 694).

The distinction between study skills and learning strategies is substantive. An action such as highlighting the main idea of a paragraph may be a useful study skill, but its benefit only becomes apparent when the learner cognitively manipulates the highlighted text in the execution of a learning strategy such as paraphrasing to generate a summary. Both of the terms *learning strategies* and *study skills* have been reviewed in relevant literature in Chapter 2, because the concepts are closely related and relevant to the research.

1.2 Rationale for the research

The intent of the learning strategy course was to improve the ability of students to learn, which implies that the intervention should bring about meaningful change in student learning behaviours. Indeed, the intervention was designed to teach students to learn how to learn science and was focused by three questions. How can students be guided to learn the skill of learning? What does current research tell us about the nature of learning behaviours and how students learn best? How can this research guide the design and delivery of a learning strategy course?

A synthesis of the literature about the nature of learning behaviours by Vermunt (1996) provides a classification of learning activities into cognitive processing, metacognitive regulation, and affective learning activities. Cognitive processing activities such as relating, selecting, and memorising, lead directly to learning progression and improved capacities to gain knowledge, understanding and skills. Metacognitive regulation activities such as planning, reflecting and adjusting, moderate the cognitive and affective learning behaviours and therefore indirectly impact on learning efficacy. Affective learning activities such as attributing, motivating and judging oneself are “directed at coping with the feelings that arise during learning” (p.26), and lead to an emotional state that will affect the progression of a learning process. Djigunovic (2000) found that students who use learning strategies frequently were characterized by high motivation for learning and by attributing success in learning to both effort and task enjoyment.

In recognition of the cognitive, metacognitive and affective aspects of learning, the following objectives, which are represented in Figure 1, served as the terms of reference in the development of the course. The course objectives were to:

i) improve student ability to apply learning strategies to science studies

ii) improve performance in science

iiI) encourage students to believe that their science performance is determined not only by their innate ability and but also by their selection of, and facility with, appropriate learning strategies (ie. the student has control over them), so that perceived competence is maximised.

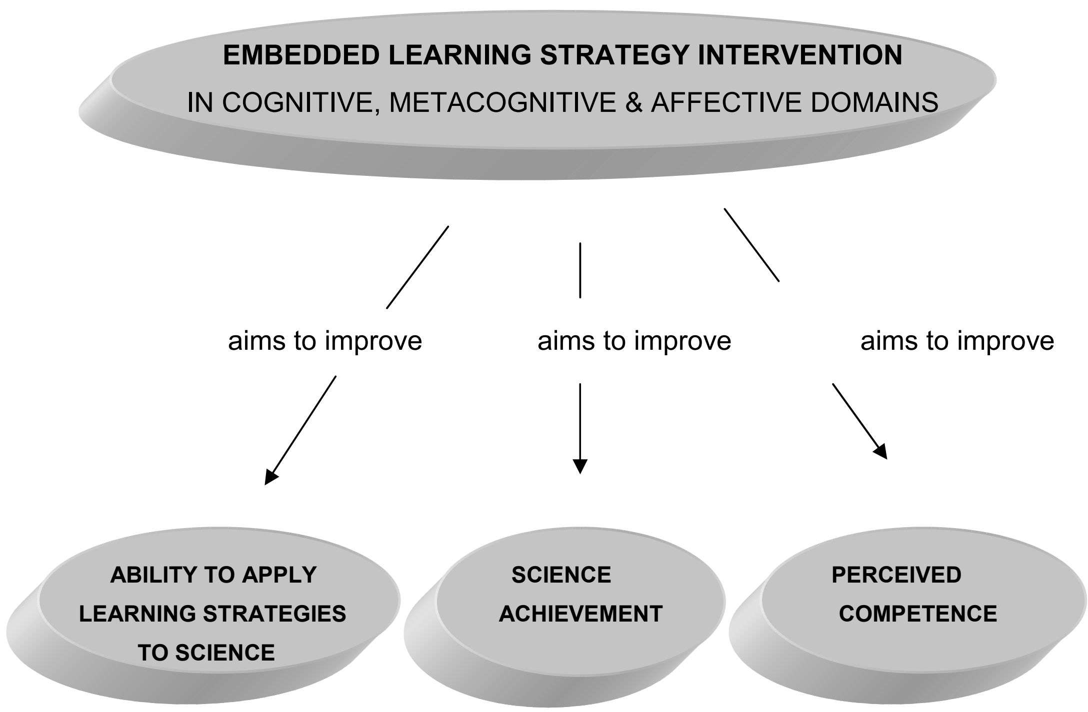


Figure 1.1 Objectives of the embedded learning strategy intervention

The intervention program aimed to operate in each of the cognitive, metacognitive and affective domains of learning. Specific activities directed to improve student functioning in each of these domains are described in detail in Chapter 3.

A decision to embed the learning strategy instruction within the science curriculum was based on the conclusion drawn by Hattie, Biggs and Purdie (1996) from a meta-analysis of 51 learning skill studies that there is a current concensus that "direct teaching of general, all-purpose study skills is not effective" (p. 101). According to Hattie et al. (1996)

> if strategy training is carried out in a metacognitive, self-regulative context, in connection with specific content rather than generalized skills, and if such training is supported by the teaching context itself, positive results are much more likely (p. 101).

1.3 The research problem and the research questions

The consistent positive feedback received from students in response to the short courses in 'learning how to learn science' which were conducted and refined over several years, combined with the writer's experiences as a tutor, revealed a need that led to consideration of the following general questions:

- To what extent is learning strategy education currently valued and fostered in Western Australia by science teachers?
- How much would students benefit from a year long, formal learning strategy course which was embedded within the science curriculum?

Consideration of these questions prompted a decision to design and implement an extended learning strategy course (the Science Learning Strategy (SLS) program) and to embed the course within the context of the science curriculum. This process is described and evaluated in the setting of a research project. The general questions, mentioned above, were formalised into four specific research questions which shaped the research:

1) What role do Western Australian science teachers currently play in the delivery of learning strategy education to high school science students?

2) What perceptions of the effects of the embedded learning strategy course on student ability to apply learning strategies to science are held by:
   a) students, b) parents and c) the teacher?

3) What perceptions of the effects of the embedded learning strategies course on science achievement are held by:
   a) students, b) parents and c) the teacher?

4) What perceptions of the effects of the embedded learning strategies course on performance attribution are held by:
   a) students, b) parents and c) the teacher?

Performance attribution refers to the practice of students attributing (finding causal explanations for) their science performance to natural ability, effort or learning strategy capability. These questions were addressed through a two-phase process. Phase one occurred during 1998 and Phase two during 1999. Phase one of the project essentially involved the development, trialing, evaluation and modification of the learning strategy course and materials. Phase two consisted of the year long implementation of the learning strategy course and the collection of data needed to formulate responses to the research questions.

The intervention was delivered at the Year 8 level for several reasons. Firstly, early instruction may prevent students from forming poor learning habits. Secondly, Year 8 students may feel quite vulnerable on entering high school and may benefit from instruction which helps them to manage the increasing teacher expectations and the faster pace of learning at the high school level.

1.4 Research methodology

In the light of my employment as a teacher of secondary science, it seemed that the research questions posed in this project could best be answered by taking on the role of 'teacher as researcher'. This approach has a number of significant advantages which van Zee (1998) has described. Firstly, she explained that teachers may be more willing to modify their teaching practices if they read reports of research by other teachers. Secondly, questions investigated and findings made by teachers may be more credible to other teachers and may be more directly applicable to classroom practices than research conducted by tertiary researchers. Van Zee also reported that collaborating with university researchers can enhance teachers’ understanding and implementation of research and allows teacher/researchers and teaching staff to collaboratively focus on issues related to science teaching and learning.

The motivation for developing this intervention has been to improve the quality of the learning process of individual students. A positivist approach would have been of very little use in fulfilling the aims of this study which were, in part, to obtain a detailed reflection of the intricacies, subtleties and problems related to students' experience of a learning strategies program (Hitchcock & Hughes, 1989).

In particular, the project was configured in a case study format and incorporated both quantitative and qualitative data in order to reveal the fine and complex detail of intervention effects. A case study design was selected for this study as the outcomes are planned to be a “holistic, intensive description and interpretation of a contemporary phenomenon” (Merriam, 1988, p. 9), rather than simply a quantitative result which would have done little to illuminate the minutae of the teaching-learning environment.

The study took place in an all girls school over a two year period during which time data collection took the form of numerous parent and student interviews, questionnaires, student work samples and science test results. Teacher observations of the students’ progress also were made. Details of the measurement tools are provided in Chapter 3, as are the data collation and analysis methodologies.

1.5 The significance of the research

The significance of this research is that it seeks to inform the reader about the role that Western Australian science teachers play in the delivery of learning strategy education to secondary students. It also reveals the perceptions of the effects of the embedded learning strategy course on learning strategy competence, performance attribution and academic performance, that are held by students, parents and teachers.

Vermunt's (1996) enunciation of the interdependence of cognitive, affective and metacognitive learning behaviours has been the driving rational for the design of the Science Learning Strategy (SLS) intervention which is the subject of this thesis. A review of the literature revealed that many interventions focus on only one or two of these aspects. The Project to Enhance Effective Learning (PEEL), for example, focused on metacognitive aspects of learning behaviour (Baird & Mitchell, 1986; Baird & Northfield, 1992; Gunstone & Baird, 1988; White, 1988). The project described in this thesis attempts to assess the combined impact of teaching students cognitive, meta-cognitive and affective learning strategies.

The literature survey also revealed a dearth of research in which a learning strategy intervention had been embedded within content areas. McComb's (1988) program, for example, whilst one of few which combined metacognitive, cognitive and affective learning strategies, was taught as a separate course. Programs implemented by Nolan Wells (1995), Pessin (1991), Fralick (1990), Lamon (1990) and Haussler and Hoffman (2002) are exceptions to this trend. In the present study, the learning strategy instruction was an integral part of the science course.

Many of the studies reviewed were of short duration, with some involving as little as 200 minutes of instruction (Masuda, 1993). The present intervention was of extended duration (over the course of an academic year), and consequently answered the call from Hodo (1989) and Wilson (1988) for lengthier investigations.

In relation to a specific attribute of affect, research has been conducted which shows that encouraging students to view failure as the result of lack of effort, rather than a result of low ability, task difficulty or luck, improved academic performance and task persistence (Fazzari, 1993). The present study, however, took a somewhat different tack and responded to Wittrock’s (1986) suggestion that research be conducted to ascertain the effect of training students to attribute poor performance to *unsound cognitive learning strategies* instead of attributing it to lack of effort or low innate ability.

In examining the data gathered from a combination of quantitative and qualitative methods, the researcher has attempted to render, at least in part, the influences of several significant aspects of the intervention on the perceptions of the participants. The effect of constructivist pedagogy and group learning on the perceived efficacy of the learning strategy intervention was also observed.

The total data set is significant in that it offers solutions to the research problems underpinning this thesis, namely, the degree to which learning strategy education is currently valued and fostered in Western Australia by science teachers and the extent to which high school students can benefit from a year long, formal learning strategy course, embedded within the science curriculum.

1.6 Limitations of this research

Teacher surveys were sent to members of the Science Teachers Association of Western Australia (STAWA) directly and also distributed at the STAWA conference. The high return rate of the teacher survey may have been due to the fact that science teachers who join their professional association (STAWA) and participate in CONSTAWA are likely to have a strong desire to develop their classroom practices and be willing to reflect on their pedagogy. This may have produced an unrealistically optimistic view of the extent to which Western Australian science teachers are including learning strategy instruction in their science programs.

Possible 'pollution' of learning strategies to other classes was not measured. Class 5 students may have shown friends in other classes some of the strategies they were learning. This problem was minimised because teachers in other Year 8 science classes did not implement the SLS program.

Due to timetable constraints the five classes often completed tests on different days and some students may have had advanced warning about what was on the test paper. Consequently, academic performance data may have been compromised.

Student use of learning strategies developed in Year 8 science could have been tracked over several years to achieve more triangulation of data over time.

Due to a number of constraints, the parents were not asked to complete a follow up questionnaire at the end of the year. Parent responses may have been more expansive in a written questionnaire than those garnered in the telephone interview.

Another teacher taught the class during Term 2 and Term 3, although the teacher/researcher regularly conducted SLS work in class time as planned, and returned to teaching Class 5 full time in Term 4.

Teacher perception of student performance attribution was based on student questionnaire responses. There seemed to be no other way for the teacher to become aware of the causal explanations for performance the student were making.

1.7 Summary of this thesis

The first chapter has given an overview of the investigation designed to determine student, parent and teacher perceptions of the effects of embedding a learning strategy course in a Year 8 science program at a private girl's college in Western Australia. Chapter 2 reviews additional literature relevant to the issues concerning this thesis. Chapter 3 describes the teaching program, and the methodology used in the investigation is detailed and evaluated in Chapter 4. The 1998 pilot study is also described in this chapter and results are discussed. The role of science teachers in including learning strategy instruction as a component of their pedagogy is described in Chapter 5. The data relating to perceptions of the effect of the SLS course on student ability to apply learning strategies to science is presented and analysed in two chapters – Chapter 6 gives a student perspective and Chapter 7 details the perspectives of parents and the teacher/researcher. Chapters 8 and 9 present and analyse data about perceptions of the effects of the SLS program on academic performance and performance attribution respectively. Finally, Chapter 10 responds to the Research Questions and provides an evaluation of the intervention. Chapter 10 concludes with a summary, reflections and recommendations.

Chapter 2
Contributions from the literature

2.1 Introduction

The literature informing the design, implementation and evaluation of the Science Learning Strategy (SLS) course can best be organised into a number of principal areas of interest. This chapter examines the literature related to these areas which include the case for learning strategy education (Section 2.2); effective learning strategy instruction (Section 2.3); the cognitive science view of learning and constructivist approaches to education (Section 2.4); constructivism in the classroom (Section 2.4.1); group learning in the constructivist classroom (Section 2.4.3); and assessment and learning in a constructivist framework (Section 2.4.4). Also included is a review of literature relating to meaningful learning and the nature of understanding (Section 2.5); student epistemologies, metacognition and the affective dimension of learning (Section 2.6); motivation and its relationship to metacognitive, cognitive and affective aspects of learning (Section 2.7); and learning activities and learning styles (Section 2.8).

These topics underpinned and informed the research agenda which was to firstly, determine the extent to which learning strategy education is currently valued and fostered by science teachers in Western Australia. Secondly, the research aimed to investigate the degree to which students would benefit from a year-long learning strategy course, embedded within the science curriculum.

2.2 The case for learning strategy education

The term 'learning strategy' was defined in Chapter 1 and for the purposes of this discussion will be taken as meaning the effective use of appropriate techniques, in an appropriate sequence, to complete a learning task (Gall, Gall, Jacobson & Bullock, 1990). The literature reviewed in this section describes currently held views about learning strategy education.

Few of today's adults will have been taught the basic skills involved in learning whilst at school. There seems to have been a mistaken belief that these skills develop naturally over time and therefore teachers do not need to spend valuable class time teaching them (Mayer, 1996). Nist and Simpson (2000) comment that "teachers at all levels assume that students already have a repertoire of studying behaviour when they enter the classroom" (p.645). Thomas and Rohwer (1987), however, found that some study skills such as taking notes in class, do in fact, improve over time without instruction. However, they also found that many important learning skills, such as making up questions to guide reading and making visual representations of ideas (such as concept maps) do not show natural increases over time.

What benefits can learning strategy education deliver? Purdie and Hattie (1999), in a meta-analysis of 52 studies, found that having many learning strategies (versatility), produced strong positive correlations with both cognitive and affective outcomes. In a previous meta-analysis of 270 effect sizes from 51 studies, Hattie, Biggs and Purdie (1996) concluded that learning strategy intervention programs do work most of the time. The best results occurred when the interventions were in context, and used tasks within the same domain as the target content, and promoted a high degree of learner activity and metacognitive awareness. The Science Learning Strategy intervention encompassed these recommendations.

Loranger (1994) interviewed three successful and unsuccessful high school students who were required to study an article to examine how well the students were able to:

i) determine the author's purpose for writing the article
ii) detect the organizational plan e.g. problem and solution, comparison and contrast
iii) generate a system for studying the material
iv) relate the information to prior knowledge of the domain
v) detect relevant and irrelevant material
vi) paraphrase the material to produce a cogent summary
vii) take notes

Each group of students was given an article on the same topic. (The article provided to the unsuccessful students was rated as being of 5th- grade readability while successful students were given an article of 10th grade readability.) The successful students spent only 14% of the allocated time for the task reading the article, while unsuccessful students spent 42% of the time reading it. The successful students were able to attend to relevant cues in the text to determine the authors' purpose while weaker students were not. The successful students were more competent at identifying important aspects of text. Note-taking, a deep processing strategy (Van Meter, Yokoi & Pressley, 1994), was the strategy at which the most pronounced difference appeared between the groups. Successful students spent 53% of the time reading and taking notes while unsuccessful students spent only 13% of the time doing this. The notes of the successful students were more coherent and organised and more effectively aided recall. The unsuccessful students were unaware of their inefficient strategy use. Note-taking strategies in the forms of dot point notes, mind maps and idea organisers, were strongly emphasised in the SLS program.

The accepted view of expert learners has been that they are highly skilled or knowledgeable in a given domain. Bruer (1993) suggested that expertise depends on well-organized, domain-specific knowledge that arises only after extensive experience has been gained in a particular area. In the same way, for learners to become expert in the domain of learning strategies, extensive practice should be provided in the learning strategy area. For this reason, the SLS course was conducted over the whole academic year, ensuring that individuals were provided with ample 'time on task.'

Ertemer and Newby (1996) illustrated how learning strategies can influence academic performance. They described two classmates, who having no prior knowledge of the material in a chapter of their text, were required to familiarize themselves with it in preparation for an upcoming essay test. One competent student, who was aware of herself as a learner, wass able to reflect on her study behaviours and her learning strategies, and select those which she felt would be most helpful in preparation for the test. She was able to recognize organizational patterns in the text and use these to advantage. She also stopped periodically to assess the progress she is making. This student performed very well in the test, and was able to access her knowledge from a variety of view points and apply it to different problems. In contrast, the other, less able student, depended on her usual strategies of reading and re-reading the text and on memorizing the definitions of vocabulary words. This student was unable to apply her learning to the different situations described in the test and performed poorly.

The concept of an expert learner is defined by Etremer and Newby (1996) as a "strategic, self-regulated, and reflective learner" (p. 3). They explain that expert learners "are aware of the knowledge and skills they possess, or are lacking, and use appropriate strategies to actively implement or acquire them" (p.1). Ertemer and Newby theorise that by engaging in reflective thinking to evaluate the results of their learning efforts, students can increase their awareness of effective learning strategies and find ways to use these strategies in other learning situations. They describe a model of expert learning, which shows ho a "learner's metacognitive knowledge of cognitive, motivational and environmental strategies is translated into regulatory control of the learning process through ongoing reflective thinking" (p.1).

The SLS Program assumed that students can develop at least some of the characteristics described for successful learning – that they are not saddled with a given level of learning competence. Further endorsement for the importance of providing learning strategy education took the form of qualitative evidence gathered by the researcher. In tutoring many high school science students over the previous decade, the researcher found that, almost invariably, students who were underachieving at school, had poor learning strategies and their academic results improved considerably with coaching in this domain.

2.3 Effective learning strategy education

Assuming that learning strategy education is valuable, how should instruction proceed to most effectively promote constructive and independent learning behaviour?

Nist and Simpson (2000), Pressley, El Dinary, Gaskin, Schuder, Berger, Almasi and Brown (1992) and Baird and Northfield (1992) have inferred that learning strategies are most effectively acquired when teacher pedagogy promotes strategies, motivation, metacognition and knowledge in interaction. Weinstein and Mayer (1986) concluded that good teaching should include not only teaching children how to learn, but also how to remember and think and how to motivate themselves.

These suggestions support the view that learning strategy instruction should incorporate cognitive, metacognitive and affective approaches, that learning takes place in those domains and that there is interaction between the domains. For example, Anderman and Young (1994) examined individual differences and classroom effects in relation to motivation and learning strategy use. They reported that students who experience academic difficulties have lower scores in terms of self-efficacy, goal orientation, expectancy, value (attitude), and self-concept of ability in science. These students demonstrated less adaptive patterns of motivation and cognition than high-achieving students. These authors have identified some specific classroom practices and procedures that influence students' motivation in middle-school science classes. Borkowski, Car, Rellinger and Pressley (1990) found that competent learning strategy use is strongly linked to high motivation and self-esteem.

According to Vermunt (1996), instruction in learning strategies should be “mainly aimed at developing self-regulated control strategies and mental learning models in students in which the construction and use of knowledge are central” (p. 48). (Vermunt’s reference to students constructing their own knowledge alludes to constructivist epistemology, which is discussed at length in Section 2.4.) Instructional principles needed to achieve this are divided by Vermunt into six general principles, namely, focusing on learning and thinking activities, teaching of strategies situated in the subject domain, gradual transfer of control, developing students’ mental model of learning, taking learning orientation into account, and promoting transfer of learning and thinking strategies to new situations.

Vermunt (1996) explains how these principles are achieved through a three phase teaching/learning process. Firstly, thinking strategies and domain-specific conceptions of students are identified and instruction is adapted to suit their learning styles and pre-conceptions. Secondly, cognitive, affective and regulative learning and thinking activities are taught in coherence. Covert activities are modeled as overtly and explicitly as possible (to provide a scaffold). The importance of scaffolding is described by Chin and Brown (2000). (In the SLS intervention, scaffolding was provided to assist students in developing new learning strategies). Next students are directed to use the modeled strategies in different situations, and get process-oriented feedback on the quality of their work. Gradually, scaffolding is withdrawn, and by creating a challenging learning environment, continuous use of the newly acquired skills is achieved. Finally, tests are administered which determine if student efficacy in the learning strategy domain have changed

In a review of the findings of research studies into what constitutes quality learning strategy programs, Nist and Simpson (2000) came to four conclusions. Firstly they described the need for a substantial amount of time to be committed to instruction for learning strategy development to occur. Secondly, they argued that students should be given time to practise analyzing texts and tasks to determine which learning strategies are most suitable. Thirdly, Nist and Simpson (2000) strongly stressed the importance of having instruction embedded within a specific context and specific domain. Finally, they recommended that effective strategy instruction should be explicit and direct and that students receive feedback about their attempts. Nist and Simpson (2000) bemoan the fact that “very few researchers have actually collected and analyzed students’ strategies to determine whether they have correctly interpreted and applied the strategy, and few, if any, have shared that information with the students during the training period” (p. 654).

Although expertise, metacognitive knowledge and regulation and reflection are mentioned frequently in the literature, the relationship between them has not been well established. Weinstein and Van Mater Stone (1993) have commented that without reflection, expert leaning cannot occur. Reflection, they have said, is the key to the process and successful learning cannot occur without it. For this reason, the SLS course regularly required students to reflect on their learning. Extensive long term practise and feedback are also considered crucial for the development of expert learning in a domain (Bruer, 1993).

Further on the point of whether learning strategy intervention should be embedded within a content area or taught in a stand-alone course, Gall, Gall, Jacobsen and Bullock (1990) described advantages and disadvantages of each approach in terms of implementation and resource requirements and recommended a combination of both. However, they also commented that a major disadvantage of the separate course approach is the lack of transfer of learned skills to other classes. Armbruster and Anderson (1981) pointed out that each content area has its own types of tasks, texts and appropriate study strategies and contended that content-area teachers are in the best position to deliver study strategy instruction that is relevant to their field.

Vermunt’s (1996) recommendations and those of Nist and Simpson (2000), described above, have largely been adopted in the design and delivery of the SLS course. Details of how this was achieved are described in Chapter 3.

The notions described in this section informed the decisions to extend the SLS intervention over a complete academic year, to embed the instruction within the Year 8 science course, to include in it significant metacognitive, cognitive and affective components, and to provide students with regular feedback on learning strategy attainment.

2.4 The cognitive science view of learning and constructivist approaches to education

Traditional instruction has been characterized by Freire (1972) as a "banking concept" in which students are viewed as "receptacles to be filled by the teacher. The more completely he fills the receptacles, the better a teacher he is. Education thus becomes an act of depositing, in which the students are the depositories and the teachers are the depositors." (pp. 45-46). This view of learning falls within the behaviourist philosophical tradition (O'Connor, 1992). Whilst it may appear to be a rather bleak view of the mechanics of classrooms, there are many cultures in which the delivery of traditional, didactic instruction is an established and accepted role for teachers. In Western Australian schools, Miller and Kandl (1991) found that mathematics classes were characterized by transmissive teaching methodology. This was still the case in the survey of Western Australian mathematics teachers conducted by Spyker and Malone (1996). Goodrum, Hackling and Rennie (2001) describe the current picture of science teaching and learning as "disappointing". They describe high school science teaching as chalk and talk teaching, copying notes, and "cookbook" practical lessons. Roth and Roychoudhury (1994) consider that for students growing up in Western society and attending its schools, "objectivism is the predominant epistemology" (p. 5).

Confrey (1990) characterised traditional direct instruction as having the following features which may also be viewed as limitations. Short, non-process oriented answers are required which are accepted as providing an assessment of successful learning. Teachers follow prepared lesson plans and check regularly to see if student responses correspond with expected answers. If they do not, instruction is revised slightly until the desired answers are received. Finally, responsibility for determining if an adequate level of understanding has been achieved lies primarily with the teacher.

A contrasting intellectual tradition that is rapidly gaining acceptance as the prevailing theoretical framework in educational psychology, is the cognitive science perspective (Calfee & Berliner, 1996). The view from this perspective (Perkins & Blythe, 1994; Resnick & Resnick, 1992), is that all learning involves thinking as well as the construction of knowledge and meaning by the individual through modification and extension of prior learning. This **constructivist** approach had its origins in the work of Piaget and Vygotsky (Burton, 1996) and in Ausubel's assertion (1968) that "the most important single factor influencing learning is what the learner already knows" (p.332). Constructivism is now widely accepted as a central tenent of learning by both theorists and practitioners (Tsai, 1998; Yager, 1995). Many researchers have investigated constructivist approaches to teaching and learning and their work has generated a number of significant books, such as Baird and Mitchell (1987), Dawson (1991), Fensham, Gunstone and White (1994), Hand and Prain (1995) and Treagust, Duit and Fraser (1996). Significant chapters of books relating to constructivism are those of Duit and Treagust (1995), Fensham (1994), Gunstone (1995), Novak (1995), and Scott, Asoko, Driver and Emberton (1992). The series of science texts, *Primary Investigations* (Fletcher, 1994), produced by the Australian Academy of Science, has been adopted widely throughout Australia and is based on a constructivist methodology. Journal papers relating to constructivism abound in the literature.

2.4.1 Constructivism in the classroom

Given that constructivism has wide acceptance among the researchers in education, how has it changed the pedagogy of classroom teachers? Spyker and Malone (1996) found that many Western Australian teachers who were aquainted with constructivist teaching strategies during workshops "rejected the majority of the constructivist thrusts, in the interests of discipline and their responsibility to ensure that students completed the syllabus and were successful at examinations. This resistance was evident among both young and older teachers" (p. 5). This reflects the perception of Costa, Marques and Kempa (2000) that science teachers generally have a very limited knowledge of education research findings. "What teachers regard as sound pedagogical knowledge is usually derived from personal experience and common sense" (p. 35). These authors proposed that researchers and practitioners should address the serious gap between research and practice in science education. The current project attempts to meet this need.

In classrooms where the teacher *has* embraced a constructivist philosophy, the teacher becomes a facilitator of learning (rather than a director), and provides opportunities for individual learners to modify and advance prior understandings to encompass new content (Hand & Vance, 1995). The SLS course focused strongly on encouraging students to develop their science understandings. Nolen (2003) noted that shared student perceptions that the science class was focused on developing understanding, were positively related to students' self reported satisfaction with learning.

2.4.2 Student conceptions

Research on student conceptions indicates that students often have immature conceptions across topics and achievement levels which are resistant to change by traditional, transmissive teaching styles (Driver, Guesne & Tiberghien, 1985; Brown & Clement, 1987; von Glasersfeld, 1992). Confrey (1990) comments that children's alternative conceptions "make sense within the limited framework experienced by the child. To the child they may be wonderfully viable and pleasing" (p. 109). Treagust, Duit and Fraser (1996) found that students can simultaneously hold differing private and public beliefs about the same concept. They comment that "sometimes students persist almost totally with their pre-instructional conceptions, and that sometimes students try to hold on to two inconsistent approaches - one intuitive and one formal" (p. 2).

It is very difficult to identify the alternative constructions of individual students when using a transmissive teaching approach. A most revealing exercise is to provide a class with a traditional explanation of a concept, to question them about that concept until the desired response is received (as is usually done in traditional teaching approaches) and *then* to ask every student to write down their understanding of the concept in their own words. It soon becomes very obvious that what we *think* we have taught students is not necessarily what they learn.

Constructivist teaching strategies have been shown to effectively encourage students to abandon or modify inadequate constructions. Mansfield and Happs (1996) and Ben-Zvi and Hofstein (1996) provided elegant examples of successful conceptual change achieved through the constructivist practice of considering students' views. Hewson (1996) suggests that "a teacher must be aware of the importance of the status of students' views and of components of the conceptual ecology, and include both status and ecology considerations explicitly in classroom teaching" (p. 136). Classroom ecology refers to accord between student and teacher epistemologies.

One benefit for students of coming to learn through the process of clarifying their conceptual models is described by Skemp (1976) and Glynn and Duit (1995), as allowing students to better understand new, but related tasks. Skemp expressed the view that this kind of understanding is more enduring and satisfying.

A teacher using constructivist principles generally uses a probe to reveal the initial understanding of individual students. Numerous strategies can be used for this purpose such as making predictions (Gunstone, 1990), free writing, making physical models or concept mapping (Novak, 1981). An extensive list of probes has been provided by Wandersee, Mintzes and Novak (1994).

When elicited student concepts diverge from the accepted scientific view, the teacher can implement strategies to promote conceptual change. Wandersee *et al.* (1994) referred to a wide range of concept modification strategies. These strategies may be based on cognitive conflict identification and resolution, or on the development and refinement of existing student ideas towards the accepted science point of view (Scott, Asoko, Driver & Emberton, 1992). Strategies used to promote conceptual change would typically provide opportunities for students to test the strength of their initial constructions through, for example, observing a demonstration about which they have made a prediction, through experimental work or through comparison with the ideas of classmates.

Finally, opportunities are provided for students to modify, and then retest their refined constructions in parallel situations. Driver and Oldham (1986) have suggested an additional review phase in which students reflect on how their constructions have changed. This suggestion is supported by Tobin, Tippins and Hook (1995), who believe that at the final phase of the construction process, students “need time to think things through and then time for such cognitive activities as to clarify, elaborate, justify, and consider the merits of alternatives” (p.48). This suggested course of action was followed in a number of activities in the SLS course. For example, a strategy used during the implementation which was very powerful in helping students move to more sophisticated constructions, was a strategy that the researcher terms *edit circles.* This strategy involved individuals presenting and explaining their work to the other members of a small group. The group members offer constructive criticism and then time is allowed for students to adjust their work to reflect their modified constructions.

A selection of other specific constructivist strategies are described in Vance and Miller (1995) and Scott, Asoko, Driver and Emberton, (1992). Some of the strategies described by these authors have been used during the S.L.S implementation. These include story writing, mind mapping (Buzan, 1972), writing explanations in their own words and Predict-Observe-Explain tasks (Gunstone, 1990).

2.4.3 Constructivism and group learning

During the intervention, group learning was regularly used as a teaching strategy. Group learning is a prominent feature of a social constructivist classroom and has been both lauded and criticised in the literature. Stanbridge (1990) concluded that a benefit of constructivist instruction, in groups, is that it allows individuals to contribute effectively at their own level. She commented that a constructivist approach works well with mixed ability groups which can be difficult to manage using traditional methods. Stanbridge explained that stronger students may benefit by elucidating their ideas for others and that weaker students may benefit from exposure to cognitive modelling by their peers.

Roth and Roychoudhury (1994) found that although the students in their study were the product of traditional transmissive teaching style, they responded positively to a constructivist style physics course which featured small group discussions. Roth and Roychoudhury (1994) noted that students in their study reported many benefits from working in groups. "Joining their efforts helped students to scaffold each other to new competencies" (p. 22). The coordination of different points of view helped students to understand better the significance of laboratory results, and helping others allowed them to elaborate their own understanding. Students also felt that working in groups prepared them for real life where cooperative skills are essential. Only 10% of the 42 students in the study indicated that they did not like to work in groups. Strommen (1992) percieved that students working in groups come to view their peers as resources rather than competitors. Basili and Sanford (1991) described successfully achieving conceptual change using cooperative learning approaches.

However, group tasks must be carefully managed. Linn and Burbles (1993) described many benefits of group work but have cautioned that we must not ignore the adverse effects of group behaviour. Subtle social constraints, such as camaraderie and not wanting to criticize, can mean that group learning can lead to 'groupthink', and may only benefit some students in a group.

2.4.4 Assessment in the constructivist framework

In considering both traditional and constructivist approaches to teaching, it is important to acknowledge that the type of assessment has a profound bearing on the instructional practice in the classroom. Clarke and Stephens (1996) referred to this phenomenon as ‘the ripple effect’ and have identified significant impacts on mathematics instruction when assessment practices change. As previously mentioned, Spyker and Malone (1996) found that teachers rejected professional development in constructivist pedagogy because of pressures to complete the syllabus and to prepare students for examinations.

The assessment approach, which is most appropriate in the traditional transmissive model of teaching, focuses mainly on the testing of instrumental learning (procedural and factual knowledge) (NCREL, 1994). Test development, scoring and interpretation of student performance in the western world over the last three decades has been based on the *psychometric* model (Birenbaum, 1996). Birenbaum describes the aim of this model to be objective with fair assessment requiring a high level of standardization because of the high stakes attributed to test scores. In describing some of the unfortunate assumptions of this model, Birenbaum (1996) writes

> the paradigm that has guided the development of psychometric theory and practice assumes the universality of achievement of test scores. Such an assumption stems from the view that a consensus can be reached regarding the meaning of educational goals and objectives. Another psychometric paradigm implies that goals can be separated from the means for their attainment. Hence, psychometric experts are regarded as the qualified agencies for the development of achievement tests and the analysis of their results, instead of the teachers who actuate the instructional process (p. 5).

The psychometric experts have created the impression that their assessment methodology is objective, and that subjective judgment is minimized. The psychometricians have been very successful at promoting a view of the infallibility of this kind of assessment and have managed to convince the majority of the public of their accuracy at rating performance and ranking students. The Tertiary Entrance Examination, completed by university applicants at the end of Year 12 in Western Australia, is an example of this situation.

However, human discretion is an integral part of the marking process in any examination. Wiggins (1990) referred to numerous American national and state testing programs and detailed many items which involve human judgment. In describing standardized tests, he comments that “the procedure by which items are chosen, and the manner in which norms or cut-off scores are established is often quite subjective-and typically immune from public scrutiny and oversight" (p. 3).

Other shortcomings of traditional assessment have been described (Black, 1995; Desforges, 1990; Herman, 1992; Johnston, 1989) but perhaps the most problematic is the negative effect that formalized testing has on student learning (Johnston, 1989). Herman (1992) has pointed out that external examinations undermine curriculum, instruction and policy decisions. The higher the stakes, the greater the pressure placed on schools to prepare students to do well. Schools interpret the curriculum in ways that will enable their students to best jump through the hoops of external standardized examinations. Emphasis is placed on retention of information and performance of drills, and students are not encouraged to develop relational (conceptual) understanding. Recent publications in *The West Australian* newspaper (January 1997- 2003) of 'league tables', comparing the Tertiary Entrance Examination performance of schools is an unfortunate example of how this pressure is manifested. The New South Wales (NSW) Department of Education has been involved in a legal battle to prevent the publication of similar 'league tables' of NSW schools (Lovatt & Smith, 1995). Unfortunately, in 1999, the year in which the SLS intervention occurred, the assessment of science in the school was still largely traditional. In Year 8, 90% of the students' marks came from summative classroom tests. The remaining 10% was allocated to learning strategy assignments as described later.

If we accept that assessment and instructional practice are inextricably linked (Resnick & Resnick, 1992), we must necessarily change the assessment in a way that will facilitate, rather than impede, the transition to a constructivist framework.

Fortunately, there has been a major change in assessment of student learning emerging in many countries. This change has arisen largely as a consequence of the increasing acceptance of a constructivist view of learning and a gradual erosion of traditional, didactic pedagogy (Birenbaum, 1996). This move for change is already well underway. In Western Australia, the *Curriculum Framework* document, released in 1998 by the state government education authority (Curriculum Council), promotes constructivist teaching strategies and outcome-based assessment and reporting. Schools throughout the state (both government and private) are required to implement the *Framework* by 2004. In response to the *Framework*, the state government Education Department of Western Australia (1998), has produced an assessment guide, entitled *Student Outcome Statement*s (1988), that provides descriptions of learning progress at various levels of the learning continuum. The Education Department requires government schools to use the *Student Outcome Statements* for reporting on student progress by 2006.

The change has been towards what is variously called performance assessment, authentic assessment, alternative assessment, direct assessment, constructive assessment, incidental assessment, informal assessment, balanced assessment, curriculum-embedded assessment and curriculum-based assessment (Birenbaum, 1996). Grace (1992) explains that these kinds of terms “refer to the practice of realistic student involvement in the evaluation of student achievement. Authentic assessments are performance-based and instructionally appropriate” (p.1). They rely on information from a variety of sources and the stress is placed on formative rather than on summative assessment so that assessment can be the “servant of learning” (Black, 1995, p. 272) while still permitting formal certification and reporting. A strong emphasis is now being placed on the integration of assessment and instruction. In this alternative assessment model

> the perceived position of the student with regard to the evaluation process changes from that of a passive, powerless, often oppressed subject, who is mystified by the process, to an active participant who shares responsibility in the process, practices self-evaluation, reflection and collaboration, and conducts a continuous dialogue with the teacher. (Birenbaum, 1996, p.7)

Particular classroom strategies used in authentic assessment include open–ended questions, exhibits, demonstrations, hands-on execution of experiments, computer simulations, journal and logbook writing, checklists, peer and self assessments and student portfolios. Many detailed descriptions of these strategies have been given (for example Birenbaum & Dochy, 1996; Desforges, 1990; Tamir, 1996) and extensive, specific information about them is available from the National Center for Research on Evaluation, Standards and Student Testing (CRESST), the Northwest Regional Educational Laboratory (NWEL) and many of the other sources available through the Educational Research Information Center (ERIC) via the Internet.

Peer assessment was regularly used during the intervention. Portfolio assessment was also used during the SLS intervention to assess the developing learning strategy competence of students. Unfortunately the portfolios of learning strategy tasks counted for only 10% of each students final grade. Portfolio assessment is a widely used strategy that warrants further description here because it so adequately reflects the intentions of alternative assessment previously described. An often quoted definition of a portfolio used for assessment, by Arter & Spandel (1992), is

> a purposeful collection of student work that tells the story of the student's efforts, progress, or achievement in (a) given area(s). This collection must include student participation in the selection of portfolio content; the guidelines for selection; the criteria for judging merit; and evidence of student self-reflection. (p.36)

Birenbaum (1996) has pointed out that whilst the portfolio does not contain all of a student's work, it is not a random selection. Entries are carefully selected to demonstrate that learning has occurred, indicate what a student knows and can do in a particular subject, and reveal his or her accomplishments and progress.

Forster and Masters (1996) provided an overview of portfolios and portfolio practices in an Australian setting and Mitchelmore (1996) reviewed the introduction of portfolio assessment in Year 8 science classes in a Western Australian high school. The aim of these types of assessments is to "better capture the significant outcomes that we want students to achieve and to better match the kinds of tasks which they will need to accomplish in order to ensure their future success" (NCREL, 1994, p. 6). Portfolio assessment of students' learning strategy competence has been used in the intervention in this study.

Common features of alternative assessment tasks have been described by Linn, Baker and Dunbar (1991) as including complex learning, higher order thinking skills, stimulation of active student responses, multi-step tasks, and significant commitment of student time and effort. Baker and O'Neil (1994) added task authenticity to this list and stressed that the task should be inherently valuable to students either in the short or long term and consider that a major benefit of performance-based assessment is that it creates an opportunity for the integration of high quality subject matter into implicitly useful tasks. This is an important point, as assessment has been considered by some teachers to be an unfortunate interruption to their teaching programs. By making assessment authentic, an amalgamation of assessment and learning becomes possible (Clarke & Stephens, 1996; Wiggins, 1990). Students learn *through* the performance of relevant assessment tasks. Student motivation should be enhanced if they see that the work they do in class is being monitored and also is intrinsically interesting and valuable.

2.5 Meaningful learning and the nature of understanding

One aim of the SLS course was to improve student learning and understanding of the science curriculum. In order to design the program and evaluate its success at achieving its aims, the terms learning and understanding were clarified and are described in this section.

Most educators would agree that one of the main goals of instruction is to promote student understanding of what is being taught so that learners can demonstrate an increased level of understanding when the course is completed. For example, when assessing a physics course we expect our students to be able to solve problems using formulae and are pleased when they are able to do so.

However, Nickerson (1985), has noted compelling evidence that "students often manage to get through courses without acquiring a clear understanding of some of the most fundamental aspects of the material the courses are intending to cover" (p.201). Indeed, Rosnick and Clement (1980) pointed out that having the ability to write down the correct answer to a question does not necessarily mean that students understand what they are doing. Novak (1996) remarked on how the use of concept maps with chemistry students can reveal alternative conceptions and incomplete understanding, even among students who performed well in traditional written examinations. Nickerson (1985) commented that results of studies involving conceptual difficulties in elementary mathematics showed that students can use algorithms to solve problems without really understanding the conditions under which the algorithm or principle is applicable. Gabel and Bunce (1994) consider that many students' conceptual understanding "is inadequate to solve chemistry problems and that students frequently solve exercises, using an algorithmic approach almost exclusively" (p. 303). Gabel (1981) found that the majority of students in a study relied strictly on algorithmic techniques, and that in the majority of cases where students used algorithms, there was no evidence that reasoning was used in the problem-solving process.

These authors are alluding to the contention that science and mathematics curricula and teacher methodology are generally focused on promoting only some aspects of the understanding of students.

The following paragraphs address these questions: i) what aspects of understanding are focused on? ii) what other aspects are there? and iii) are these other aspects of understanding important? The answers to the questions have influenced the choice of strategies incorporated into the S.L.S course and the pedagogy the teacher/researcher used to deliver science and learning strategy education.

Various different models of understanding have been described in the literature. Skemp (1976) was among the first to initiate the current discussion on the meaning of understanding. Skemp had always believed that understanding meant knowing what to do and why. His colleague, Mellin-Olsen called this *relational* understanding and also referred to another kind of understanding as *instrumental* understanding. Skemp described instrumental understanding as “rules without reasons” and commented that he had previously not regarded this as understanding at all. Skemp found, however, that many pupils, and to his ostensible surprise and concern, many teachers, consider that possessing algorithms and being able to use them to solve problems is what is meant by understanding. Nesher (1986) considered that competent algorithmic performance plays a role in developing understanding because algorithms free the mind to work on more complex solutions. Nickerson (1985) contended that understanding is not an all-or-nothing state and its acquisition is non-linear. Describing the concept of understanding another way, Buxton (1978) proposed four levels of understanding and described these as rote**,** observational (pattern observation), insightful (at which point the learner understands how and why) and formal, which he described as proofs which are only appropriate after relational understanding has been achieved.

Byers and Herscovics (1977) expanded Skemp's model to include his original relational and instrumental understanding but also described two additional levels of understanding which were identified by teachers. These two levels were intuitive understanding which is "the ability to solve a problem without prior analysis" and formal understanding which is characterised as "the ability to connect mathematical symbolism and notation with relevant mathematical ideas and to combine these ideas into chains of logical reasoning" (p. 26). The authors noted that the four kinds of understanding may interact and reinforce or hinder each other. This interactive effect is evident when children's ‘playground’ or naive conceptions (intuitive understanding) override instruction and impede learning. Byers and Herscovics (I977) contend that effective learning seems to require a spiral approach in which the different aspects of understanding are used successively and repeatedly at ever increasing depth. They comment that "the road to relational understanding may well pass through memory and intuition" (p.27).

Relational and instrumental learning have also been described as deep and surface processing respectively. In the deep processing approach to learning, students treat the learning material (text, experiment write-up, etc.) as an opportunity to gain an “understanding of the underlying meaning of the material” (Snow, Jackson & Corno, 1996, p. 284). In the surface approach, students learn the material, “without attempting to link it to a larger conceptual framework” (p. 264).

Some other observations about the nature of understanding (Nickerson, 1985) are that understanding increases with knowledge and that understanding not only requires adequate knowledge but also requires the learner to participate actively in the construction of deeper understanding. Nickerson (1985) expresses a constructivist viewpoint in his assertion that understanding "requires the connecting of facts, the relating of newly acquired information to what is already known, the weaving of bits of knowledge into an integrated and cohesive whole" (p.234).

Nickerson's perception of understanding is reflected in Glynn and Duit's (1995) view that meaningful learning and genuine understanding of science is best achieved when students "*activate* their existing knowledge, *relate* it to instructional experiences, and *construct* new knowledge in the form of conceptual models" (p. 23).

This view of understanding is echoed by White and Gunstone (1992) who provide us with a sophisticated description of its nature

> understanding is a function of the number of elements (propositions, strings, episodes, images, intellectual and motor skills and cognitive strategies) of knowledge the person possesses about the target, whether that target is a concept, whole discipline, a situation and so on, and of the mixture of different types of element and the pattern of associations that the person perceives among them. (pp. 12-13)

White and Gunstone (1992) point out that understanding is difficult to assess because it is a continuous function of a person's knowledge, is not a dichotomous state and must be judged against some arbitrarily set degree. Furthermore, the judgement is subjective because it varies with the judge and the status of the person being judged.

Skemp (1976) considered that instrumental instruction is easier for students to understand and provides more immediate and apparent rewards because they can often get the right answer faster and more reliably. What advantages then, does he see in encouraging students to develop relational understanding? Skemp commented that the possession of relational understanding has the important advantage of allowing students to adapt to new tasks and considers that, although harder to learn, once learnt, the result is more enduring. Skemp also concluded that relational knowledge can be a satisfying goal in itself and that people who achieve these goals are often motivated to expand their knowledge. Byers and Herscovics (I977) describe relational understanding as having the advantage of being "deeper than instrumental understanding because it enables the student to deduce particular rules from more general relationships whereas instrumental understanding requires the retention of many disconnected rules" (p.24).

If relational understanding has these important benefits, why don't more teachers promote it? Possible reasons suggested by Skemp (1976) are that teachers believe that relational understanding would take too long to achieve and is too difficult for students. Teachers might perceive that algorithmic skills are needed for other subjects while newly graduated teachers might feel unable to push for change in a school where the teaching is instrumentally focused. Other reasons suggested by Skemp are the ‘backwash effect’ of examinations and time limitations due to over-burdened syllabi. Relational understanding is difficult to assess and teachers may have difficulty in changing entrenched teaching styles.

Another possible reason why teachers do not promote relational understanding is that students don't want it. Most teachers are familiar with students who show resistance to theoretical explanations and ask for the algorithm. In the study by Miller and Kandl (1991) mentioned previously, students ranked knowing how to get the correct solution to a problem as their top priority although they recognised that they also needed formulas and rules to apply to the problem. Learning ‘why’ was considered ‘nice to know’ and ‘useful on occasions’ but was not viewed as an efficient use of classroom time. Students expressed awareness that assessments focused on what and how. In a survey of 1500 students at Years 11 and 12 (Spyker & Malone, 1996) students were conservative in their opinions about moving to authentic assessment. Their aim, and that of their parents, was to achieve good results in a final or public examination.

A move towards the promotion by teachers of relational understanding in students seems highly desirable, although other kinds of understanding appear to be prerequisite. Different disciplines lend themselves more or less to relational instruction. Chemistry, for instance, requires extensive factual knowledge before students are able to move on to relational understanding.

It seems that teachers need to include more relational methodologies in their teaching so that a balance is achieved between the different forms of understanding. However, will such change be accepted by students raised on instrumental instruction? What if they object (reasonably enough) that relational pedagogies do not prepare them for traditional post-secondary examinations or for tertiary courses which are still based on instrumental instruction? Change at a school and classroom level is necessary but will not be sustainable unless students perceive that assessments at the post-compulsory school and post-secondary level reinforce this balanced teaching approach. In Western Australia, the move towards formative, outcomes-based assessment, as outlined in the *Curriculum Framework* document produced by the Curriculum Council of Western Australia (1998), gives cause for optimism. However, the influence of the tertiary entrance examinations is still strongly felt, and needs to be considered to support the changes in assessment at the school level that are underway.

Assuming that relational learning and meaningful understanding are the desired student outcomes, what student epistemologies, classroom strategies, and teacher epistemologies best promote these outcomes? The following discussion seeks to answer this question and reveals some of the reasoning behind the design of the SLS course.

2.6 Student epistemologies, metacognition and the affective dimension of learning

Teaching methodologies informed by constructivism require a high degree of learning effort from students who have generally been raised on a passive learning model. In a constructivist classroom, students are required to assess the quality of their knowledge constructions and are also expected to actively participate in modifying and developing them. Students will only be prepared to take on these demanding tasks if they perceive value and are motivated to do so. To assist students completing the SLS course to recognize both the intrinsic, and extrinsic value of the learning strategies program, 10% of the science marks for the year were allocated to SLS work in this study.

What students believe about their learning “has an influence on how they interpret the task, how they interact with the text, and ultimately, the strategies they select” (Nist & Simpson, 2000, p. 652). A potent example of the impact of a student's epistemology on learning behaviour is described by Gunstone (1992) in a study on students’ understanding of electricity

> one student began with a clashing currents model (in electricity) and, after working through the many experiences and structures we provided in the classroom, remained committed to that model. He informed me as we left the school that he believed the clashing current model to be appropriate because his father had told him so - and his father was an electrician. (p.130)

The conclusion drawn by Gunstone (1992) from this incident was that "the clear affective component of both this student's belief and his commitment to retaining that belief is significant" (p. 130). Modifying student conceptions then is a difficult process. Duit and Treagust (2003) report the absence of any study which found that “a particular student’s conception could be completely extinguished and then replaced by the science view” (p. 673).

The engagement of the learner with the learning of science is influenced by the feelings students have towards the subject matter (Alsop & Watts, 2000; Thompson & Mintzes, 2002). Alsop and Watts consider that conceptual change learning is “as much dependent on the affective domain as on the cognitive” (p. 21). Duit and Treagust (2003) emphasise that the impetus for conceptual change is within the student’s control. They comment that for conceptual change to occur the student must assent to the change and desire it. Duit and Treagust describe this notion as “intentional conceptual change”. (p. 672). Considerable research (see for example Tobin, Tippins and Hook (1995) and Roth and Roychoudhury (1994)) has found significant inter-individual differences in the consequences of a specific epistemological stance to learning, on learning strategies employed. For example, Tamir (1996) reported that students who strongly prefer rote memorization, demonstrate a strong preference for teacher written or textbook summaries. In contrast, students who are prefer using principles and critical questioning, tend to study in depth and use a variety of organizational learning tools. Based on this evidence, the researcher recognised the existence of a broad spectrum of student epistemologies and designed the SLS course to cater for this variety.

Classroom variables such as classroom climate, curriculum, teacher practices and interactions with other students have a strong impact on students' attitudes to science and hence their engagement in it. For example, Simpson and Oliver (1990) and Anderman and Young (1994) found that in classrooms where teachers use practices such as displaying the work of the highest achieving students, giving special privileges to students who get the best grades (i.e., ability-focused instructional practices), on average, results in students being less focused on their learning. Students in this classroom environment are unlikely to want to master and deeply understand their science and are more intent on demonstrating their ability and outperforming others (ability-focused).

The degree of fit between a teacher's and student's epistemology will affect the learning process in a classroom. Changing only teachers' views to constructivism without changing students' views may lead to "discrepancies in the classroom ecology" (Roth & Roychoudhury, 1994, p. 32). Schon (1987) described examples of differing student and teacher epistemologies disrupting learning. To avoid this disruption, the teacher/researcher was cognisant of the need to cater for the varying epistemologies of students. Those who preferred to be passive learners (as in a didactic teaching mode) were coaxed, rather than forced, towards adoption of relational learning strategies.

Student epistemologies about learning are closely linked to the process of metacognition and, according to Flavell (1987), the two concepts overlap. Metacognition, he said, refers to the learners' views and beliefs about learning as well as the active regulation of their learning processes. Vermunt (1996) links these metacognitive dimensions to students' cognitive processing strategies and to their study motivation. According to Vermunt, "metacognition, in the sense of both regulation strategies and mental models of learning, plays a central role in regulating student learning" (p. 45). Vermunt (1996) includes the process of making students aware of their own and alternative ways of approaching a learning task, as an important way in which learning can be improved. This process was a key element of the SLS course.

Gunstone (1992) defines metacognition as "the amalgam of student knowledge, awareness and control relevant to their learning" (p. 135) and argues that these components are personal constructions which can be modified where needed. Baird and White (1996) contend that "learning with understanding is fostered when learners engage in *informed, purposeful* activity, to the extent that they exert adequate *control* over personal learning approach, progress and outcomes" (p. 190).

Vermunt (1996) asserts that the level of student commitment to learning activities is influenced by their perception of internal and external influences. Internal sources influencing students' commitment to learning include their mental models of learning, learning styles and degree of skill in the use of the learning strategies. "The effectiveness of external regulation devices is dependent on the interpretations and appraisals students give to them" (p. 45). For example a student may choose to accept or ignore teacher feedback. The success of learning strategy education is dependent on student commitment to learning and learning orientation.

These research findings informed the decision to expose students in the SLS program, to a range of classroom and learning strategies, to cater for students with differing beliefs about learning and different learning styles. For example, some classroom activities were partly teacher directed, while at other times the teacher acted only as a facilitator to learning. Some of the learning strategy work was done in groups and at other times individually. After students had been introduced to the full range of learning strategies, they were free to choose those that best suited their learning styles. As previously mentioned, 10% of the science mark for the year was allocated to S.L.S work. The researcher has found, anecdotally, that conveying to students the notion that learning strategy competence is valued, improves student commitment to improve learning behaviours. Progress in learning strategy competence can be encouraged by providing positive feedback either verbally, or by commenting on written work (e.g., concept maps). The researcher has also found that, with encouragement and persistence, it is possible to 'wean' students partially off a passive learning style, in spite of some initial resistance.

2.7 Motivation and its relationship to metacognitive, cognitive and affective aspects of learning

Singh, Granville and Dika (2002) comment that “in recent years affective variables have emerged as salient factors affecting success and persistence in mathematics and science subject areas” (p. 323).

Anderman and Young (1994) decried the lack of research on motivation in science education and commented that literature on science education reform has focused on the cognitive aspects of science learning and instruction. They cited several researchers (Pintrich, Marx & Boyle, 1993; Strike & Posner, 1992; Walberg, 1991) who have called for examination of motivation as the key element that has been missing from the discussion of science education and reform. Anderman and Young (1994) stressed the importance of this research in the light of evidence provided by Blumenfield and Meece (1988) that science teachers may have a more direct effect on students’ motivation than on their cognition.

McCombs (1988) suggests that students must be motivated if they are to actively engage in appropriate cognitive, metacognitive and affective learning strategies. McCombs comments that instruction to improve learning strategies must involve the promotion of self-control or self-directed learning. Motivation to learn is described as a central ingredient in self-regulated learning and continuing motivation is characterised as the precursor to continued learning. McCombs (1988) defines the concept of intrinsic motivation to learn as

> a dynamic, internally mediated set of cognitive, metacognitive and affective processes (including expectations, attitudes, beliefs about the self and the learning environment) that can influence a student’s tendency to approach, engage in, expend effort in and persist in learning tasks on a continuing, self directed basis. (p. 163)

To any educator it is intuitive that students must be motivated if they are to learn. However, while Nist and Simpson (2000) recognise that there is a lot of research on motivation and on strategic learning or studying, they consider that “researchers are just beginning to examine how these constructs interact” (p. 651).

Literature focusing on motivation and strategic learning includes the work of Graham and Weiner (1996). They describe the main concepts in the area of motivation theory as “the interrelated cognitions of causal attribution, efficacy and control beliefs and thoughts about the goals towards which the subject is striving” (p. 67). Graham and Weiner (1996) comment that control beliefs encompass the terms *locus of control* (the degree to which an individual believes a performance outcome is under their control) and *attribution* (the perceived cause of an outcome or causal explanation).

A person with an external, or low locus of control, feels that something or someone out of their personal control (e.g., luck, or a teacher) has caused their success or failure. An internal, or strong locus of control belief implies that an individual feels personal responsibility for their success or failure (Parkes, 2000). Nauta, Epperson and Waggoner (1999) found that more able students who attribute their success to their efforts, rather than their ability, are able to take personal credit. Less able students tended to attribute the cause of their failure to their own perceived lack of ability.

Paris, Newman and Jacobs (1985) argued that it is necessary to directly address processes that relate to perceptions of personal control if we want students to be self-controlled and self-motivated learners. Wittrock (1986) listed motivation, belief systems, perceptions, expectations and attributions as specific processes that mediate learning and achievement. McCombs (1988) listed theoretical perspectives relevant to the relationship between motivation and learning that include competence motivation, self-efficacy theory, attribution theory, importance of self-control, metacognition and self-regulated learning processes, strategy use and strategic behaviour. A selection of literature addressing some of these issues is now described.

Attribution theory (Weiner, 1983) assumes that the principal motivator of student learning behaviour is the search for causal explanations (attributions) of performance. The contention Weiner (1983) made is that the character of these attributions will influence the emotional responses, performance and motivation of learners and that the influence is moderated by the locus of control, causality and the stability of these attributions. He contended that higher performance and motivation result from viewing academic success as personally caused, likely to recur and under one's control (i.e., that it is governable). The SLS program aimed to engender in students a greater locus of control through training in goal setting and attributional feedback.

Palmer and Goetz (1988) presented evidence that ability attributions have a significant correlation with performance expectancies, persistence and the development of learned helplessness. Children who attribute failure solely to ability are likely to have low performance expectations, poor levels of persistence and feel helpless to change their performance. For this reason, efforts were made in the SLS program to encourage attributions to factors that students can control, such as learning strategy competence.

Dweck, Davidson, Nelson and Enna (1978) found that girls are more likely to attribute failure to lack of cognitive ability, while boys tend to attribute failure to lack of effort. DeBacker and Nelson (2000) reported that boys had higher scores than did girls in perceived ability. Kavussanu and Harnisch (2000) found that there was a positive relationship between girls with high perceived ability and high levels of self esteem. Haussler and Hoffman (2002) comment that improving self concept through attribution training can “reduce or reverse” (p. 870) the decline in the level of girls’ interest in secondary science. Girls then, particularly, may benefit from identifying their learning strategies as factors they can control which can affect their school performance. This identification may help girls to interpret failure as something they can do something about. Girls who are working hard (and may therefore not attribute poor performance to lack of effort) may be persuaded to attribute performance to learning strategy competence rather than solely to limited, innate cognitive attributes if they do poorly in an assessment. Training in learning strategies and learning strategy attribution for girls may have a positive impact on their motivation and performance. Nauta, Epperson and Waggoner (1999) report that female students who performed poorly at college were more likely to attribute their failures to their own perceived lack of ability rather than to effort or learning strategy facility. The authors comment that “this attribution is clearly self-defeating because it suggests that something about the self is to blame for one’s failure” (p. 671).

Wittrock (1986) suggests that future research should study how “attribution to cognitive strategies, rather than effort and ability, might influence learning and achievement” (p.306). The present study responds to Wittrock’s (1986) suggestion. The findings by Dweck and colleagues (1978) suggest that this approach may be especially effective for girls.

In a review of the literature, Ruble, Grosovsky, Frey and Cohen (1992) commented on the acceptance, by researchers in the field, of a view that a sense of competence has a powerful impact on achievement-related behaviour and motivation of students. This sense of competence equates to the term “self efficacy” defined by Bandura (1982) as “a persons belief in his or her capabilities to mobilise the motivation, cognitive resources and courses of action needed to exercise control over task demands” (p 53). Schmeck and Meier (1984) found that perception of self-efficacy is positively correlated with deep information processing. Importantly, Locke , Zubritzky and Lee (1982) were able to demonstrate that self-efficacy directly effected task performance, goal choice and goal commitment and found that self efficacy could be improved through training in task strategies such as goal setting. Students in the SLS program were taught to set goals for upcoming assessments and then to review their performance and reflect on why they did or didn’t achieve their goals.

Many authors have expressed the view that motivation and achievement can be increased by increasing students' perceptions of personal control (e.g., Baird & White, 1982; Bandura, 1982; Schunk, 1984, Stipek, 1981, Stipek & Weisz, 1981; Thomas, 1980; Tobin, Tippins & Gallard, 1994; Wang, 1983; Weiner, 1983). Watkins (1986) found that if students believe they have control over their learning, they are more likely to use deep processing approaches to learning.

Interventions described by Wang (1983) as being successful in improving a sense of personal control and enhancing achievement include direct instruction in self-management skills (planning, information organization, goal setting, time management) and providing opportunities for self-managed learning (self-evaluations of learning, carrying out learning plans). Wang contended that learning environments which provide opportunities for acquiring self-management skills, together with opportunities for self-direction, self-initiation, and self-evaluation, will enhance both student perception of self-efficacy and task performance. These skills were fostered in the SLS program. For example, learning plans were developed by students on a regular basis.

Metacognitive skills training in planning, monitoring, regulating and evaluating learning activities is critical to enabling self-control of learning (McCombs, 1988). Self-monitoring, in particular, has been found to contribute to improved acquisition, generalization and transfer of knowledge and skills (Wang & Lindvall, 1984; Georghiades, 2000).The PEEL (Project to Enhance Effective Learning) program in

Victoria (Baird & Mitchell, 1986) is an extensive project focusing on the positive impact of metacognitive activity on student thinking skills. The PEEL study determined that metacognition can be promoted successfully and does facilitate conceptual change (White & Gunstone, 1989).

A program sharing some attributes with the SLS program is the Cognitive Acceleration in Science Education (CASE) program, developed in the mid 1980s in the United Kingdom by Shayer and Adey (1993). This course focuses on developing students' metacognition and reasoning ability. Using the ideas of Piaget, the CASE intervention lessons are designed to encourage the development of thinking from concrete to formal operations. CASE requires the delivery of 32 lessons over a period of two years and has successfully promoted cognitive development, resulting in increased academic achievement of students in science, mathematics and English (Shayer & Adey, 1993).

Students' use of learning strategies depends on judgements they make about contextual appropriateness, perceived competence, personal control, available alternatives and perceived 'costs' (Paris, Newman & Jacobs, 1985). Palmer and Goetz (1988) posit the notion that learners view strategies as differing in the kinds of tasks for which they are appropriate and in the level of effort, intelligence and prior knowledge required for effective use. Additionally they comment that "the match between the student's perception of their personal attributes and the attributes of the strategy, affects their judgement of the personal effectiveness of the strategy, and ultimately, their decision to use it' (p.45). Palmer and Goetz (1988) present empirical evidence to support this model.

In a synthesis of the literature in this area, McCombs (1988) concludes that

> current perspectives on learning, motivation and the affective role of the learner have led to the recognition that for effective learning to take place, the learner must engage in the self-management or self-control of his or her own learning. To assume this responsibility requires that learners have appropriate attitudes and orientations towards learning (i.e. that they possess concepts, skills, and strategies for being self motivated), and that they perceive themselves to be competent in their abilities to engage in appropriate learning strategies (i.e. that they have perceptions of efficacy and the appropriate cognitive, metacognitive, and affective strategies and

> skills for self-control of learning). The fact that many students are deficient in strategies and skills for self-motivation and self-control of learning underscores the need for an effective skills training program that addresses essential and trainable metacognitive, cognitive and affective (motivational) strategies and skills. (p. 153)

The discussion in this section has informed the decision to address student motivation, metacognition and affective aspects of learning in the SLS program.

2.8 Learning activities and learning styles

In a synthesis of literature on types of learning activities, Vermunt (1996) described the specific processes involved in cognitive, affective and metacognitive learning acivities (Table 2.1). Many of the specific learning processes mentioned in Table 2.1 are embedded in the SLS program.

Table 2.1 Learning activities (After Vermunt, 1996)

Types of Learning activities	Specific processes
Cognitive Thinking activities that are used to process learning content	Relating, structuring, analyzing, concretizing (thinking of examples), applying, memorising, critical processing, selecting
Affective Processing the feelings that arise during learning to produce an emotional attitude to learning that may positively, neutrally, or negatively affect the learning process	Attributing, motivating, concentrating, judging oneself, appraising, exerting effort, generating emotions, expecting
Metacognitive regulation Regulating the cognitive and affective learning activities thereby indirectly influencing learning results	Orienting, planning, monitoring, testing, diagnosing, adjusting, evaluating, reflecting, forming mental models of learning (eg. developing opinions about who is responsible for their learning)

Vermunt (1996) perceived that instructional approaches to promoting student use of these learning activities could take three forms: taking over or directing student learning and thinking activities (strong external control); activating students to use particular learning activities (shared control); and capitalising on the proper use of learning activities that students already engage in (loose external control). In the latter type of instructional approach, the teacher expects students to autonomously implement appropriate learning and thinking activities.

Which of these approaches is best employed in the learning strategy course? The shared control instructional model was considered the best for the students in their first year of high school because students at this age (13 years) generally have less than expert knowledge about how to perform many learning activities (Weinstein, 1988). As students in this study progressed through the year, they were assisted towards the stage at which they were able to autonomously implement appropriate learning and thinking activities. Students who achieve this goal will have become independent learners who are able to cope with the demands of society's burgeoning knowledge base. “The most important task of teaching is no longer transmitting knowledge, but initiating, coaching and influencing the thinking processes that students use to learn” (Vermunt, 1996, p. 48).

Learning style is an important aspect of affect which must be considered in the design and delivery of a learning strategy course. Researchers have defined the term ‘learning styles’ in many different ways; a comprehensive summary of these styles was provided by Snow, Jackson and Corno (1996). For the purpose of the present investigation, Vermunt’s (1996) interpretation has been adopted. Vermunt found large differences between students in the manner in which they carried out learning functions and described these in terms of four learning styles – undirected, reproduction directed, meaning directed and application directed styles, which vary across cognitive, metacognitive and affective dimensions (Table 2.2).

Table 2.2 Learning styles and their components (After Vermont, 1996)

Components	**Learning styles**			
	Undirected	Reproduction directed	Meaning directed	Application directed
Cognitive processing	Hardly any processing	Stepwise processing	Deep processing	Concrete processing
Affective processes	Low self-esteem Expectations of failure	Fear of forgetting	Intrinsic interest	Practical interest
Learning orientation	Ambivalent	Certificate and self-test oriented	Person oriented	Vocation oriented
Metacognition-regulation of learning	Lack of regulation	Mostly external	Mostly self-regulated	Both external and self-regulation
Metacognition - mental model of learning	Cooperation and being stimulated	Intake of knowledge	Construction of knowledge	Use of knowledge

According to research by Vermunt (1996), students will only experiment with other styles if they have made a conscious reflective decision to do so. Logically, they can only experiment with other styles if they know they exist. The teacher therefore has a responsibility toward those students, who are not aware of other learning styles, to reveal the possibilities, and to assist students to gain experience with them, so that they can optimise their learning potential. It is important for teachers to remember that some students will have learning styles that are detrimental to their academic performance (Gall, Gall, Jacobsen & Bullock, 1990). The SLS program attempted to expose students to a range of learning strategies and to develop the learning styles of students.

Fouzder an Marwick (2000) stressed the importance of not stereotyping students as having a particular learning style, as styles change with different classroom and learning situations. Gall *et al* (1990) suggested that teachers should discuss with students the advantages and disadvantages of their preferred style and encourage students to see the advantages of more effective learning styles. Class discussions and edit circles were held during the SLS course to achieve this end.

In reviewing research on how students differ in their approach to processing information in order to learn it, Entwistle (1988) found that some students have a 'meaning' orientation in which they try to understand the material and to link ideas, whereas other students have a ‘reproducing orientation’. These latter students rely on memorization and work sequentially through the material they are studying without fitting ideas into an overall view. (Entwistle’s meaning orientation is similar to instrumental understanding described by Skemp, 1976).

Table 2.3 Deep and surface learning behaviours. (After Anderman & Young, 1994).

Deep Learning Strategies
Students try to figure out how things they learn in science are connected to things in the real world.
Students try very had to connect new work to what they’ve already learned.
When they make mistakes, students try to work out why.
Students spend some time thinking about how to do their work before they start it.
Students try to understand the main ideas, not just memorize facts
Surface Learning Strategies
When the work is difficult, students either give up, or do the easy parts.
When they don’t understand their science work, students get the answers from friends.
During lab activities students sometimes just copy what other students write down.
When students have reading assignments, they read them as quickly as they can.

Entwistle and Kozeki (1985) reported that a meaning orientation was associated with higher academic performance. The reproducing and meaning orientations described by Entwistle (1988) appear to correspond to the cognitive psychological concepts of surface and deep processing described by Anderman and Young (1994) and Chin and Brown (2000) which are summarized in Table 2.3.

Mayer (1984) has shown that students must manipulate information in some way in order to store it in long-term memory and that the more deeply information is processed, the better it is stored in long-term memory and the more easily it is retrieved. Dawson (1994) has shown that requiring students to actively process concepts through activities such as the construction of summaries, flow charts, concept maps and participation in small group consideration of pivotal questions, can effectively enable students to build upon existing knowledge to develop more scientific constructions.

The teacher/researcher included activities to facilitate the development of a meaning directed learning style (e.g., concept mapping and mind mapping) to encourage deep processing. As previously mentioned, a meaning directed learning style is associated with higher academic performance.

2.9 Summary of Chapter 2

The literature discussed in this chapter has been organised into seven areas of interest which are relevant to the research described in this thesis. The case for learning strategy education was the first topic to be examined. Section 2.3 focused on describing effective learning strategy instruction.In the last decade or so, educational researchers have placed a strong emphasis on constructivist approaches to teaching and learning. Section 2.4 reported current views about the implications of adopting a constructivist model in the classroom. In particular, the role of group work, and assessment issues are discussed.

Literature describing the concepts meaningful learning, and the nature of understanding, were included in Section 2.5. The final sections of the chapter examined opinions about the affective and metacognitive aspects of learning. Student epistemologies, motivation, and its relationship to metacognitive, cognitive and affective aspects of learning, were among the topics focused on. Researchers' views about learning activities and learning styles conclude the chapter.

Chapter 3

The Science Learning Strategies program

3.1 Introduction

The Science Learning Strategies (SLS) program, implemented in 1999, allowed students to experience and gain competence in a range of learning strategies which they might not otherwise have encountered. The students were taught these strategies as an integral part of their Year 8 science course.

Loranger (1994) explains that expert learners use different learning strategies than do less able students. However, as the question of causality between learning strategy efficacy and academic success is not yet fully answered by educational research, it was considered important not to impose a 'correct' or 'expert' set of strategies. Consequently, students were introduced to a range of strategies in first semester and encouraged to select and develop their preferred strategies in second semester. Some of the strategy instruction formed discrete lessons or parts of lessons. In total, 890 minutes of class time were used for direct strategy instruction in 1999. In addition, strategies (e.g. concept mapping) were often set as homework to deliver or reinforce science content. In this way, it was possible to embed the SLS Program in the science curriculum without sacrificing content. Various learning styles also were catered for by providing a mix of teaching strategies. For example, learning strategy tasks were sometimes completed in groups and at other times, individually.

It was unrealistic to attempt to teach a large number of learning strategies to the class in the space of one academic year. Consequently, the course focused on thorough tuition in a limited number of cognitive strategies, that are well suited to the science curriculum (e.g. concept mapping and mind mapping), as well as metacognitive and affective strategies. A complete list of the strategies addressed in each of the cognitive, metacognitive and affective domains is provided in Figure 3.1. The rationale for including strategies from these three domains was discussed in Chapters 1 and 2. Details of when each strategy was taught are provided in Figure 3.2.

As described in Chapter 2, meaningful change in learning strategy competence is best fostered by simultaneously addressing student learning behaviour in the cognitive, metacognitive and affective domains of learning. There is little point in showing students better ways to prepare for a test if they have no desire to improve their performance, or if they have not reflected on the effectiveness of their own strategies. The strategies addressed by the intervention, classified according to the three learning domains, are shown in Figure 3.1. The meanings of the short strategy descriptors used in Figure 3.1 are given within the lesson descriptions in Section 3.2.

Cognitive domain	Metacognitive domain	Affective domain
• Test taking strategies • Practice tests • Study habits & revision time distribution • Time planning • Setting priorities • Study diary • Visit/revisit/chunks? reward • Listening skills - active listening • Note making - selecting key concepts from text • Dot point notes • Elaborative summary strategies - paraphrase, spider maps • Mind maps • Concept maps • Memorisation strategies- e.g., mneumonics • Analogies • Visual & sensory techniques	• Goal setting • Self talk before, during and after tests • Peer review of mind maps, concept maps etc. • Asking for help - parents, teachers, friends • Post-test error attribution and action • Identifying and modifying governable factors that affect learning performance • Time planning/setting priorities • Identifying preferred learning styles • Checking achievement of objectives • Self-testing	• Goal setting and motivation- what mark do I want? Why do I want it? • Relaxation and self talk before, during and after tests • Performance attribution • Improving self efficacy (perceived competence) • Identifying and deciding to modify governable factors that effect learning performance • Establishing and maintaining motivation • Teacher expectations • Learning style – reward self for active learning • Work ethic • Potential effect of learning strategy efficacy on performance

Figure 3.1 Learning domains of strategies included in the SLS Program.

In the remainder of the chapter, lessons incorporating SLS activities are described in detail and teaching and learning materials developed for the program are described. Later in the chapter metacognitive devices are explained and assessment implications of the SLS program are clarified.

3.2 Program implementation

During 1999 the teacher/researcher taught the class for the first and fourth terms. A different science teacher taught the class for the second and third terms and continued to reinforce the SLS Program under the supervision of the teacher/researcher. The researcher regularly came in to the class to teach new aspects of the course as detailed in Figure 3.2. In Term 1, the total class time spent on SLS work was 295 minutes – an average of 32 minutes per week. Homework relevant to the intervention required a maximum of 130 minutes over the term, although most students began or completed the set tasks during class time. In Term 2, the total time spent on the program was 250 minutes – an average of 31 minutes per week with some time spent at home to maintain summaries. During Term 3, the time spent in class dropped to 215 minutes, an average of 24 minutes per week, while in Term 4, 150 minutes were spent – an average of 21 minutes per week. More time was spent in the first half of the year to introduce and practise the learning strategies. It is important to note that the time spent learning science was not reduced significantly during the program, as content was often delivered via the learning strategies. In so doing, science scores of students undergoing the SLS program should, at the very least, not be adversely affected, when compared to the mean scores of the other two classes.

Details of the distribution of in-class SLS instruction through 1999 are shown in Figure 3.2. The class time spent in delivering the SLS program and the time required to mark SLS tasks are also included. The Lesson Type numbers refer to the lessons used to deliver the learning strategy instruction. The Lesson Types are described in detail in the following text.

3.2.1 Lesson Type 1 - Introducing the SLS Program and managing code names

15 minutes

1. The aim of the SLS Program and research project were explained. Students were told that the program was designed to help them 'learn how to learn' science more effectively and that the research project was a way of showing other teachers that the program was effective. The students were reassured that the program had been developed and tested over several years and had proven successful and popular with previous Year 8 students.
2. The Parent Permission letter (Appendix 3.1) and Parent Questionnaire (Appendix 3.2) were handed out.
3. The reason for code names was explained (so Student Questionnaires and LASSI-HS answers would be anonymous but able to be cross checked (triangulated) over time) and it was stressed that these must stay the same throughout the year. A class list was passed around the room. Students were asked to choose a code name and to write their code name next to their name. Students also wrote their code name in their diary. (Absent students did this when they returned to school). The last person to fill in their code name

checked the list for any matching code names. When code list was complete (e.g., absentees followed up) the envelope was sealed (without the researcher viewing it) and placed in a filing cabinet in the science office.

Term 1 1/2/99-1/4/99

Week No.	1	2	3	4	5	6	7	8	9
Lesson Type	1	2	3	4, 5	CAMP	6 ,7, 8	9	6, 10	7
Time spent (min)	15	45	10	45, 20		15, 20, 30	15	25, 30	25
Marking time (min)		40	40				~120		

Unit 1 (weeks 1–9)

Term 2 19/4/99-2/7/99

Week No.	1	2	3	4	5	6	7	8	9	10
Lesson Type	9	11	6	9	6, 12	9				13, 7
Time spent (min)	15	25	10	15	10, 15	15				30, 20
Marking time (min)	~120			30		30				

Unit 2 (weeks 2–6) Unit 3 (weeks 6–10)

Term 3 19/7/99-24/9/99

Week No.	1	2	3	4	5	6	7	8	9	10
Lesson Type	6	13	9, 14	15		16, 6		9		
Time spent (min)	10	35	15, 30	35		35, 10		15,		
Marking time (min)		30	30					30		

Unit 3 (weeks 1–2) Unit 4 (weeks 3–7) Unit 5 (weeks 8–10)

Term 4 11/10/99-17/12/99

Week No.	1	2	3	4	5	6	7	8
Lesson Type	6, 7, map choice	9	6, 17	9, 18	19	map choice	6, 7	
Time spent (min)	10,25,25	15	10,50	15	20	50	10,25	
Marking time (min)		30		~120,30				

Unit 5 (weeks 1–2) Unit 6 (weeks 3–8)

Figure 3.2 SLS program timetable for 1999

3.2.2 Lesson Type 2 - Selecting the main idea and developing dot point notes from text

45 minutes

1. The importance to science learning of being able to select the main ideas from written text was explained. Students were shown a 25 page summary of a year's work collected from a Year 8 student the previous year and compared in size to

a stack of the 6 student work-books totalling 600 pages that were to be completed in Year 8. The student work-books had been written by staff at the school and took the place of a science textbook. The point was made to the students that by Year 12, this effect is magnified. A stack of 6 lever-arch files (representing one from each academic subject studied at Year 12 level) was compared in size with a 250 page sheaf of paper (representing student summaries of the material covered in Year 12).

2. An overhead transparency was displayed of a page from a text which covered some content from the first Biology topic.
3. Students were asked to select the main ideas (the selected ideas were underlined on the overhead as the students suggested them). Each respondent was questioned about which cue/s she used to identify the point as a main idea (first or last sentence in a paragraph, paragraph headings, bold or italic font, diagrammed, boxed text etc.). A list of these cues was placed on the white-board. Students wrote this list into the front of their work-books where it could be referred to.
4. It was explained that, over the year, students were expected to keep a continuous summary of the work-books as we progressed through them and that the summaries would be assessed.
5. Students were informed that we would be learning different ways to summarise and that we would begin with dot-point notes. The process of compiling dot-point notes of five pages of work-book text was modelled on the white-board using student suggestions (good setting out, minimizing text to main ideas, etc.)
6. Students were asked to continue the dot point summary for homework.

3.2.3 Lesson Type 3 - Dot-point notes - continued

10 minutes

1. The dot-point notes were collected, marked and annotated prior to this lesson. Before being returned to the students, examples of effective note-taking were displayed, viewed and discussed. Students requiring extra help at dot-point summaries were provided with an extra practise sheet for homework (Appendix 3.3)
2. Dot-point notes were continued for homework, collected, assessed, annotated and returned several days later.

3.2.4 Lesson Type 4 – Mind mapping (described in Section 3.4)

50 minutes

1. Students were given 15 seconds to memorise a list of 10 words and were then asked to write down as many of the words as possible from memory.
2. This process was repeated with 10 coloured pictures.
3. Students were asked to indicate by a show of hands whether they remembered more of the words or pictures (78% of students remembered more pictures than words).
4. The students were then asked about the point of this exercise. The importance of colour, graphics and mnemonic associations to aid memory were explained.
5. A simple mind map about mind mapping was displayed.
6. The power of mind maps was demonstrated by showing Year 11 Human Biology mind maps. It was explained that a whole text chapter can sometimes be reduced to one A3 map or to a series of numbered maps. The cumulative effect by end of Years 11 and 12 was described.
7. An audio tape of 1998 Year 8 students comments about mind mapping was played. Advantages discussed included that mind maps can be easily modified, are easily recalled, help synthesise topics, give students the big picture, and are quick and easy to learn. (Students were not expected to accept these points. Instead a selection of summarisation strategies were taught to allow students to resolve cognitive conflicts around their preferred strategy.)
8. Students were provided with A3 paper. Students were told to 'have a go' at mind mapping 15 pages from their text. The importance of giving themselves the opportunity to practise and to have confidence that they that they would ‘get the hang of it’ was stressed. The mind map was to be completed for homework.

3.2.5 Lesson Type 5 - Mind mapping - continued

20 minutes

1. Students mapped a further section of the book in class with assistance from teacher/researcher when required.
2. Each student’s map was checked and guidance offered where appropriate.
3. Students were told to continue mind mapping the rest of the topic. The completed map was handed in at the end of the unit for assessment.

3.2.6 Lesson Type 6 - Test planning lesson (1 week prior to test)

15 minutes

1. Students were given an SLS Planner (described in Section 3.4 and provided in Appendix 3.4) one week prior to each test.
2. The method for completing the Test Planner section was demonstrated. The assessment structure for Record sheets was explained. Students completed the Test Planner section, were instructed to retain and follow the Planner and to fill in the Test Diary section as the test approached. The Test Feedback section was completed after the test and the Record sheets were collected for assessment.
3. The Planners were marked, returned and placed into student portfolios.

3.2.7 Lesson Type 7 - Check your Learning Chart (CLC)

20 minutes

1. For each new topic, the teacher placed large 'Post It' notes on a laminated A1 sized poster, one for each major concept or heading, within a topic or section of the booklet. The C.L.C poster was placed on a pin-up board at the side of the laboratory.
2. Approximately, once a week, students reviewed the work covered in that week and identified any problems. Students were encouraged to use the objectives at the front of the text, as well as the text itself as guides to checking their learning. They placed their name and page reference to the problem on a small 'Post It' note and attached this under the appropriate heading on the CLC.
3. The posted student names were collated onto a CLC Teacher Summary Sheet. As soon as possible, small groups of students with similar problems discussed their understandings with each other and with the teacher/researcher until they were able to effectively explain or demonstrate their understanding of the concept. Frequent opportunities, such as during practical work, to conduct this remedial work were found or created. Once a student had clarified her understanding, she was permitted to place a ticket in the raffle (Section 3.3.20). Usually, this remediation process took only a few minutes and students were generally helped while others were completing set tasks. Very occasionally, the problem required extended attention during a lunchtime.
4. This process was repeated during the pre-test revision period and the larger groups that generally requested help prior to the test came up to the board where the concept was discussed and clarified. The remainder of the class proceeded with independent revision while this was being done.

3.2.8 Lesson 8 – Mind map edit circle (peer evaluation)

30 minutes

1. Assessment criteria were described.
2. In groups of four, each student described the meaning of her map to the rest of the group. While each person was describing their map, the rest of the group assessed the mind map on the marking sheet (Figure 3.7).
3. Students then discussed the marks others have given them. This provided an opportunity for cognitive conflict to take place and encourage students to modify their conceptions. Individuals then modified their own maps if convinced. For homework, each student was to complete any modifications, and assess her own modified map. The evaluation sheet was to be handed in with the map next lesson.
4. A discussion of concerns/problems with mind maps occurred.
5. Students were instructed to mind map the remainder of the topic on a blank A3 sheet.

3.2.9 Lesson Type 9 - Test feedback lesson

1. Tests were returned to the students and the solutions to the test were explained.
2. A Reasons for Errors sheet (described in Section 3.6.2 and Figure 3.6) was provided, and the rationale for using it explained. Students were told that it would help them to identify why they were getting questions wrong and give them the opportunity to make changes to prevent the same types of errors from re-occurring. Students wrote their names in the appropriate column for each error.
2. Students completed the Test Feedback section of the Planner and wrote a diary reminder, one week prior to the next test, to make necessary changes to their study method.

3.2.10 Lesson Type 10 - Factors affecting test performance

30 minutes

1. Using a blank sheet of paper in landscape orientation, students wrote the term Factors Affecting Test Performance in the centre of the page. Working independently, students wrote in as many factors that affected their own personal test performance as they could think of (e.g. I can’t concentrate at the kitchen table).

2. Individuals volunteered factors and these were placed on the white board. Students copied down others' suggestions if they were personally relevant.
3. The tendency to attribute poor test performance to only one factor, namely ability level, was discussed. It was pointed out that, as shown by the brainstorm activity, there are many contributing factors and many of these can be controlled by students.
4. Students were asked to highlight at least five factors listed on their sheet *which they could have done something about*. For homework, students wrote next to the highlighted factors what they should or could have done better. If they didn't need to change any factors, they were to pretend to be helping a friend who has things underlined. For the next lesson, five or six students were asked to read out their suggestions and all students were instructed to place a note in their diary one week prior to the next test to remind them to implement any useful changes they had thought of.

3.2.11 Lesson Type 11 - Idea organisers

25 minutes

1. Students were shown a prepared example of an idea organiser (further details are described in Section 3.5.2) which had summarised the previous unit. Idea organisers were described as an alternative to mind maps. Words and symbols could be combined. Advantages and disadvantages were discussed.
2. The teacher/researcher modelled the preparation on an idea organiser based on a section of the text that the students had completed in the previous week.
3. Students were then each provided with blank idea organisers and asked to summarise the rest of the unit in two pages or less.

3.2.12 Lesson Type 12 - Idea Organisers - continued

15 minutes

1. The best ideas from completed student idea organisers were collated into a single A4 organiser for the topic, a copy of which was provided to each student.
2. The collated summary was discussed and students were asked to compare it with their own and observe differences. Students could then decide whether their version should be modified.

3.2.13 Lesson Type 13 - Concept mapping

35 minutes

1. The teacher displayed an incomplete concept map on friction (with five terms) and asked students to brainstorm useful links.
2. The value of concept maps (described in Section 3.4.2) was discussed.
3. Students were provided with a six term concept map on levers and were asked to complete it in class. The teacher-researcher provided assistance to individuals as required.
4. A completed map was provided for them to check against.
5. A map containing eight terms and nine links was provided for homework. Students were required to complete the links.

3.2.14 Lesson Type 14 - *Science Learning Strategies* Booklet

30 minutes

1. The *Science Learning Strategy (SLS)* booklets (described in Section 3.5.3 and shown in Appendix 4.2) were handed out. Students were shown the Contents page, and several example sections.
2. Effect of negative self-talk during tests were discussed in the light of the test the previous day. An analogy of negative self-talk distracting from performance during tests to a nasty 'pesky parrot' on your shoulder, was made. Students in pairs practised strategies for countering the 'parrot' with one person providing the kind of negative self-talk they experience during a test and the other person countering it with rational comments. The effectiveness of this activity was then discussed.
3. Students were asked to read the *SLS* booklet for homework and score their aptitude from one to five (five being the highest aptitude) for each strategy in the first box provided.

3.2.15 Lesson Type 15 - Selecting main idea and spider mapping

35 minutes

1. A number of students in the mid-year interviews indicated that they were still having difficulty selecting the main ideas from text.
2. Consequently, spider mapping was introduced as a key-word based version of mind-mapping, which although less effective for memorisation, allowed rapid summarisation for the purposes of this lesson.
3. The process of using the index and objectives to lay out the map and establish the main sections was demonstrated. Students participated in the process of

identifying where each main section began and finished by skimming the text. They determined how many main subsections branched from each section.

4. The teacher modelled the process of selecting the main points from text for the first few sections. This was done with reference to the objectives.
5. Students then brainstormed the main points for a further 10 pages of text and established which material was core and non-core.
6. Students were required to complete the spider map for homework.

3.2.16 Lesson Type 16 - Spider mapping - continued

35 minutes

1. 'Edit circles' of three or four students were formed to review each other's spider maps. Students presented maps to the group so that superfluous, missing or inaccurate material were identified, and map owners made changes after taking account of the feedback of the group and referring to the relevant section in the text to see why they had found it problematic.

3.2.17 Lesson Type 17 - *SLS* Booklet - continued

50 minutes

1. The sections on Learning, Test Preparation and Test Taking strategies were revised and discussed in detail. Students went through all strategies and filled in the space provided by assessing their competence at each strategy on a scale of 1-5.

3.2.18 Lesson Type 18 - *SLS* Booklet - continued

15 minutes

1. A discussion focusing on revising how learning strategy efficacy can effect performance was held. Students were encouraged to consider that natural ability is just one factor and that governable learning strategies play a significant part in academic performance.

3.2.19 Lesson 19 - *SLS* Booklet - continued

20 minutes

1. The importance of deep processing was outlined and a discussion of how the process of producing mind maps, idea organisers and concept maps leads to better learning, was facilitated. Students described their confirming experiences.
2. A discussion took place about how to keep these strategies going next year when class time is not provided. Suggestions were discussed. The importance of

knowing goals and remembering the benefits of the learning strategies were discussed.

3.2.20 Raffle

Students who were working in a focused way, who were trying hard, who completed homework on the night it was set each wrote her name on a raffle ticket and placed it a weekly raffle draw. Small prizes were awarded each Friday. First prize could only be won once by a particular student during each semester. Students were able to win multiple second prizes.

3.3 The 1998 pilot study

The strategies used in 1998 were essentially the same as those used in 1999 and are not detailed further. The program was concentrated into two terms instead of four and the overall class-time requirement was 555 minutes (Figure 3.3). Results from the 1998 pilot study are described in Chapter 4, Sections 4.7-4.13.

3.4 Teaching and learning materials

3.4.1 Mind maps

Mind mapping was developed by Buzan (1989) as a system using pictures and mneumonics to represent meaning and laid out so that relative importance of concepts is apparent. Advantages of mind mapping described by Buzan are that the central idea of a topic is more clearly defined, the relative importance of each idea is indicated by its distance from the centre of the page and links between concepts can be shown, thus aiding integration of ideas. In effect, when students draw and annotate links between concepts, they are producing simple concept maps. An important feature of mind mapping is that mneumonic symbols are easily remembered. Also, new information can be added at a later date without having to squeeze it in between lines of text. An example of a student mind map is shown in Appendix 3.5

A major advantage of mind mapping not described by Buzan is that in order to choose an appropriate mneumonic or image, students need to have a sound grasp of the concept. Also, an invaluable benefit for the teacher is that mind maps reveal in a clear and quickly evaluated format, the understanding that a student has about a topic. Importantly, alternative conceptions also are easily detected.

3.4.2 Idea organisers

Idea organisers are a simple tool to help students to develop knowledge hierarchies and to assist them in selection of key information from text. Concise notes are encouraged by limiting the number of A4 sheets which can be used for a given summarization task. Appendix 3.6 shows a section from a student idea organiser on the topic of Tinkering with Machines.

3.4.3 Concept maps

Much has been written on the value of concept mapping in the science classroom (e.g., Novak & Godwin, 1984; Novak, 1990; Roth & Roychoudhury, 1993) as a method of promoting deep processing. Key concepts are linked by propositions. Initially, students can be provided with the concepts so that only the propositions linking the concepts need to be filled in. With more experience, students can also identify the key concepts that should be included within a topic. Appendix 3.7 shows a student concept map for the topic Pulleys.

Term 3 Chemistry 2		
a. Post test study diary, test feedback sheets. (x2)	30 minutes	30 minutes
b. Check Learning Chart (x 3) (includes 20 min assisting CLC students.) Students not requiring clarification use time for mind maps/notes, testing in pairs etc.		30 minutes
c. View pink file action statements from last test and then complete test planner (x2)		50 minutes
d. Mind map instruction		50 minutes
e. Revision strategies discussion		15 minutes
Term 3 - Tinkering		
a. Post test study diary, test feedback sheets, attributions (x2)		30 minutes
b. Check Learning Chart (x 3) (includes 20 min assisting CLC students). Others use time for mind maps/notes etc.		30 minutes
c. View action statements from last test and then complete test planner (x2)		50 minutes
d. Factors affecting test performance lesson		20 minutes
e. Concept mapping (x2)		40 minutes
f. Mind map edit circle with peer assessment form		30 minutes
Term 4 - Animals		
a. Post test study diary, test feedback sheets. (x 1)		15 minutes
b. Check Learning Chart (x 3) (includes 20 min assisting CLC students.) Others use time for mind maps/notes etc.		30 minutes
c. View action statements from last test and then complete test planner (x1)		25 minutes
d. Mind map edit circles with verbal feedback		10 minutes

Figure 3.3 Time allocation for strategy trials in 1998

3.4.4 *Science Learning Strategies* booklet

The booklet, *Science Learning Strategies,* was written by the researcher to raise student awareness of the large number of strategies covered by the SLS program that impinged on their learning. The full text from the booklet, minus the colour illustrations, is provided in Appendix 4.2. The booklet also aimed to provide students with additional information about particular strategies and the process of learning in general.

The booklet covered strategies relating to the topics Getting Organised, Managing Stress, Learning, Test Preparation and Taking Tests. Specific strategies are listed in the Index shown in Figure 3.4. A sample of material from the booklet is provided in Figure 3.6.

INDEX

Figure 3.4 Index of the *Science Learning Strategies* booklet

An additional function of the book was to require students to reflect on their strategy competence. Three boxes (as seen in Figure 3.5) were provided for each strategy so that over time, students could rate their progress towards mastery on a scale of 1-5. The first box was filled in early in the year, the second towards the middle of the year and the third at the end of the year.

3.5 Metacognitive tools

Four devices were designed to aid the metacognitive development of students. These were the SLS Planner, Reasons for Errors sheet, a Peer Evaluation device and the Check your Learning Chart.

3.5.1 SLS Planners

The SLS Planners (Appendix 3.4) consisted of three sections which were completed at different times. The Planning section was completed one week prior to each test. Students initially ticked which test mark range they would be satisfied with. Then students entered the test date into the right hand column of the chart working backwards to the current date. All assignments and tests were entered into the appropriate columns together with the percentage each of them was worth. Out of school activities and commitments were added. The assessments and activities were then numbered in order of priority. Students were encouraged to be realistic in this task. Time left for all homework and time planned for science test revision was recorded for each day.

The Study Diary section was completed in the week leading up to the test. Students recorded the actual time spent revising for the science test and ticked the range of strategies they used during the revision period.

The Test Feedback section was completed after the test and returned to the students. It contained reflective questions to encourage students to consider if they had reached their percentage target, whether they had stuck to their study plan the consequences of not following it, and what changes they might make when approaching the next test.

3.5.2 Reasons for Errors sheets

The Reasons for Errors sheets were given to students at the same time as marked test papers were returned. For each error, the students were required to indicate why they had made the mistake. A Reasons for Errors chart is shown in Appendix 6.2. One objective of these sheets was to gather data about student error attributions. More importantly, they provided students with a detailed analysis of what caused them to make mistakes and hopefully allowed them to work at reducing those types of errors in future tests. The intention was to demonstrate to the students that many mistakes were governable and to encourage a sense of control over performance.

3.5.3 Check your Learning Chart

Students were required to periodically review their learning to see if they were achieving course objectives. A large laminated sheet was provided with topic headings listed. Students identifying any problems they were having by placing Post It notes bearing their names, under the relative headings.

Small groups of students with similar concerns, together with the teacher, discussed their understandings. Students were assisted by this process to modify their alternative conceptions.

3.5.4 Peer evaluation sheets

Peer Evaluation sheets were used by students to assess each others SLS work. Figure 3.6 shows a sheet used by students working in an edit circle to evaluate and constructively criticise mind maps.

3.6 Assessment

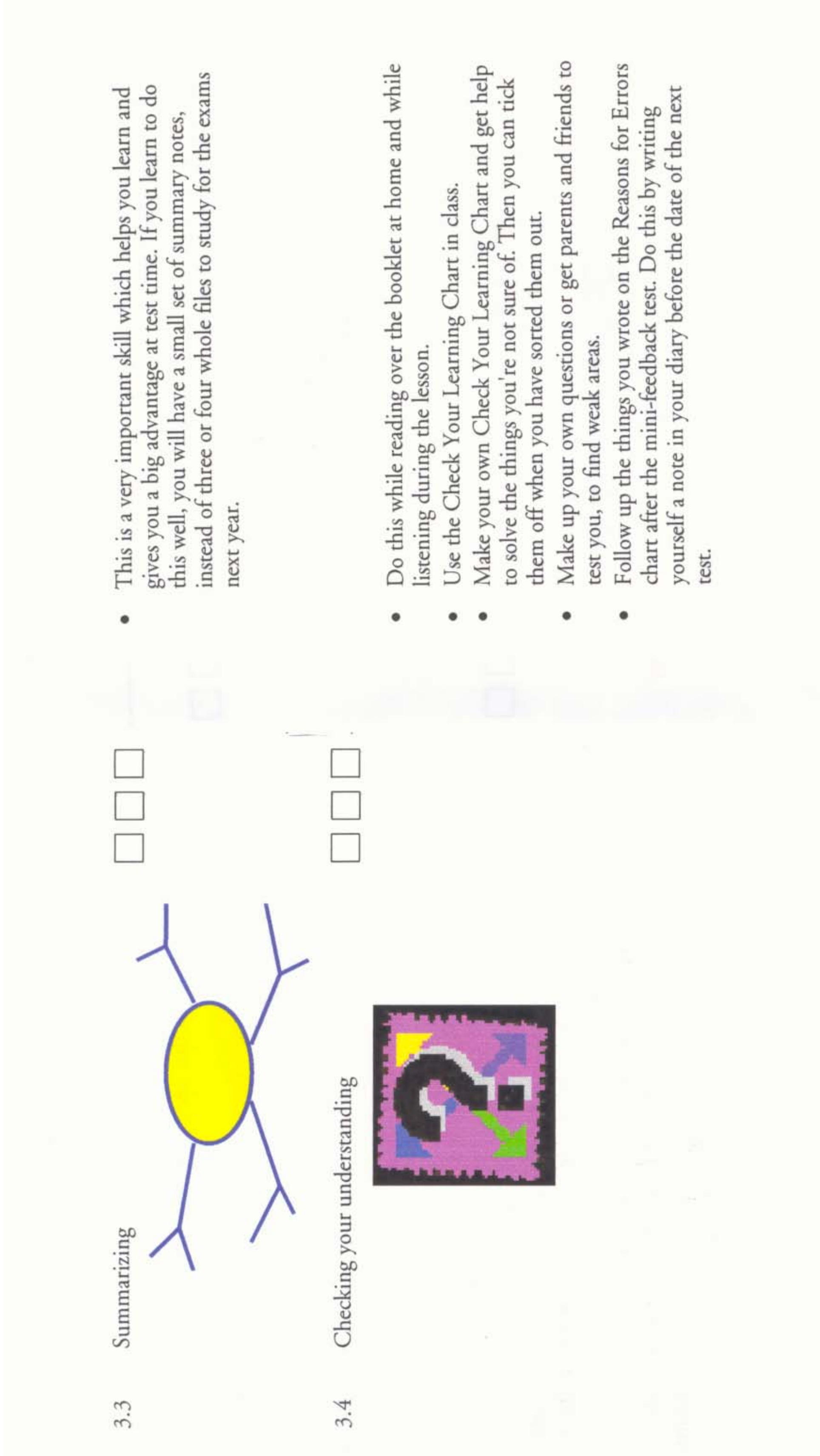
Two weeks into each new topic, students completed a 20-minute, low stakes (10% of unit mark), 'mini-feedback' test which generally included 10 multiple choice questions and several short answer questions. At the end of each four week unit, students completed a 40 minute major feedback test, worth approximately 70% of the marks for that unit. This test was also composed of multiple choice and short answer questions.

Markers name________________

❖ *Good use of colour:*	Yes -**1**		No -**0**
❖ *Layout*	Very clear - **2**	Moderately clear - **1**	Poor - **0**
❖ *Use of symbols*	Very good - **2**	Moderate/too wordy - **1**	Poor - **0**
❖ *Accuracy*	Very high (1 or 2 errors) - **2**	Moderate(3-4 errors) -**1**	Poor(>4 errors) - **0**
❖ *Covers course*	Fully -**3**	Mostly - **2**	Moderately - **1**

	COLOUR/ 1	LAYOUT/ 2	SYMBOLS/ 2	ACCURACY/ 2	COVERAGE/ 3
Map owner ____________ Total score /10					
Map owner ____________ Total score /10					
Map owner ____________ Total score /10					
Map owner ____________ Total score /10					

Figure 3.5 Mind map evaluation sheet



3.3 Summarizing

- This is a very important skill which helps you learn and gives you a big advantage at test time. If you learn to do this well, you will have a small set of summary notes, instead of three or four whole files to study for the exams next year.

3.4 Checking your understanding

- Do this while reading over the booklet at home and while listening during the lesson.
- Use the Check Your Learning Chart in class.
- Make your own Check Your Learning Chart and get help to solve the things you're not sure of. Then you can tick them off when you have sorted them out.
- Make up your own questions or get parents and friends to test you, to find weak areas.
- Follow up the things you wrote on the Reasons for Errors chart after the mini-feedback test. Do this by writing yourself a note in your diary before the date of the next test.

Figure 3.6 A section from *Science Learning Strategies*

The remaining 10% of marks for each unit was allocated to the Science Learning Strategies program and was composed of marks for mind maps concept maps, record sheets etc. Samples of each type of SLS task were placed into student portfolios which were retained by the teacher/researcher.

3.7 Summary of Chapter 3

This chapter has described the teaching-learning process used for the Science Learning Strategies intervention in 1999. Lesson outlines, and an indication of the time required for implementation of the program have been provided. In 1999, in-class instruction required 14.8 hours, although students regularly completed SLS tasks for homework. Assessment information has been provided and the materials developed for the SLS Program were described and illustrated.

Chapter 4

Research methodology

4.1 Introduction

The enthusiastic response from students trialing learning strategy instructional materials led the writer to formulate the two Research Problems which are the subject of this thesis:

- To what extent would students benefit from a year long, formal learning strategy course which was embedded in the science curriculum?
- Is learning strategy education currently valued and fostered in Western Australia by science teachers?

To address these problems, four Research Questions were developed to inform the study:

1) What role do Western Australian science teachers currently play in the delivery of learning strategy education to high school science students?

2) What perceptions of the effects of the embedded learning strategy course on student ability to apply learning strategies to science are held by:
   a) students, b) parents and c) the teacher?

3) What perceptions of the effects of the embedded learning strategies course on academic performance are held by:
   a) students, b) parents and c) the teacher?

4) What perceptions of the effects of the embedded learning strategies course on performance attribution are held by:
   a) students, b) parents and c) the teacher?

The methodology adopted for this project falls under Erickson's (1986) encompassing term, interpretive research, which he defines as having as its central focus "interest in human meaning in social life and its elucidation and exposition by the researcher" (p. 119).

Peshkin (1993) applauded the 'generative potential' of qualitative research and advocated the use of interpretive approaches as providing clues and insights for empirical generalisations derived from quantitative data. He also noted the benefits of anti-positive approaches in clarifying complexity and giving information about processes, relationships, settings and situations.

Hitchcock and Hughes (1989) support the view that interpretative research is the most suitable basis for research by teachers and comment that classroom-based teacher research "should facilitate reflection and criticism and a more informed view of the educational process which will in turn help to improve professional practice" (p. 13). They caution about the objectivity of the teacher delivering the intervention also being the researcher. However, Hitchcock and Hughes conclude by saying that the involvement of the teacher as researcher may be viewed as a strength if the goal is to improve the learning process. The teacher/researcher’s focus in this investigation has solely been to improve the learning journey of students.

The methodology used to answer the Research Questions is detailed in this chapter. The chapter also defines the research population and describes the research instruments employed in the study. The statistical methodology used to analyse the quantitative data is detailed and the research methodology is evaluated against appropriate criteria. The remainder of the chapter describes a pilot study conducted in 1998 during which aspects of the SLS course and measuring instruments were clarified and refined.

4.2 Research population

A class of 26 Year 8 students at a private girls' college in Western Australia, participated in the Science Learning Strategy Program (SLS program) which augmented the science curriculum. An additional four Year 8 science classes of similar size completed the standard science curriculum. The Year 8 students were assigned to heterogeneous classes alphabetically and by sports faction.

The students attending this school are from families in middle to high socio-economic groups. Most of the school’s graduates (75-80%) achieve entry to university and the remainder go on to technical or further education. Academic achievement is highly valued and rewarded by students, parents and staff. In the previous seven years in which government data has been published comparing academic performance of schools in the Tertiary Entrance Examination, the school has consistently placed in the top ten schools in the State of Western Australia.

At the beginning of the year, all Year 8 students completed a Student Questionnaire that examined, among other things, their motivation to achieve the best results in science of which they were capable. On a five point scale, where 5 indicated a very high motivation, the average response was 4.5. Interest in science was also quite high, with a mean score of 3.5.

In terms of ability, Year 8 students at this school did very well on the NFER Verbal Reasoning Test (NFER-Nelson, 1992) administered at the start of 1999. This test examines the reasoning abilities of students and also identifies students' most effective medium of problem solving. It indicates the likely ease with which a student will be able to acquire new concepts and understand new ideas across a range of subjects. At the start of Year 8 in 1999, the average score for the year group was 114.34 (percentile equivalent of 81.5) and for students in Class 5 receiving the intervention, 113.52 (percentile equivalent of 79.7).

No students in the class receiving the intervention had any specific learning disabilities, and there was only one student who was born overseas in the class. Her language skills were excellent and did not interfere with her science learning.

During interviews at the start of the year, few of the students reported learning strategy instruction prior to the study and those that had, reported that it was fragmentary and was not content area specific. Several students reported that they had been taught some individual strategies, the most commonly encountered strategy being mind mapping. In an interview at the beginning of 1999, six of the 20 students interviewed reported having learnt mind mapping. Of these, two students reported that they had only done a few mind maps and a third student indicated that she "didn't get the idea” and had not understood mind mapping in primary school.

During the course of the year, all Year 8 students received limited study skill instruction in a Personal and Vocational Education (PVE) course. The course included only three, 40 minute periods in total on the topics previewing texts, skimming, scanning, identifying main ideas, note-making and summarising (weeks 6, 7 and 8 of Semester 1). In weeks 13 and 14 of Semester 1, goal setting and time management were addressed. One period in Semester 2 was used to teach examination preparation.

Examination of the PVE curriculum revealed that the instruction given in the PVE course was not extensive or content area specific. Student interviews conducted in the middle of the year and in the November Tools for Learning Questionnaire showed that few students were able to recall what was taught in the PVE course during the first semester. Students could not remember having been taught learning strategies consistently in any other subjects. Five students responding to Question 7 in the Tools for Learning Questionnaire answered directly that there was no other instruction provided. Other students responded as follows

> Not really. In PVE (Personal Vocational Education) we did a little bit of stuff before test week, but not otherwise (Brittany)
> Not really (Jemma)
> Not very much. Only a bit in PVE (Robin)
> No, I can't think of any other core subjects where we've learnt this (Gabby)
> No, science has been the only one (Louise)
> In PVE but not consistent (Ginia)
> We have learnt a bit about studying and note taking in Social Science and a little bit in English (Isabel)
> Not really, only in Science (Annabel)
> PVE but less consistent (Nicola)

And yet students believed it was important to include learning strategy education within subjects. Question 6 of the November Tools for Learning Questionnaire asked students how important it was to be taught learning strategies in science.On a scale of 1 to 5, 55% of the respondents chose a rating of 4 or 5, indicating strong support for the inclusion of learning strategy education in science. Although six students left this question blank, none believed that it wasn't important at all for learning strategy instruction to be included in the science course and 28% indicated moderate support for the idea. Discussions with heads of other departments revealed that other learning areas in the school were not embedding formal learning strategy instruction in the curriculum at the time of the study. All of the students in the class agreed to participate in the program and were given written parental permission to do so.

Of the five heterogeneous classes in 1999, only the researcher's class was exposed to the year long learning strategies program. The five classes all completed the same Year 8 science curriculum.

4.3 Research instrumentation

In Chapter 1, an introduction to the research instrumentation was provided in Section 1.4. Data consisted of both quantitative and qualitative information gathered during a pilot study in 1998 and during the implementation phase in 1999. The instruments used to collect this data are described and exemplified in the following sections. A summary of the instrumentation is provided in Table 4.1.

Table 4.1 Summary of research instrumentation and relationship to the Research Questions

Parameter	Perception		
Measured	Student	Parent	Teacher
Teacher involvement in delivering learning strategy instruction (Research Question 1)	-	-	• Teacher mail survey N=425
Learning Strategy Utility INITIAL (Research Question 2)	• Student Questionnaire (Q1-3) N=120 • February interview	• Parent Questionnaire (Q1-5)	• LASSI-HS* • SLS Planners • Strategy work samples • Student Questionnaire (Q 4i-4iii) • February group interview
Learning Strategy Utility MID YEAR	• July Tools for Learning Questionnaire (N=11) /interview (N=10) (All questions except 10, 16, 23, 28, 32, 35**) • SLS booklet		
Learning Strategy Utility FINAL (Research Question 2)	• Student Questionnaire (Q1-3) Q4*** • December interview (n=9) • November Tools for Learning Questionnaire (Q1-2) • SLS booklet	• Parent phone survey (Q1-3,5)	• LASSI-HS • S.L.S Planners • Strategy work samples • Student Questionnaire (Q 4i-4iii) • Tally of tool use • Test Taking Questionnaire
Academic Performance INITIAL (Research Question 3)	• Student Questionnaire (Q 5) • Interviews	• Parent questionnaire	• Test results
Academic performance MID YEAR	• July Tools for Learning (Q 10, 16, 23, 28, 32, 35)		
Academic Performance FINAL (Research Question 3)	• Student Questionnaire (Q5) • November Tools for Learning Questionnaire (Q 3, 4, 5, 10) ***Q 6-7 provide background information • Year 8 academic results • Interviews	• Parent phone survey (Q 4)	• Test results
Performance Attribution INITIAL (Research Question 4)	• Student Questionnaire (Q 6)	• Parent questionnaire (Q 7)	• February interview Q7
Performance Attribution FINAL (Research Question 4)	• Student Questionnaire (Q 6) • November Tools for Learning Questionnaire (Q 8-10)	• Parent phone survey (Q 6-7)	• Interviews

*   LASSI-HS – Learning and Study Skills Inventory-High School version (Weinstein & Palmer,1990).
** July Tools for Learning Questionnaire Questions 36 and 37 provide background information and are not included in this Table.
*** November Tools for Learning Questionnaire Q 6-7 provide background information

4.3.1 Teacher Survey

Information pertinent to Research Question 1 was gathered via an anonymous mail survey of 425 secondary school science teachers in Western Australia who were members of the Science Teachers Association of Western Australia. There were approximately 1500 full time equivalent science teachers in Western Australia at the time of the inquiry (Science Teacher's Association of Western Australia, 1998, personal communication).

The questionnaire (Appendix 4.1) sought information about the degree to which science teachers view learning strategy instruction to be their responsibility and the extent to which they incorporate this instruction into the science curriculum. A sample question is provided in Figure 4.1.

Question 3
To what extent do you believe it is important for you to teach study strategies (eg. how to summarize, how to draw concept maps, how to revise) to **lower** school students, during science classes?

1	2	3	4	5	6
Not important at all			As important as teaching subject processes and content		The most important aspect

Other opinion?____

Figure 4.1 Sample question from the Teacher Survey.

4.3.2 Student Science Learning Strategy Questionnaire.

All Year 8 students in the author’s school completed the Student Science Learning Strategy Questionnaire at the beginning and end of the year in 1998 and 1999 to determine how their perceptions of academic ability, learning strategy utility, and performance attribution changed over time. The anonymous survey (Appendix 4.6 and 4.7) yielded information relevant to Research Questions 2a, 3a and 4a. Students used code names so that responses would be uninhibited and so that individuals' beginning and end of year responses could be compared to determine changes over the course of the year. A sample question is provided in Figure 4.2.

Question 6 - Term 1 1999 Version

Looking back over Year 7, which of the following statements **best** describes your science performance?

A. I usually get the science results that I want
B. I don't usually get the science results that I want
C. Other____

This is because **(you may circle more than one reason)**
D. I put as much effort as I can into my science studies
E. I have natural science ability
F. I have good strategies and habits for studying
G. I don't put in enough effort
H. I don't have much science ability
I. I don't have good study strategies and habits
Other____

Figure 4.2 An example from the Student Science Learning Strategy Questionnaire

4.3.3 Parent Science Learning Strategy Questionnaire

Parents were surveyed with a parallel version of the Student Questionnaire at the beginning of 1998 and 1999 to determine perceptions of their daughters' academic ability, learning strategy utility, and performance attribution. The surveys (Appendix 3.2) were anonymous and parents used their daughter's code name to allow matching. This survey provided a means of triangulating data in relation to Research Questions 2a, 2b, 3a, 3b, 4a and 4b, and also served to raise parental awareness about the value of learning strategy education.

4.3.4 The Learning and Study Skills Inventory-High School Version (LASSI-HS)

The LASSI-HS is a cross-curricular 76 item self-report instrument developed by Weinstein and Palmer (1990) which uses ten scales to measure three latent variables, namely, affective/effort related activities, cognitive, and goal-oriented activities (Olivarez & Tallent-Runnels, 1994). Year level norms for the LASSI-HS were constructed by the test developers after extensive testing and validation.

The LASSI-HS (Appendix 4.8) has been used extensively by the research community and has been shown to produce reliable measures of students' learning and studying behaviours (Murphy & Alexander, 1998). Murphy and Alexander found that the overall Cronbach's α reliability coefficient for the 76 items was 0.92 with a coefficient α = 0.84 for the ten scales. The LASSI-HS contains 10 scales that measure Attitude (ATT), Motivation (MOT), Time Management (TMP), Anxiety (ANX), Concentration (CON), Information Processing (INP), Selecting the Main Idea (SMI), Study Aids (STA), Self Testing (SFT) and Test Strategies (TST). The focus of each scale is described in Table 4.2. Results for cognitive behavioural scales in the LASSI-HS (attitude, motivation, anxiety and concentration) are reported because it is essential to attend to the motivational variables that determine whether or not the other strategies are chosen carefully and used effectively (Weinstein, Goetze & Alexander, 1988).

Table 4.2 Description of LASSI-HS scales

Scale	Number of items	Aim of items	Example item
Attitude (ATT)	8	To ascertain student interest in, and perceived fruitfulness of, school education. The questions aim to determine how clear students are about their educational goals and how important or worthwhile school is to them	I only study the subjects I like
Motivation (MOT)	8	To determine students' work habits, work standards and doggedness	When work is difficult I either give up or study only the easy parts
Time Management (TMT)	7	Student use of time management principals is examined	When I decide to do schoolwork, I set aside a certain amount of time and stick with it
Anxiety (ANX)	8	These items assess the degree to which students worry about school and their performance.	While I am taking a test, worry about doing poorly gets in the way of keeping my mind on the test
Concentration (CON)	7	Students' ability to maintain close attention to school tasks is investigated.	I find that when my teacher is teaching, I think of other things and don't really listen to what is being said
Information Processing (INP)	8	These items examine the use of mental imagery, verbal elaboration, comprehension monitoring and reasoning.	I change the material I am studying into my own words
Selecting the Main Idea (SMI)	7	Students' ability to discriminate between important and less important material is investigated.	I have a hard time finding the important points in my reading
Study Aids (STA)	7	This scale probes the degree to which students can create or use techniques or materials to help them learn and remember new information.	I use study aids such as italics and headings that are in my textbooks
Self Testing (SFT)	8	These items look at preparation for lessons and tests and examine whether students monitor their level of understanding.	I try to think of possible test questions when studying my class material
Test Strategies (TST)	8	Test preparation strategies and test-taking strategies are determined by this scale (e.g. knowledge of methods of studying and learning material for later recall), time allocation for revision, knowing about the types of questions to expect.	I have difficulty adapting my studying to different types of subjects

The LASSI-HS items have a scale of 1-5 (expressed in the test as a, b, c, d, e) and there are a total of 76 items which summatively measure student learning and studying behaviour. An example of a LASSIE-HS item follows in Figure 4.3.

I try to make connections between various ideas in what I am studying	
a	not like me at all
b	not very much like me
c	somewhat like me
d	fairly much like me
e	very much like me

Figure 4.3 An example from the Information Processing scale of the LASSI-HS.

The LASSI-HS was trailed with half of the Year 8 group at the beginning of 1998 and with the whole Year 8 group at the end of 1998 to see how non-subject specific learning strategies change over the year without learning strategy instruction. In 1999, all Year 8 students completed the LASSI - HS at the beginning and end of the year. The results relate to Research Question 2c.

4.3.5 Academic Results

Academic results were analysed to establish the variation in class means and ranges over the years 1994 - 1999 in order to address Research Question 3c. Classes during this time had been heterogeneous with respect to ability and all Year 8 teachers had more than five years experience. Courses had not altered significantly.

The tests, yielding data relevant to Research Question 3, were conducted for each of the six topics covered during the academic year. All Year 8 classes completed identical test papers.

The first test during each topic, called a Mini-feedback test, was of a short 20 minute duration, was generally worth only 10% of the topic mark, and was conducted mid-way through each topic. The low percentage weighting of the Mini-feedback tests allowed students to practise test techniques under less pressure, while providing an opportunity to identify weaknesses in their understanding of the topic. The Mini-feedback tests consisted of 10 multiple-choice items and three to six short answer questions. Each multiple choice question consisted of a stem and four or five responses. Some of the responses were distractors involving known alternative conceptions.

The End of topic tests ran for 40 minutes and consisted of 10 to 20 multiple choice questions and a number of short answer questions, a sample of which is provided in Figure 4.4.

Example Multiple Choice Test Item:

Five students tried to write a definition to say what a machine with a force advantage is. Which of the following do you think is the **best** answer?

a) A machine with a force advantage allows us to do a job with less work.
b) It's a machine that allows us to do work by overcoming friction.
c) A machine with a force advantage lets us move a heavy load by applying a small force.
d) It's a machine that allows us to do work without using energy.
e) A machine with a force advantage is something that can do work.

Example Short Answer Test Question:

Describe the appearance of the eggs of amphibians and reptiles and explain why they are structured like this.

Figure 4.4 Example questions from the End of Topic tests

4.3.6 Student Learning Strategy assignments

Students filed learning strategy assignments, together with their completed test papers, in a portfolio which was retained by the researcher. This learning strategy material included mind maps, concept maps, dot point notes, etc., and was assessed to determine student progress in relation to Research Question 2c.

Ninety percent of the marks for Year 8 assessment were allocated to tests and assignments. The remaining 10% of the marks, for classes *not* receiving the intervention, were allocated to assessment of class work such as worksheets and group work. For the class receiving the intervention, this 10% was assigned to tasks associated with the intervention; for example, students were asked to submit mind maps or paraphrased notes. This allocation of marks to learning strategy tasks ensured that students and parents perceived that student efforts to improve learning strategies were valued and acknowledged.

4.3.7 Science Learning Strategy Planners

The SLS Planners were completed by students prior to each Mini-feedback and End-topic test. These forms (Appendix 3.4) required students to nominate a desired test percentage, and to plan and prioritize their study and recreation time. Students also recorded the strategies used, the time spent for test revision, and provided reflection on links between their study behaviour and test results. The SLS

Planners were assessed by the researcher for completion and the results contributed to the 10% class mark described in the previous section. A sample from the Test Feedback section of the Planner is shown in Figure 4.5.

The SLS Planners served the dual functions of promoting student metacognition and data gathering for Research Question 2a, 2c, 4a and 4c. In relation to the former, the teacher's comments on the SLS Planners provided students with written feedback about the quality of their test planning skills and study strategies and promoted reflection on the impact of these on test performance.

1. .Did you stick to the **Actual time** you had planned to study for the science test? 1. Yes/No **(circle your choice)**

2. If you **didn't** stick to it, do you wish you had? 2. Yes/No **(circle your choice)**

3. If you wished you had stuck to it, how can you make sure you stick to it next time?

____

4. Was your mark better than, worse than, or the same as the one you would be satisfied with? 4. Same/Better/Worse **(circle your choice)**

5. If your mark was better or worse, why do you think this happened?

____

6. Do you want to improve your mark in the next test? 6.Yes/No **(circle your choice)**

7. If you said Yes in question 6, what things can you do to help your mark improve?

____

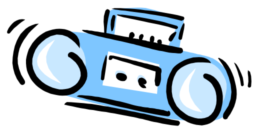
Figure 4.5 Example section of the Test Feedback section of the SLS Planner

4.3.8 *Science Learning Strategies* Student Information Booklet

At the beginning of Semester 2, students were provided with the *Science Learning Strategies* booklet (produced by the teacher/researcher). The booklet included coloured illustrations. The full text without the illustrations is provided in Appendix 4.2. The Information Booklet served the functions of providing students with information about learning strategies, promoting student metacognition and enabling data gathering for Research Question 2.

The booklet contained material relating to the following headings: Getting Organised, Managing Stress, Learning, Test Preparation and Taking Tests. A sample from the Test Preparation section is shown in Figure 4.6.

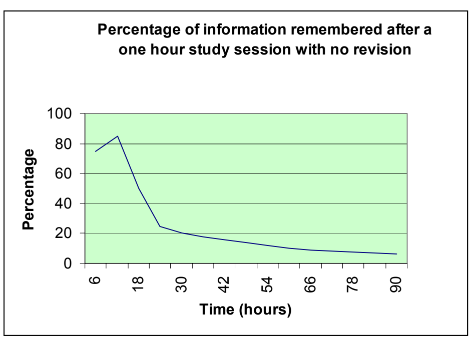
Rewarding yourself after studying



- Reward yourself when you finish a section. Having this reward to look forward to is a big help. Play with the dog, or watch a bit of TV before starting the next section.

Memorizing

- Using mneumonics means using key words or images to remind you of the sound or meaning of an idea you are trying to remember e.g. drawing a taxi to remind you that *taxis* means that the **whole** of an organism responds to a stimulus.
- Use mneumonics whenever you can. They are a great aid to memory.
- Use pictures or mneumonic words to represent ideas in mind maps and diagrams.
- Revising your notes lots of times helps you remember much more.



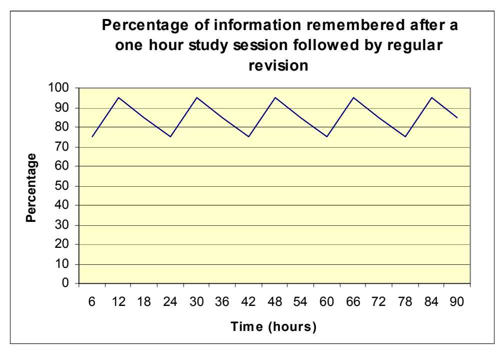


Figure 4.6 Example from *SLS* booklet

Students were required to rate their learning strategy competence (from one to five) in the boxes provided in the information booklet at the start, middle and end of Semester 2. They entered a five if they considered themselves 'very good' at a strategy, or put a one for the strategies they needed to 'work hard on'. Students were challenged to see if they could increase the ratings each time by improving weak learning strategies. Booklets were collected at the end of the year and the ratings recorded.

4.3.9 Test error attributions

Students were asked to complete a Reasons for Errors sheet (Appendix 6.2) while the teacher was providing test feedback. The sheet provided nine suggested attributions and an ‘other’ section which students selected for each test error. The data collected related to Research Questions 4a and 4c.

4.3.10 Check your Learning Chart

The Check your Learning (C.L.C.) Chart (described In Section 3.3.7), whilst primarily a teaching 'tool' also provided data to address Research Question 2c. User names and the frequency with which individuals used the Chart, were recorded in 1999.

4.3.11 1999 Year 9 interviews

Six students from the 1998 pilot study who had progressed to Year 9 were asked to discuss and record on audio-tape their reflections about the learning strategy work completed in the second half of 1998. These students were the first six of the 1998 cohort to be encountered by the researcher in 1999, and were not specifically selected. They were given the recorder and asked to make any comments they liked about the work we had done the previous year.

The intention of these interviews was to provide information about the future pathway of the intervention, to permit a degree of time triangulation and to gather data relevant to Research Questions 2a.

4.3.12 1999 Year 8 Interviews

Permission to interview students about the subject of this research was sought from, and granted by Curtin University of Technology on the researcher's candidature documents in February 1998. The school Principal and head of science were informed via a Research Proposal that student interviews would occur. Permission to implement the Proposal was granted by the Principal and head of science in 1998.

Written parental consent to interview students several times during the year was obtained from parents at the beginning of 1999. The consent form (Appendix 3.1) was included as part of an explanatory letter to parents introducing the SLS program.

Twenty three of the 25 class members were willing to participate in the interview program. Within the first four weeks of the year, a brief five minute interview of the 20 students who were available at the specified times was conducted to determine extant learning strategy competence. The students were interviewed in groups of two or three to help overcome any anxiety that might have existed at such an early stage of students' high school experience.

In the final week of Semester 1, longer 15-minute interviews were conducted with 10 students which were based on the July Tools for Learning Questionnaire (Appendix 4.3). Class members were assigned to three ability levels based on their previous science test results. Using an alphabetical class list of students' telephone numbers, on a single evening, the researcher contacted three or four students from each ability grouping. (The remainder of the class completed the Questionnaire in written format.)

All students contacted agreed to be interviewed individually at mutually convenient times during school lunch-breaks. These 15-minute interviews were designed to illustrate how student attitudes to the program changed over time and to obtain detailed explanations of why perceptions of its value to them had developed. To allow students to refer to samples to support their statements, and to aid as a guide to memory, they had access to a folder containing their learning strategy work samples during the interviews.

Final interviews were conducted at the end of 1999. Nine students were interviewed about aspects of the SLS Program. Students were selected on the base of availability at the hectic end of term.

The interviews detailed in this section, sought to elicit fine grained, perceived causal information in relation to Research Questions 2a, 3a and 4a.

4.3.13 Log of time spent on learning strategy instruction

Time required to complete learning strategy instruction in semester 2 of 1998 was recorded so that accurate programming for 1999 could occur. In 1999, the time required was recorded on the lesson planner, together with researcher observations about the intervention.

4.3.14 Tools for Learning Questionnaire

This instrument included mainly open-ended questions to investigate student perceptions of the effect of the learning strategies ('tools for learning') on academic ability, learning strategy utility, and performance attribution (Research Questions 2a, 3a, and 4a).

The researcher's class completed the pilot version of this survey at the end of 1998 In 1999, eleven students from the researcher's class completed the expanded version (Appendix 4.3) in the final week of Semester 1. (Ten other students were interviewed instead of completing the written questionnaire.) Figure 4.7 shows some questions from the survey.

At the end of November students completed a second Tools for Learning Questionnaire (Appendix 4.4) which also collected data for Research Questions 2a, 3a, and 4a.

6. Why do you think I've been getting you to learn to use Mind Maps and Idea Organisers? How do you think they're supposed to help you?

____

7. Thinking just about Mind Maps, how easily do you manage to choose the most important material to put onto them?

1	2	3	4	5
Very difficult				Very easily

Figure 4.7. Example questions from the 1999 July Tools for Learning Questionnaire

4.3.15 Test Taking Questionnaire

The Test Taking Questionnaire (Appendix 4.5) was completed at the end of 1999. The questionnaire asked students about their use of particular test taking strategies, whether the strategy had been learned from the SLS program and to what degree the strategy had helped with test results. The information gathered was used to answer Research Question 3a. Sample questions are provided in Figure 4.8.

4.3.16 Student feedback

In 2001, the researcher encountered a tertiary nursing student who had completed a four week learning strategy course in the researcher’s Year 9 class in 1996. During the encounter, the student made unsolicited verbal comments about how valuable the learning strategies had proved throughout her school and university studies.

Staying calm

Often in tests we get anxious and worried and this can stop us from concentrating.

1. Did you have any negative or worrying thoughts in the test yesterday? Yes No (circle)
2. If you circled Yes, describe what strategies you used to help you stop these negative thoughts.

3. Where or when did you learn the strategies?

4. How much has using strategies to stop negative thoughts helped with your test result/s

0	1	2	3	4	5
I don't get anxious	Hasn't helped				A very big help

Figure 4.8 Example questions from the Test Taking Questionnaire

4.4 Analysis of results

Data were arranged in two ways. Whole class comparisons of the intervention group with all other Year 8 students (Classes 1-4) and data related to the progress of individual students in the researcher's class (portfolio etc.).

Chi square statistical analysis was used to determine if Class 5 final grades (A+, A, B, C, D) varied significantly from those of Classes 1-4. T-Tests were used to analyse LASSI-HS results, Parent and Student Questionnaires responses and final scores. Results of the statistical analysis were used to address Research Questions 2b and 3b.

Learning Strategy Assignments (mind maps, concept maps etc.) were collected and assessed regularly using relevant marking keys to reveal information relevant to Research Question 2c. Interviews were transcribed by a typist, coded and analysed. All sources of data were triangulated and dis-confirming evidence sought.

4.5 Evaluating the research methodology

The research presented in this thesis needs to be able to withstand careful scrutiny by peers if it is to be described as disciplined inquiry, a term which refers to the principled nature of the research process (Shulman, 1988). The criteria for evaluation of any research varies according to the paradigm in which the investigator operates (Gage, 1989; Peshkin, 1993). In the constructivist framework in which this study is placed, the usual positivist criteria for evaluating the research methodology - internal and external validity, reliability and objectivity are not suitable (Guba & Lincoln, 1989). Guba and Lincoln put forward the alternative measures respectively - credibility, transferability, dependability and confirmability, to replace these terms. For example, in the constructivist paradigm, internal validity becomes "an assessment of the degree of isomorphism between a study's findings and the 'real' world" (p. 236). The positivist concept of internal validity as the extent to which you believe that at least part of the correlation between the independent and dependant variables was caused by the independent variable (Porter, 1988) has no relevance in a classroom where every student follows a different learning journey. The intent of the research is to try to paint pictures of at least some of the journeys of students which have been influenced to some degree by the intervention.

4.5.1 Trustworthiness and authenticity

Guba and Lincoln (1989) described *trustworthiness* and *authenticity* as the two overarching principles for evaluating a research program framed within the constructivist paradigm. These parallel the idea of rigour in the logical positivist tradition. The degree to which the methodology employed in this study relates to these two overarching criteria is now examined. The criteria are described and applied against the research methods employed in this study in the sections which follow.

4.5.1.1 Credibility

Credibility is established by accurately representing the meaning expressed by respondents (a criterion which parallels the positivist notion of internal validity). Guba and Lincoln (1989) recommend techniques for promoting "isomorphism between constructed realities of respondents and the reconstructions attributed to them" (p. 237). Several of these, prolonged engagement and persistent observation, have been met in this study.

The researcher was in contact with the students for at least four hours per week for 23 weeks. During the other 17 weeks, the researcher spent 30 minutes per week, on average, with the students. This degree of contact fulfills the requirement of prolonged engagement.

The criteria, persistent observation, was met by conducting a pilot study in 1998 and by having students engaged in learning strategy work during class time regularly throughout the year.

4.5.1.2 Dependability

Dependability parallels the positivist criterion of reliability. Reliability is described in the positivist framework as the "extent to which a measure is free from random error components" (Judd, Smith & Kidder, 1991, p. 51). By comparing parent, student and teacher perceptions and observing student progress with multiple learning strategies, triangulation has been achieved and dependability promoted.

It is beyond the scope of this project to replicate the study in additional schools or in additional years to further develop the dependability of the investigation. However, pilot work in 1998, use of historical data, replication of surveys during 1998 and 1999 and four-weekly evaluations of learning strategy work samples and study diary sheets indicate that an attempt has been made to achieve a significant degree of dependability.

4.5.1.3 Confirmability

Confirmability relates to the positivist concept of objectivity and seeks to establish the integrity of the findings of the research by assessing the extent of researcher bias. Data should be able to be tracked to its sources and the logic used to interpret data should be clearly described.

Objectivity is achieved by ensuring that data and outcomes of the inquiry are not made up by the researcher, but are based on the material generated and interpreted by different people. In this study, many students and parents were given voice in this report. Interview format and procedures were been guided by Cohen and Manion (1994) and Zimmerman and Pons (1986). Interviews were audio-taped and verbatim transcripts were prepared by an independent party. Survey design was evaluated against the checklist proposed by Jaeger (1988, p.329). Questionnaires were evaluated before use by several experienced researchers and adequately piloted. Necessary adjustments were made.

Samples of student work were collected and retained and marking procedures were made transparent. Teacher effects were mitigated by having a second teacher take the class for half of the academic year. The teacher delivered the science curriculum in her chosen style and set SLS assessment tasks (e.g. Idea organisers) for homework At mutually agreed times, the researcher taught the class components of the SLS program.

Precision and appropriateness of statistical treatments and data analysis has been maximized. Examination of the discussion of results in association with the presentation of raw data (e.g., in the form of work samples and verbatim interview excerpts) illustrates the degree to which the precision criterion has been met in this work. Logical arguments have been made explicit and are supported by stated evidence.

4.5.1.4 Triangulation

Triangulation is an important method of demonstrating credibility, dependability and confirmability. Data and methodological triangulation have been achieved by employing multiple quantitative and qualitative methods to gather data over time, across classes and from the varying perspectives of students, parents and teachers. Investigator triangulation could not be achieved in this study.

Mathison (1988) proposed that multiple sources of data can be compared to seek dis-confirming evidence and sees this as an important aspect of triangulation to be added to Denzin's (1978) original aspects of data triangulation, investigator triangulation and methodological triangulation. Dis-confirming evidence has been sought and made explicit in this study and used to adjust emerging theory (Erickson, 1986).

4.5.1.5 Transferability

Transferability is a relative term which parallels the positivist concept of generalizability. Transferability depends on the degree of correspondence in the conditions of the contexts between which comparisons are drawn. Thorough description of the context in which a study takes place helps to improve the transferability of the findings. Roth and Roychoudhury (1994) contend that detailed study of a distinct population is a goal of interpretive research in that it "allows for replication, or comparison with different groups and is the equivalent of the experimental control in natural settings" (p. 33).

This study has used Guba and Lincoln's (1989) approach of 'thick description', wherein the working hypotheses are made explicit and the database provided is as exhaustive as possible to allow other researchers to apply the findings to their own situations. The data have been described comprehensively in the body of the text or in the appendices.

Embedding the findings within the particular contextual information, and then relating findings to background knowledge arising from previous research about learning strategy instruction, has produced understandings that should contribute to the development of theory in this field.

The high socio-economic group from which the students were drawn, and the fact that the students were all female, may limit the generalizability of the study for those who choose to examine it from the positivist viewpoint. However, with the shift towards private education in this country, an increasing number of schools mirror closely the situation in which the study is based, making generalisation to other settings increasingly feasible.

4.5.2 Authenticity

Guba and Lincoln (1998) promoted the inclusion of evaluation criteria related to the rights of stakeholders in research studies. Taylor (1996) described these criteria as fairness, education, improvement and empowerment.

4.5.2.1 Fairness

Fairness relates to the extent to which participant's differing constructions and values are sought and accurately represented. In interviews and questionnaires, students were encouraged to speak freely without 'fear or favour'. Beginning and end of year questionnaires were anonymous and confidentiality was maintained in reporting student responses. All students in the class were invited to participate in interviews; those who were not interviewed because of time constraints were given a written equivalent of the interview format in which they could express candid opinions about the learning strategy intervention.

The experimental effect on the classes receiving the intervention was minimised by the extended duration of the instruction and the regularity with which work was collected. The inhibiting effect of the interview process on the students was mitigated as the researcher was their normal class teacher and the repetition of interviewing should have allowed students to adjust. Conversations were audio-taped rather than video-taped as cameras can be intimidating.

4.5.2.2 Empowerment

Empowerment relates to the degree to which respondents have been given opportunities to have a role in the research. The researcher sought and acted on suggested improvements to the intervention made by students. For instance, completion of the SLS Planners was made optional after some students revealed that they did not find them helpful. Similarly, students in the 1998 class made many useful suggestions about the intervention which were incorporated in the 1999 program.

Through a constructivist approach to teaching and learning, students were encouraged to take responsibility for their own learning and to profit from this greater degree of ownership and self-regulation. Recognition of the significant effort required by students in assuming this responsibility was evidenced by the allocation of 10% of the marks for science to learning strategy work. Individual differences in learning styles were catered for by allowing students to chose preferred strategies in second semester.

4.5.2.3 Education and Improvement

The formative design of a number of the measurement tools, such as the Check Your Learning Chart, SLS Planners and the *SLS* booklets, provide the reader with evidence that the researcher's primary concern was to facilitate improvements in students' learning behaviours and performance. Extensive data relating to Research Questions 2 and 3 have been presented to permit evaluation of the extent to which the study promoted education and scholastic improvement.

4.6 The 1998 pilot study

The 1998 pilot study was developed to trial components of the Science Learning Strategy intervention for 1999. Two measurement instruments were used across all Year 8 classes in May and December of 1998. One was the cross-curricular learning strategies questionnaire, the LASSIE-HS and the other, developed by the researcher, was the science focused Student Questionnaire. (The May 1998 version is in Appendix 5.2. The December 1998 version was the same as the 1999 December version and is provided in Appendix 4.7). An associated Parent

Questionnaire (Appendix 5.3) and a science specific Tools for Learning Questionnaire (Appendix 5.4) were also trialed.

All aspects of the intervention were tested in 1998 including teaching strategies, use of metacognitive tools, assessment of learning strategy work samples and use of devices such as the CLC and SLS Planners.

A diary of the time spent trialing aspects of the intervention was maintained (Appendix 5.1). The SLS pilot program began in term three. Of the 45 hours of science instruction delivered in the second half of 1998, 5 hours in total were used to deliver the intervention. (In a traditional classroom at least one fifty minute period per topic would be devoted to pre-test revision. This time has been subtracted from the total time required to cover the SLS program.)

Synthesisation strategies used in the intervention, such as concept mapping and mind mapping, required students to *actively* participate in the *construction* and *monitoring* of their own learning. These strategies replaced traditional revision strategies involving work-sheets, revision sheets, copying notes from board etc. and were therefore time efficient. The SLS synthesisation strategies aimed to promote better understanding, and to help students and the teacher identify concepts that were not fully understood. In this way, SLS tools can be viewed as a conduit for learning, rather than as a time-consuming add-on.

4.7 The LASSI-HS 1998

The LASSI-HS developers Weinstein and Palmer (1990) assert that students with a high percentile rank on a given scale are likely to be relatively able in that aspect of learning. A student achieving a low percentile equivalent on a given scale is likely to be weak in that area and may benefit from assistance with that aspect of learning.

Table 4.3 shows the results from the whole Year 8 group in May and November 1998 and the November scores from Class 3 (the group receiving the intervention) and Classes 1, 2, 4, 5 (did not receive the intervention).

There were some unexpected results. Over the course of 1998 the mean scores for all classes combined fell substantially for eight of the ten scales. The greatest percentage falls were in the following scales: CON (12), TMT (9.7), SFT (8.2), and

ANX (7.3) and MOT (6.0). Slight improvements occurred in the STA scale of 3.6% and in INP (1.9%). The researcher's expectation was that the scores on most scales would either remain the same, or would improve slightly over the year as students matured and gained experience in the school environment. This pattern did not eventuate. The reasons for these falls, while intriguing, are not the focus of this study.

Table 4.3 Mean scores on LASSI-HS for May and November 1998 - percentile equivalents

	All classes May	All Classes Nov	Intervention Class 3 Nov	Classes 1, 2, 4, 5 Nov
CON	66.0	54.0	51.6	54.7
MOT	61.7	55.7	53.9	56.2
SMI	60.8	59.0	64.2	57.5
SFT	59.8	51.6	50.1	52.1
ANX	58.4	51.1	51.6	51.0
TMT	58.2	48.5	46.7	48.9
TST	56.4	51.4	54.4	50.6
STA	51.9	55.5	64.1	53.1
ATT	51.2	47.7	48.6	47.5
INP	50.4	52.3	54.2	51.8

The students in Class 3 received five hours of SLS training over the second semester prior to completing the November LASSI-HS. (Details of the SLS instruction can be found in Appendix 5.1.) In addition, regular homework and revision tasks were set to consolidate student learning of the strategies. Some of the students in Classes 1, 2, 4 and 5 received limited instruction in developing dot point summaries, although no other aspects of the SLS course were introduced.

In comparing November LASSI-HS scores for Class 3 and Classes 1, 2, 4, 5 (Table 4.4) some interesting trends arise. Class 3 November LASSI-HS scores were slightly higher than the scores of the control group on six scales. In comparing Class 3 changes with those of other classes, those that stood out for Class 3 were on the SMI (selecting the main idea) scale (+6.7%) and the STA (study aid) scale (+11%). The SMI scale investigates students' ability to discriminate between important and less important material. The STA scale investigates the degree to which students can create or use techniques or materials to help them learn and remember new information. The SLS program experienced by students in Class 3 contained elements that might have assisted them in developing capacity in these two areas. (Although only five hours of class time was spent on the SLS work, students regularly completed SLS tasks for homework.)

Table 4.4 1998 November LASSI-HS scores for all classes, Class 3 and Classes 1, 2, 4, 5

Scale	All classes May	Class 3 November	Classes 1, 2, 4, 5 November	Difference in fall from May scores for Class 3 versus Classes 1, 2, 4, and 5 in November
CON	66	51.6	54.7	-3.1
MOT	61.7	53.9	56.2	-2.3
SMI	60.8	64.2	57.5	+6.7
SFT	59.8	50.1	52.1	-2.0
ANX	58.4	51.6	51	+0.6
TMT	58.2	46.7	48.9	-2.2
TST	56.4	54.4	50.6	+ 3.8
STA	51.9	64.1	53.1	+11
ATT	51.2	48.6	47.5	+1.1
INP	50.4	54.2	51.8	+2.4

4.8 The 1998 Student Questionnaire

The Student Questionnaires were completed in May (n=104) and December 1998 (n=91)

Question 1 Interest in science

Question 1 asked students to rate their level of interest on a 5 point Likert type scale where a value of 1 indicated 'no interest at all' and a value of 5 indicated 'very high interest'. The percentage of students nominating each level of their interest is shown in Table 4.5. In May the largest proportion of students (45.1%) chose a rating of four and the mean level of interest was 3.7. By December, the mean was 3.3 and the largest proportion of students chose a rating of three.

Table 4.5 Student interest and perceived ability in science in 1998 (largest proportion in bold text)

Question	Month	Mean	Very low 1	2	3	4	Very High 5
Q1 Science interest	May	3.7	4.8	5.7	26.9	**45.1**	16.3
	December	3.3	8.0	17.1	**31.0**	26.9	16.9
Q2 Perceived science ability	May	3.4	1.9	14.4	32.5	**34.9**	15.3
	December	3.2	6.5	17.5	32.8	**38.8**	9.3

Question 2 Student perception of science ability

In May, the majority of students chose a rating of 4 for their perceived science ability. By December fewer students chose a rating of 5 while the proportion choosing a rating of 4 increased slightly. The mean rating in December dropped slightly to 3.2 from 3.4 in May.

A comparison was made between perceived ability and academic performance in the early part of the year. The Living Things unit was the only unit that had been completed by all Year 8 students at the time of the Questionnaire. The results presented in Table 4.6 suggest that there may be degree of inconsistency between perceived ability and actual test performance. From this comparison it seems that some girls might have underestimated their ability. Only 15.3 % of girls rated their ability as 5/5 whereas the Living Things results indicated that 21% of students scored between 90 and 100%. At the other end of the scale, 16.3% of students ranked themselves with an ability level of 2/5 or less whereas only 1% of students achieved scores that were below 40%.

Table 4.6 Percentage of students achievement in the Living Things topic test

Score/100	0-10	10-40	40-50	50-60	60-70	70-80	80-90	90-100
Percentage of students	0	1	3.5	10.6	17.7	28	17.7	21

Question 3: (December only) Motivation to get the best science results possible

The largest proportion of students (50.5%) chose a rating of five, the highest level of motivation (Table 4.7). Another large group (34.8%) chose a rating of four. These figures indicate that students at this school are highly motivated to achieve the best results they can in science. This was not however reflected in the cross curriculum LASSI-HS, where motivation of Year 8 students dropped from 61.7% in May to 55.7% in November.

Table 4.7 Motivation to get the best results possible in science

Rating	Very low 1	2	3	4	Very high 5
Percentage of students	1.1	2.2	11.2	34.8	50.5

Question 3i May (Question 4i December): Total time spent studying for a topic test

May

The May questionnaire was completed after a mini feed-back test (worth 20%) and it is likely that students may have studied less for that test than for an end-topic test worth 75%. Students may have interpreted the question as referring to the most recent test. Others may have interpreted it as their 'typical' test performance over the previous topic or even over the previous year. (In the December Questionnaire, attention was focused on the **most recent** science test.) The average study time for all year 8 students was 1.8 hours. Time spent ranged from zero minutes to 12 hours (Table 4.8).

Table 4.8 Percentage of students indicating time spent (hours) studying for tests in May

Hours	0	0.5	1	1.5	2	2.5	3	3.5	4	5	12
Percentage of students	2	9.2	24	19.4	22.4	7.7	8.2	1	2	2	1

December

The December questionnaire was completed after a major-feedback test worth 70% of the topic score (Table 4.9). The average study time for all Year 8 students was 1.4 hours. Most studied for one hour. Time spent ranged from 0 minutes to 4 hours. The smaller range and decrease in mean time spent studying for tests in the December survey may indicate that students were busier and had more demands on their time. It could also be related to changing attitudes or other factors.

Table 4.9 Percentage of students indicating time spent (hours) studying for tests in December

Hours	0	0.5	1.0	1.5	2	2.5	3.0	3.5	4
Percentage of students	4.5	20.5	27.5	11.5	20.5	7	2	4.5	1

Question 4ii: Number of days over which test preparation is spread

May

The average number of days over which test preparation was spread in May was 2.4 days (Table 4.10). Most students (44%) spread their revision over two days.

Table 4.10 Percentage of students indicating number of days studying for tests in May

Days	1	2	3	4
Percentage of students	13.7	44	31.4	10.8

December

The average number of days was 2.0. Most students spread their test preparation over one day (Table 4.11). This decrease may have been due to increasing demands for the students' time as they mature. It could also reflect attitudinal changes.

Table 4.11 Percentage of students indicating number of days studying for tests in December

Days	1	2	3	4
Percentage of students	33.5	30.5	24.5	6.5

Question 4iii: Strategies used to prepare for tests

May

Question 4iii asked students to indicate the strategies they used to study for the most recent test. The utilisation of test preparation strategies by students in May is shown in Table 4.12. The phrase 'Just read book' in the list of strategies was problematic in that it was disparaging and in the December version of this questionnaire, was rephrased as 'Read book'.

The most commonly used strategy in May was to complete the revision sheets in the book (76%) and many (71%) used the strategy 'Get someone else to test me'. A large proportion of students (65.4%) reported using their own wording when taking notes while only 16.3% reported using book wording to make summaries.
Other strategies mentioned included memorising, making up memory rhymes, make up a song, getting extra help from science teacher in tutoring centre, test myself, make up questions and then test myself, use words to remind me of things.

Table 4.12 Percentage of students using various strategies in preparing for tests in May (n= 104)

Strategy	Description	Percentage of students
A	Just read book	54.8
B	Underline/highlight book	42.3
C	Make a summary of book (using book wording)	16.3
D	Make own version of notes (using mainly my own wording)	65.4
E	Practise out loud	48.1
F	Make my own tables or diagrams	17.3
G	Complete the revision sheets in the book	76.0
H	Get someone else to test me	71

December

In December, the questionnaire was revised to include a greater choice of strategies to prepare for tests (as per the December 1999 version provided in Appendix 4.7). Twenty four of the 115 Year 8 students were absent as the test was conducted on the last day of the year so that students could base their answers on the last major feedback test which was held two days earlier. Overseas and country students had left. Consequently, the number of responses was 91. The range of strategies listed (Table 4.13) was much broader than the strategies available for selection in the May questionnaire.

By December, the percentage of students underlining or highlighting key phrases increased by 20.3% to 62.6%. The proportion of student completing revision sheets dropped only slightly from 76 to 65.9%. The proportion of students using their own wording to summarise the book as against the percentage of students using their own wording to make summaries was much closer in December. By December, 48.3% of students were using text wording while 41.8% of students were using mainly their own wording (as against 16.3% and 65.4% in May).

Table 4.13 Percentage of students using various strategies in preparing for tests in December (n=91)

Strategy	Description	Percentage of students
A	Read book	86.8
B	Underline/highlight book	62.6
C	Copied notes from booklet	48.3
D	Made dot point notes from booklet	29.6
E	Make notes in my own words	41.8
F	Made up a mneumonic	14.3
G	Learnt a small section at a time	39.6
H	Tested myself until I knew a section before continuing	33.0
I	Had regular breaks during a study session	40.7
J	Rewarded myself after studying each section	15.4
K	Went over what I studied from day before to make sure I still remembered it, before learning new section	20.9
L	Made up questions and answered them	27.5
M	Got someone else to test me	47.3
N	Asked for help if I didn't understand something	29.6
O	Drew a mind map	17.6
P	Learnt to re-draw the mind map from memory	5.5
Q	Drew a concept map	5.5
R	Did a revision sheet	65.9

The proportion of students making their own diagrams stayed around 17% in both surveys. Students relied less heavily on others to test them at the end of the year. In May, 71% of students relied on this strategy, while only 47.3% of students reported using it in December. At the end of the year many students (40.7%) were having regular breaks during study sessions.

Question 5 Most regularly achieved mark range over 1998

Student perceptions of their most often achieved mark range are compared to mark ranges which were actually achieved in Table 4.15. The largest difference was in the mark range of 71-80% where 15.5% of students perceived their marks most often fell in the 71-80% range whereas 25.5 % of students actually gained a mark within this range.

Forty two point five percent of students believed their results to be less than 71% whereas 37% of students actually scored below 71%. These students appeared to underestimate their performance to some degree.

Table 4.15 Perceived mark range as against actual mark range

Mark range	<40%	41-50%	51-60%	61-70%	71-80%	81-90%	91-100%
Perceived n=83	6	2.5	8.5	25.5	15.5	29	13
Actual n=118	0	5	11	21	25.5	26	11.5

Question 6 Aspirations, satisfaction with results and reasons for performance (performance attribution)

May

Question six asked students whether they usually get the results they want and why they think they got those results. Actual performance in relation to these inquiries wasn't investigated in the May survey, although it was included in later questionnaires.

The May 1998 survey (Table 4.16) revealed that 69% of students (n=100) usually got the results they want (satisfied students) while 31% reported that they don't usually get the results that they want (dissatisfied students).

The largest proportion (33.2%) of the students satisfied with their performance in May 1998 credited their success to effort. Only 17.4% of this group mentioned ability as an explanation for their success, while 13.3% ascribed their performance to sound study strategies.

Table 4.16 Attributions of **satisfied** students in May 1998

Satisfied (n=69)	Attribution	Percentage of students
Single attribution	Effort	33.2
	Ability	17.4
	Study strategies	13.3
Two attributions	Ability, study strategies	4.3
	Ability, effort	2.9
	Effort, study strategies	8.7
Three attributions	Ability, effort, study strategies	5.8
No attributions		8.7
Other	Luck	2.9
	Enjoyment of science	2.9

The May 1998 survey (Table 4.17) showed that 31% of students were **dissatisfied** with their science results. The majority of dissatisfied students (35.5%) attributed their poor performance to having low ability solely, and a further 22.6% mentioned lack of ability in combination with another factors.

Table 4.17 Attributions of **dissatisfied** students in May 1998

Unsatisfied (n=31)	Attribution	Percentage of students
Single attribution	Effort	16.1
	No effort	6.5
	No ability	35.5
	Study strategies	16.9
Two attributions	No ability, no effort	3.2
	No ability, no study strategies	6.5
	Effort, no ability	9.7
Three attributions	No ability, no effort, no strategies	3.2
No attributions		3.2

As mentioned in Chapter 2, this is a common response from girls. Students who attribute disappointing results to ability only have reduced achievement expectations and can feel helpless to change their performance.

December

Table 4.18 shows the performance attributions of **satisfied** students at the end of the pilot study in December 1998.

Table 4.18 Attributions of **satisfied** students in December 1998

Satisfied (n=51)	Attribution	Percentage of students
Single attributions	Effort	29.4
	Ability	19.6
	Study strategies	2
	No effort	3.9
	No study strategies	2
Two attributions	Ability, effort	3.9
	Ability, study strategies	2
	Ability, no effort	7.8
	No ability, no study strategies	2
	Effort, study strategies	5.9
	No effort, study strategies	2
Three attributions	Ability, effort, study strategies	5.9
	Ability, study strategies, no effort	3.9
	Ability, no effort, no study strategies	2
	No ability, no effort, no study strategies	2
No attributions		3.9

In December, the satisfied students did not recognise study strategies as contributing to their success. Effort was again credited by 29.4% of the students as the main factor contributing to good performances. Effort was recognised as a contributor to successful performance by another 31% of students. Ability was credited by 19.6% of students as the sole contributing attribution for their success.

Table 4.19 shows the performance attributions of dissatisfied students at the end of the pilot study in December 1998. Lack of ability was seen as a factor in receiving disappointing results by a total of 33% of students. Poor study strategies were identified as contributing to poor results by 41%, while lack of effort was seen as a factor by 37.8%.

Table 4.19 Attributions of **dissatisfied** students in December 1998

Dissatisfied (n=25)	Attribution	Percentage of Students
Single attribution	Study strategies	4.2
	No effort	8.4
	No ability	16.2
	No study strategies	16.2
Two attributions	Ability, no effort	4.2
	No ability, no effort	4.2
	No effort, no study strategies	8.4
Three attributions	Ability, no effort, no study strategies	4.2
	Effort, no ability, no study strategies	4.2
	No ability, no effort, no study strategies	8.4
No attributions		16

Twelve students indicated they were satisfied with their results **sometimes** (Table 4.20). It is difficult to draw conclusions from this data although it has been included for completeness.

Table 4.20 Attributions of students who were **sometimes satisfied** in December 1998

Sometimes satisfied (n=12)	Attribution	Percentage of Students
Single attribution	Effort	25
	No effort	16.7
	No ability	8.3
Two attributions	Effort, study strategies	8.3 (one student)
	Ability, no effort	8.3
	Study strategies, no effort	8.3
	Study strategies, no ability	8.3
Three attributions	No abiliy, no effort, no study strategies	8.3

4.9 The 1998 Tools for Learning Questionnaire

The Tools for Learning Questionnaire was completed by students in the researcher's class at the end of the trial intervention in December 1998.

Questions 1-7

Students rated each strategy on a scale of one to five, where five indicates the strategy was extremely helpful and a rating of one indicates that the strategy was not useful at all. Student responses are summarised in Table 4.21. The highest percentage for each question is in bold text.

Table 4.21 Percentage of students assigning different values to learning strategies

Question	n=	Value of strategy				
		Not useful at all				Extremely useful
		1	2	3	4	5
1. How useful have you found the Test Planner in helping you to prepare for tests?	20	5	**35**	20	**35**	5
2. How useful have you found the Test Diary in helping you to prepare for tests?	17	5	**35**	**35**	12	12
3. How useful have you found the Test Feedback Sheet in helping you prepare for the next test?	20	5	10	20	**60**	5
4. How useful have you found the Check Your Learning Chart in helping you understand the work?	20	5	0	15	10	**70**
5. How useful have you found the Check Your Learning Chart in helping you prepare for tests?	19	5	15	20	11	**53**
6. How useful have you found the mind maps in helping you understand the work?	18	5	5	28	28	**39**
7. How useful have you found the mind maps in helping you prepare for tests?	17	0	5	28	24	**41**

The Check your Learning Chart (CLC) and mind maps were rated as extremely useful by a majority of students in Questions 4-7. Seventy percent of students indicated the CLC helped them to understand the work extremely well.

Test Feedback sheets also proved very helpful for 60% of students. The Test Planner and Test Diary were seen as moderately useful by the majority of students. Some of the reasons cited for the students' ratings are given in Table 4.22. A full list of responses is provided in Appendix 5.5. Of the 20 students who completed this survey, 55% felt that the learning 'tools' had helped them improve results in all of the six units and 25% indicated they had helped in five units. These responses were very encouraging. However, one person felt they were not helpful at all as she had "always understood everything in every topic."

Table 4.22 Ratings of helpfulness of learning strategies and explanations for ratings

Question	Rating	Reason
1 –Test Planner	5	It helps me know when I have to revise
	4	It helped me spread out my study time
	3	It does help but I don't look at it enough
	2	I don't stick to it x 2
	1	I don't need it
2 – Test Diary	5	Helped me to improve my study habits by learning from my mistakes
	4	Because it helps me
	3	I don't pay much attention to it x3
	2	Can't be bothered x 2
	1	I don't need it
3 – Test Feedback	5	Helps me know how hard I have to study
	4	Helps to focus on things I could fix
	3	It shows how I can do better
	2	I don't really use it
	1	It doesn't help me at all because I'm always satisfied with my test mark
4 – Check Learning Chart	5	Allowed me to understand all the booklet and refresh my memory
	4	It's a good way to make sure you understand the topic
	3	It has helped me sometimes just to clarify the topic
	2	No responses
	1	I don't understand it
5 – Check Learning Chart helps with test preparation	5	I have done much better in tests
	4	It lets you understand things before the night before the test
	3	I didn't use it very much
	2	Useful when I use it but sometimes I didn't really prepare for the test anyway
	1	I didn't understand it
6 – Mind maps improve understanding	5	Helps you understand a lot better
	4	I can see how the ideas fit together. They are REALLY useful and help you visualize your information
	3	Because I need lots of detail and when I do them they're too messy
	2	I normally understand everything very clearly
	1	I cannot remember anything about them
7 – Mind maps help you prepare for tests	5	You don't have to go through pages of notes to study
	4	A place to start my study because everything was summed up
	3	I didn't really look over them much x 2 The pictures help me remember
	2	I normally understood everything very clearly
	1	No responses

8 –Perception of the number of units, from a total of six, in which the learning 'tools' had helped improve science marks

Number of units/6	Number of students	Comments
6	11	They help you get more organised and motivated to study and do well. Without the Learning Chart I would have failed every test. It helped me understand

Table 4.22 continued

5	5	I understood and enjoyed the units. It was easier to study
4	2	For two units I don't think we did it. For some I wasn't sure how to use them
3		No responses
2	1	The two units we did mind maps in
1		No responses
0	1	I've always understood every topic

4.10 The 1998 Parent Questionnaire

Results from the Parent Questionnaire at the beginning of the pilot study were compared with the Student Questionnaire results from May 1998. The rationale for this comparison was to assess the level of agreement between parents and students and to provide a third point of view of student learning behaviours (in addition to the views of the students and teacher).

Seventy matched pairs of parent and student surveys were returned from a possible 115. However, in some pairs, either a parent or student may have omitted one or more questions. Consequently, n does not always equal 70 in Table 4.23.

Table 4.23 Comparison of student and parent questionnaire responses about science interest, ability and test revision patterns

Question	Student mean	Parent mean
Science Interest (scale 1-5*) n=70	3.66	3.78
Science Ability (scale 1-5**) n=69	3.43	3.64
Revision Time (hours) n=44	1.84	2.17
Revision Spread (days) n=50)	2.39	2.39

*1 = completely disinterested, 5 = extremely interested
** 1= very low, 5 = extremely interested

There were no significant differences between student and parent means for science 'interest', 'ability' or 'revision spread' at α=0.05. For these three measures, at least 48% of parents and students concurred. This represents a high level of agreement and adds support to the view that the students accurately reported their views and behaviour when completing the questionnaire.

Parent and student responses to 'time spent revising' were compared. Of the forty four pairs where responses were received from both parent and daughter for this question, only 13.5% nominated the same amount of study time (1.1 hours on average). The low number of matches was possibly because the item was not presented in scale form (it was open-ended) and was also not well located on the Questionnaire page.

A full record of the parent and student comparisons for this survey is provided in Appendix 5.6

4.11 Academic results

In 1996, 1997 and 1998 there were respectively 25, 22 and 23 students in each class. End of year academic results are presented in Table 4.24. From 1996 onwards, class sizes ranged between 22 and 25. The percentage of students scoring better than 80% was around 39%, with only one percent variation over the three year period. From 1996 onwards, the number of students scoring below 50% varied between five and one percent.

Table 4.24 Percentage of students achieving end of year academic results 1995 - 98

Percentage	1998 n=116	1997 n=111	1996 n=127
≥80	40	39	39
>65	34	33	39
≥50	21	24.5	16
<50	1	2.5	5

The results from 1996 onwards have been quite consistent, except that several more students slipped below achieving 50% in 1996 than in the most recent two years.

4.12 Summary of Chapter 4

This chapter has described how a research population of 26 Year 8 students attending a private girls' school was studied to investigate the extent to which the students would benefit from a year long, formal learning strategy course that was embedded in the science curriculum.

The chapter has also described the measurement of the degree to which learning strategy education is currently valued and fostered in Western Australian high schools by science teachers. The examination of these two Research Problems was guided by four derivative Research Questions that are outlined in Section 4.1. The instruments used to gather both quantitative and qualitative data over a two year period to answer these Research Questions, have been described. In Section 4.6, the parameters used to evaluate the research from a constructivist perspective have been outlined and applied to the present investigation.

At the conclusion of the chapter, the implementation of, and results from, the 1998 pilot study are described. The pilot study produced enough supporting evidence to warrant the full implementation of the SLS program in 1999. The other benefit stemming from the 1998 trial was the fine tuning of the SLS intervention and the measurement instruments used in 1999.

Chapter 5

The role of science teachers in delivering learning strategy education: Response to Research Question 1

5.1 Introduction

The Science Teacher Study Strategies Questionnaire aimed to collect information concerning Research Question 1 which queried the role Western Australian science teachers play in the delivery of learning strategy education to high school science students. The chapter describes the methodology of implementing the survey and the questions comprising the questionnaire. Responses from teachers are described and analysed.

5.2 Science Teacher Study Strategies Questionnaire

In May 1999, the Science Teacher Study Strategies Questionnaire (Appendix 4.1) was sent out to members of the Science Teachers' Association of Western Australia (STAWA) and was also included in the resource packs of attendees of the 1999 STAWA Conference (CONSTAWA). Four hundred and fifty four questionnaires were distributed and 218 responses were received. This represents a very good return rate of 48%. The high return rate may be due to the fact that science teachers who join their professional association (STAWA) and participate in CONSTAWA are likely to have a strong desire to develop their classroom practices and be willing to reflect on their pedagogy.

Question 1 Amount of teaching experience

Five percent of respondents indicated that they had been teaching for less than two years, 12% for 2-5 years and 83% for more than five years. The high proportion of respondents with more than five years teaching experience possibly reflects the fact that experienced teachers may have clarified their thinking about their role as teachers and have more motivation to respond to this survey.

Question 2 Usual perception of pressure felt at work

Teachers were asked to indicate their 'usual' perception of the pressure they felt at work on a scale from one to five (with one indicating 'not pressured at all' and five indicating 'extreme' pressure). The mean of responses was 3.7. This question was asked to ascertain whether extreme pressure may have been an explanation if the survey revealed that teachers were too overloaded to find the time and energy required to incorporate learning strategy education within their science courses. The mean response of 3.7 indicated that this was not likely to be the case for most teachers.

Question 3 Perceived importance of teaching study strategies to lower school science students.

In this question, 53.5% of respondents indicated that they considered the teaching of study strategies to be “as important as teaching subject processes and content”. No-one rated study strategies as “not important at all” while 1.5% believed them to be the “most important of all.”

Table 5.1 Teachers' opinions about the importance of teaching study strategies during science classes

Ranking	1	2	3	4	5	6
	Not important at all			As import. as subject processes/ content		The most important aspect
Percentage of respondents	0	2	22	53.5	21	1.5

A full record of teachers' comments is included in Appendix 5.7.

Some very positive sentiments were expressed:

> Without these skills, content is useless.
> I see it as essential across the curriculum.
> Teaching how to learn is as important as the content.
> If students learn how to learn, my job is easier.
> It needs to be taught. Students are coming to high school without these skills (6 individuals ie. x6).

A number of teachers commented that what they believe and what they achieve in class are two different matters (x7). Numerous teachers mentioned that time constraints due to pressure to cover the syllabus don't allow study strategies to be taught (x13). Six teachers considered it important to coordinate teaching of strategies across subjects so that students have a consistent and cohesive set of strategies to work with. Only one teacher suggested integrating learning strategy instruction with the teaching process.

Question 4 Teacher statements supporting their response to Question 3

In responding to this question 56% teachers believed that students have learning skills to varying degrees in lower school and can be taught to improve them (Table 5.2). Sixty seven percent believed that improving study strategies can improve confidence and/or motivation and 74% believe study strategies have a positive effect on science performance (Table 5.2). Twenty eight percent of teachers would like to teach these strategies if the curriculum wasn't so pressured while three percent indicated it is not their responsibility to teach study strategies. A complete list of teacher comments is provided in Appendix 5.8.

Table 5.2 Explanation for teacher opinions expressed in Question 3.

Explanation	Percentage
Students naturally have these strategies	<1
The curriculum is too hectic to allow me to teach these strategies, even though I would like to	28
I am not interested in teaching these strategies	2
It is not my responsibility to teach these strategies	3
Students are taught these strategies in special courses (other than in science) at this school	11
Students have these skills to varying degrees in lower school and can be taught to improve them	56
Improving study strategies can improve confidence and/or motivation	67
Improving study strategies may improve science performance	74

In commenting on the importance of teaching study strategies in a science context, three teachers commented that study strategies learnt in science were vital and carry through to other subjects and the rest of their schooling. Another teacher mentioned that students often don't get these skills anywhere else. One teacher responded that science teachers have "the responsibility to reinforce such skills even if they are taught in other learning areas". Another teacher mentioned that study strategies are "incorporated in the teaching of process and content".

These comments give a clear indication that many teachers can see the need for the development of student learning strategies within the science classroom.

Question 5 Learning strategies taught by respondents in lower school science classes

A range of explanations were presented and responses are shown in Table 5.3. While text based summarisation strategies were commonly taught by around 55% of teachers, only 28% taught students to develop visual representations such as mind maps to promote higher order integration of science concepts.

Table 5.3 Learning strategies taught in the lower school science classroom

Explanation	Percentage
Identify key concepts from science text/notes	77
Previewing text, skimming or scanning	48
Create summaries from the text (using mainly text wording)	53
Create summaries using mainly their own wording	59
Developing their own concept maps	35
Developing their own mind maps and/or other visual aids	28
Generating their own revision questions	24
Test revision strategies such as ratio of study time/break time/percent recall and importance of revisiting learnt material regularly	36

A variety of other strategies were mentioned and these are listed in full because of their diversity.

Student control and group learning strategies
Focus questions based on text and articles
Structured overview
Graphic outlines and vocabulary lists with their own definitions
Usually emphasise study and revision techniques every six weeks with one period of 55 minutes devoted to this
Developing flow charts, cause and event sequences etc. Critical path planning for investigations e.g. A,B,C must be completed so that P and Q can be dealt with on time
Use of portfolios, self assessment both in tests and in their own work, increasing responsibility so that students own their progress
I teach strategies during form time too
Working with a partner to question one another Use rhymed or funny story
I need to start! (x2)
Have successfully incorporated Stepping Out procedures using reflecting journals in Year 8 science (x 4)
I try to have them formulate a statement of what they are doing and WHY they are doing a particular activity in science
Creative thinking and design
It’s endless
Use of a revision guide – the aim is to equip students to actively revise
All of the above
Questioning to discover relevant/irrelevant
Using student objectives as a guide to summary preparation and revision

More chance of using summarising approach in Year 10

Use of headings, subheadings and main ideas. Drafts, setting goals, underlining key words in questions, process of elimination, mneumonics, SQ3R

Use of acronyms

Rote quizzes

Retrieval chart and graphic outlines

Create study notes as we go. Practise diagrams, glossaries

Changing data to different forms, putting information into notes

Memory strategies, fiction links

Not many of them used very often due to time constraints with delivering all of the syllabus content

Structured overviews, stop:think:answer, three level comprehension

Logical sequencing of events, accuracy in observational reporting, descriptive writing using own words

Encouraging students to form mental pictures of reading material to aid recall

<u>Question 6</u>

This final question asked science teachers to estimate (on average) how many minutes per week, per class group, they would spend incorporating learning strategy instruction into lower school science programs. The average time was 21.7 minutes, while 37% of teachers spent 10 minutes or less teaching learning strategies (Table 5.4). Another 30% spent between 11 and 20 minutes and 18% spent between 21 and 30 minutes.

Table 5.4 Mean time (minutes) spent incorporating learning strategy instruction into lower school science programs

Time (min)	Percentage	Time (min)	Percentage	Time (min)	Percentage
0-10	37	51-60	5	101-110	0.5
11-20	30	61-70	0.5	111-120	0.5
21-30	18	71-80	0.5		
31-40	5	81-90	0.5		
41-50	2	91-101	0.5		

Other comments were

Not much. I’m more inclined to spend time at the start of a course (e.g. 1 lesson on note-taking) and only do ‘refreshers’ as I notice bad habits (x2)

Study skills are taught in all subjects. It was the school focus for 1998

I can’t say because it varies so much (x10)

Not necessarily every period but once a week or once a fortnight

Our main aim is to help children become active learners and to show them how to process information and make links with prior knowledge rather than regurgitate facts

Usually periods are set aside for this rather than doing it each lesson (x 5)

5.3 Summary of Chapter 5 - Response to Research Question 1: The role of Western Australian science teachers in the delivery of learning strategy education to high school students

In response to Research Question 5, the Science Teachers Study Strategy Questionnaire completed by members of STAWA indicated that 54% of the 218 respondents valued learning strategy education as being as important as teaching processes and content and another 22.5% considered it to be more important. Sixty seven percent recognised that improving study strategies can improve confidence and/or motivation and 74% acknowledged that improving study strategies may improve science performance.

Disturbingly, however, 37% of teachers spent 10 minutes or less teaching learning strategies, although another 30% spent between 11 and 20 minutes. Also of concern was that although text based summarisation strategies were taught by around 55% of teachers, only 28% reported teaching students to develop visual representations such as mind maps to promote higher order integration of science concepts.

Some positive views were expressed about the value of learning strategy instruction and teachers reported introducing a variety of strategies in lower school science. Teachers' opinions about the importance of teaching study strategies during science classes, and details relating to the range of learning strategies taught have been summarised in Table 5.1 and Table 5.3 respectively.

Whilst moderately encouraging, these results do need to be treated with caution. Eighty three percent of the teachers who responded to the survey had been teaching science for more than five years and they were all either members of STAWA, or attended CONSTAWA. Consequently, the survey did not successfully describe how less experienced teachers, teachers who were not members of their professional association, and those who did not respond to the survey, view their role in delivering learning strategy education.

It is also of concern that 28% of those responding to the survey indicated that the curriculum is too hectic to allow them to teach these strategies even though they would like to.

The researcher’s recommendation is that students in Year 8 can best be helped by spending at least 40 minutes per week in Term 1 and 30 minutes per week for the following three terms, on learning strategy instruction. This can be achieved without sacrificing time spent learning science, by teaching content and process **through** the learning strategies. Examples of this would be to use concept maps to introduce the classes of levers, or to revise a topic by drawing and comparing mind maps. Many learning strategy tasks can be completed for homework.

Only one teacher commented that study strategies are “incorporated in the teaching of process and content” and no teachers reported implementing a formal learning strategies program within their science classes Helping teachers incorporate learning strategy instruction into the delivery of science content in the future is a major goal of this research project.

Chapter 6

Student perceptions of the effects of the SLS course on student ability to apply learning strategies to science: Response to Research Question 2a

6.1 Introduction

The SLS course was designed to help students develop learning strategies that would assist them in learning science. Perceptions of students about the effectiveness of the course in promoting good strategies for science learning are described in this chapter. Student perceptions in relation to Research Question 2a were divined through the Tools for Learning Questionnaire (Section 6.2.2), student interviews (Section 6.2.3) and through student competency ratings in the *SLS* booklet (Section 6.2.4). The February and December Student Questionnaire responses (Section 6.2.1), provided background information to inform this research project.

6.2 Student perceptions of the effects of the SLS course on ability to apply learning strategies to science (Research question 2a)

In order for students to feel assured in their learning, they need to develop confidence in their ability to use learning strategies effectively. The extent to which students perceived that the SLS course contributed to their learning strategy competence is examined in Section 6.2. Instruments used in this inquiry include the Student Questionnaire, the Tools for Learning Questionnaire, student interviews and the *SLS* booklet.

6.2.1 Student Questionnaire – February and December

All five science classes completed an identical Student Questionnaire in February (Appendix 4.6) and December (Appendix 4.7) 1999. In this analysis of the Student Questionnaire, responses from Class 5 (n=26), are compared to the results for Classes 1–4 combined (n=103). Some statistical analysis has been conducted to support the qualitative comparisons of mean values drawn from this instrument.

<u>Questions 1-3</u> Student interest, motivation and ability in science

Questions one to three asked students to rate their interest, motivation and ability in science at the beginning and end of the intervention in 1999. Results are shown in Figures 6.1 to 6.4.

In February, responses from students in Classes 1-4 were compared to those in Class 5 (Figure 6.1). At the beginning of the academic year, responses from students in both

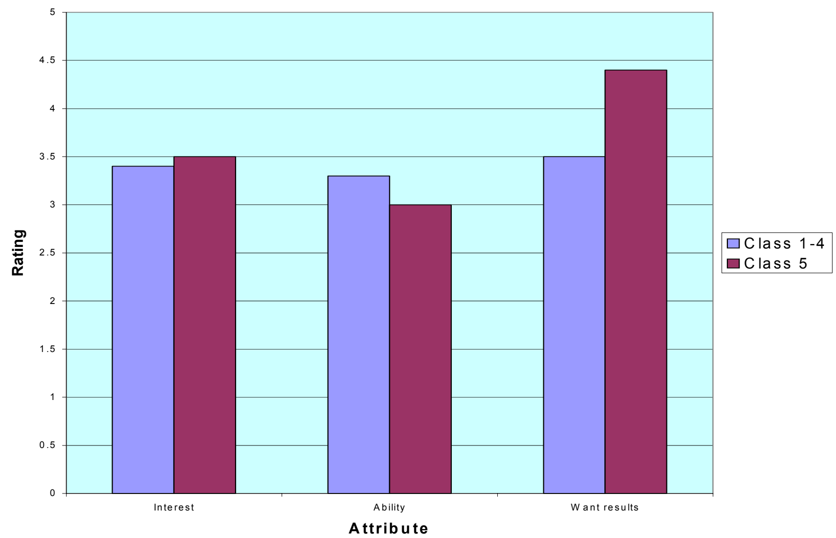


Figure 6.1 Mean ratings (on a five point scale) for Questionnaire items 1–3 in February 1999 for students in Classes 1-4 and Class 5

groups about their interest in science (on a 1-5 scale, where 5 is the best outcome) were very similar. Students in Classes 1-4 recorded a mean value of 3.4 and students in Class 5 recorded a mean rating of 3.5 (no significant difference at α = 0.05, t = -0.462).

At the beginning of the year, students in Classes 1-4 rated themselves slightly higher in ability (3.2) than did students in Class 5 (3.1). In measuring the desire to achieve the best results possible, Class 5 ratings were higher (4.4) than ratings from Classes 1-4 (3.4), although the difference was not significant at α = 0.05 (t=1.012). Class 5 students may have felt more motivated as they knew that they were in to participate in a 'special program'.

By December (Figure 6.2), the ratings for interest, ability and wanting the best results possible increased slightly for both groups. At the end of the year, Classes 1-4 rated themselves slightly higher (although not significantly at α = 0.05), than Class 5 in interest (t = 0.904) and wanting the best result (t =1.351). Class 5 students lifted their mean ability rating by 0.49 since February to reach 3.57 (significant at $\alpha = 0.05$, t = -2.803).

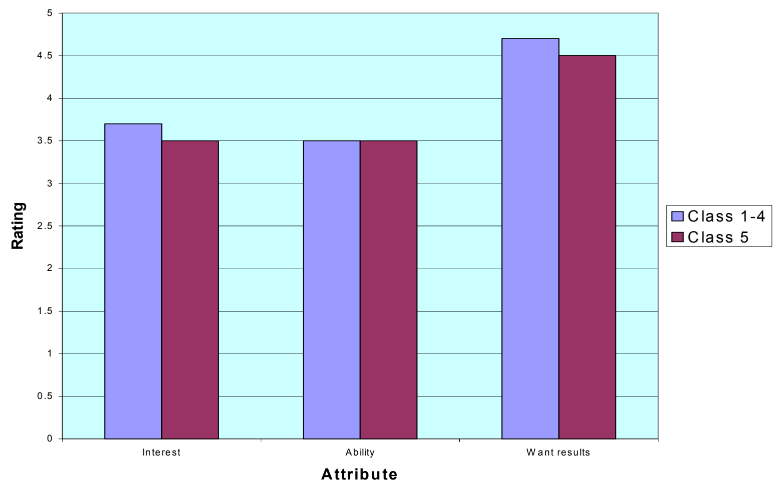


Figure 6.2 Mean ratings for Questionnaire items 1–3 in December for students in Classes 1-4 and Class 5

Classes 1-4 lifted their mean ability rating by 0.26 by the end of the year to reach a mean of 3.51. (These changes can also be seen in Figures 6.3 and 6.4.) By the end of the year, the Class 5 mean perception of ability moved from being below that of Classes 1-4 to being slightly above it although not significantly so at $\alpha = 0.05$ (t= -1.047).

Over the year students in Classes 1-4 improved most in wanting to achieve the highest results of which they were capable (Figure 6.3). They rose from a mean rating of 3.45 to 4.73 (not significant at $\alpha = 0.05$, t = -0.727) and moved from being well below the rating for Class 5 students in February to being 0.22 scale units above them in December. Figure 6.4 illustrates the changes in ratings of students from Class 5 over the year. The most significant change was the previously mentioned increase in students' perception of their ability.

In summary, at the beginning of the year, both groups of students gave very similar responses to questions about their interest and ability in science. Initially, students in Class 5 indicated a stronger desire to get the best possible results in science but at the end of the year the responses of each group on this measure were almost identical. Class 5 students raised their perception of their ability significantly from 3.08 to 3.57. The rating of 3.57 at the end of the year very slightly exceeded that of students in Classes 1-4, although this difference was not significant. This improvement in ability rating corresponded to statements made by students from Class 5 in the November Tools for Learning Questionnaire reporting gains in test scores.

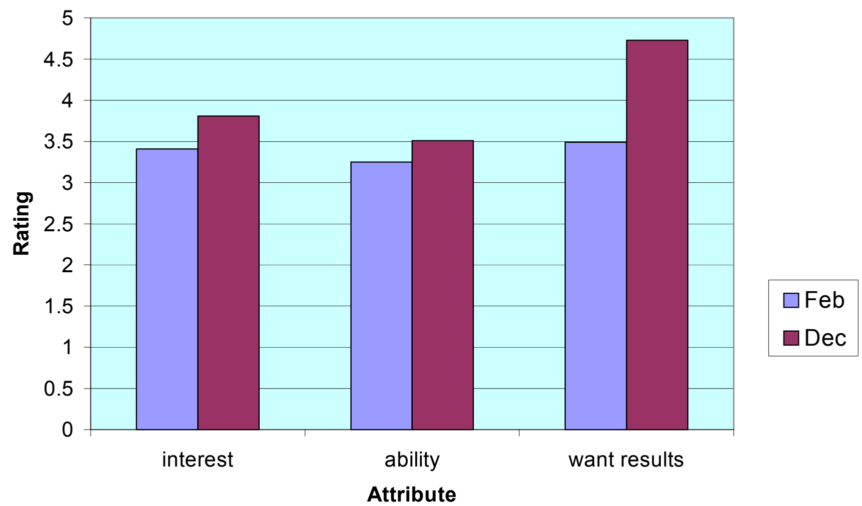


Figure 6.3 Mean ratings for Question 1-3 for classes 1-4 in February and December

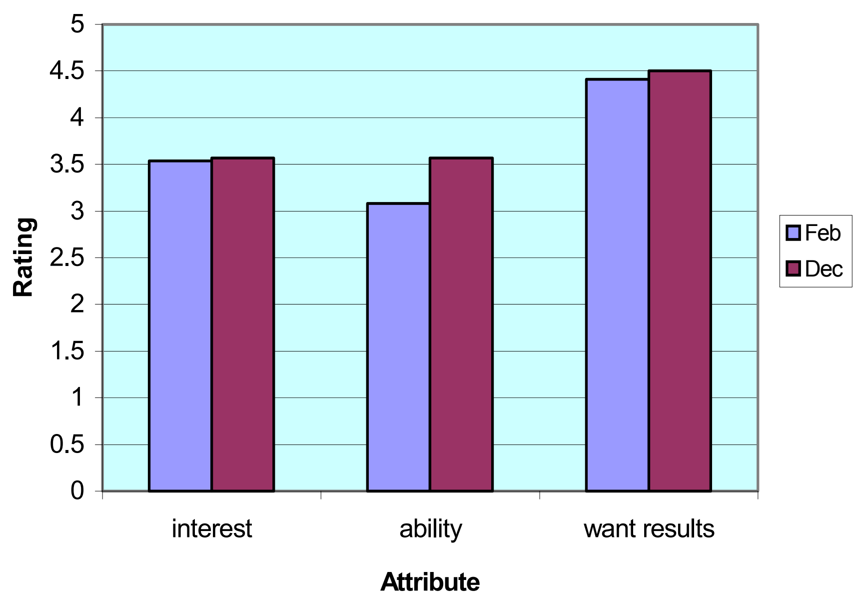


Figure 6.4 Ratings for Questions 1-3 for Class 5 in February and December 1999

6.2.2 Tools for Learning Questionnaires

The Tools for Learning Questionnaire (Appendix 4.3) was administered to Class 5 students only, in July and November. It investigated the perception of students about their competence in using the learning strategies studied in the SLS course.

6.2.2.1. Tools for Learning Questionnaire - July

Eleven students completed the July Tools for Learning probe as a written questionnaire and ten students participated in an interview based on the questionnaire. Some questions were omitted either in the interview or on the written questionnaire. For this reason, the number of students completing each item is provided, in addition to the percentages of students choosing each rating, in the tables in this chapter. The questions, with the exception of Questions 10, 16, 23, 28, 32, 35, gather information relevant to Research Question 2a (student perception of personal ability to use the learning strategies as a result of the SLS program). These exceptions probe student perception of the effect of the SLS program on their science performance and are described in Chapter 7.

For most questions, students were asked to rate their response on a scale from one to five where five indicated a very positive result and one represented the least positive response. Students were invited to elaborate on why they chose particular ratings. Quotes from interviewed students are included.

6.2.2.1.a. Mind mapping

Questions one to three, eight and nine and 11-13 of the July Tools for Learning questionnaire relate to mind mapping capability. Results are summarised in Table 6.1

Question 1 Perceived mind mapping ability (Not well at all 1 2 3 4 5 Very well)
In responding to this question only one student in July rated her ability to do mind mapping as '1 - not well at all'. The remaining 95% of students rated their competence as moderate or above (by July, the students had had considerable practise completing mind maps). A number of students commented on the fact that they were improving their mapping skills over time. For example, one student, Isabel, when asked by the researcher (RE), to rate her ability at mind mapping responded

Isabel: Well I'm improving, so I'm not sure. Probably four.

RE Can you tell me a little bit about how you've been improving. What were you like when you started and what are you like now?

Isabel: Well, seeing other good mind maps (other people's) has helped me a lot because before I hadn't done much mind mapping with drawings and things like that. I had only done ones with writing.

RE: So, what did you get better at?

Isabel: Well, I started putting in a few more pictures and more information.

This comment relates to opportunities provided for students in groups to observe other people explaining the thinking behind their mind maps.

Another student, Jemma, who had indicated a rating of four commented

Jemma The first time was hard because I hadn't done them before.

RE Do you feel you're getting better as you go?

Jemma Yes, I'd say four.

RE What sort of things are you finding it easier to do now?

Jemma Thinking of pictures to go on them and thinking of a thing in a section which represents the thing (idea) most.

This last comment identified a key development, which hopefully took place in all the students. The ability to identify a symbol, or phrase, to accurately represent a complex idea appeared to develop with time and practise. The ability to choose appropriate symbols to represent concepts can require a high level of cognitive involvement by the student.

<u>Question 2</u> Problems in producing mind maps

Student responses to the inquiry about what problems they had doing mind maps fell into some clear categories:

i) Seventeen students out of the 21 respondents were concerned that they kept leaving necessary information off them or found it hard to judge the importance of information, or decide what examples were relevant.

It should be remembered that these problems with prioritising information arise with any procedure used to summarise information. With practise students improved their judgements about what constituted key material. (By November 54% of students felt the SLS course made them very much more skilled at picking the main ideas from text, while another 40% felt they were moderately successful in choosing key information.)

ii) Four students complained that the maps took too long to produce. Mind mapping is sometimes more time consuming than other forms of summarisation. However, the time invested in producing a mind map can mean that much less time needs to be spent in studying them, than other forms of summarisation. The more important benefit is the cognitive clarification that occurs during the process of producing the maps.

iii) Five students said that mind maps didn't help them.

Negative comments by individual students follow

> I don't learn that well off them (Lara)
> I can't understand my brief work (Bree)
> I never look at them so I don't like them (Anna)
> I forget to do them (Natasha)
> I hate them (Laura)
> I need to prepare them in more detail (Sarah)
> Sometimes I do them well, sometimes I don't (Brittany)
> They take ages to do and I don't think they help me (Sophie)

It is not surprising that some quite negative views were expressed here. The whole point of the SLS course was to provide students with a smorgasbord of 'tools for learning' so that they could find what best suited them.

Although these negative comments have been made, it is evident from responses to Question 3 that only four students didn't like them at all. Sixty percent of students liked them moderately or better.

Table 6.1 Student views about mind maps in July

Question	Number of students completing question	Mean	Number and percentage of students choosing ratings least positive 1 2 3 4 5 most positive				
			1	2	3	4	5
How well are you doing mind maps? (Q.1)	20	3.3	1 5.1%	0 0%	12 60.2%	6 30.2%	1 5%
How much do you like them? (Q. 3)	15	2.7	4 26.5%	2 13.5%	5 33%	2 13.5%	2 13.5%
How easily can you choose key information to put on them? (Q. 8)	20	3.4	0 0%	2 10%	8 40%	9 45%	1 5%
How easily do you remember your mind maps for tests? (Q. 9)	20	3.1	0 0%	2 10.2%	8 40.1%	9 45.2%	1 5%
How much have mind maps helped you in understanding the ideas in the topics? (Q. 11)	20	3.2	0 0%	7 35.1%	5 25.3%	6 30.2%	2 10.1%
How much have mind maps helped you understand how the ideas in a topic fit together so that the whole unit makes sense? (Q. 12)	18	2.9	1 6%	4 22.2%	9 50.1%	4 22.1%	0 0%
Do you think that learning to use mind maps has made you more confident in your ability to learn science? (Q. 13)	18	3.0	0 0%	4 22.2%	9 50.1%	5 28.2%	0 0%

Question 3 Liking for mind maps

Over a quarter of the students indicated a strong liking for mind maps (rating four or five), with 33% having a moderate liking, 26% not liking them at all and 13.5% somewhat disliking them. Negative comments elaborating on their rating choice have been included in the comments listed for Question two.

Positive comments made by individuals were

> They are good to study with (Amanda)
> Easy to understand, I prefer pictures to writing (Sarah)
> It makes learning easier (Amanda)
> It’s easy to remember them (Lilly)
> They are colourful and nicer to look at than writing (Alex)
> If I have to do a picture then I understand the idea better (Jemma)

This last comment was very insightful. The process of producing a mind map familiarises the student thoroughly with the material. Students need to know and understand the material well enough so that judgements can be made about relative importance of information, and so that linkages between concepts can be formed.

These are difficult skills to acquire and mind mapping provides students with sustained opportunities to practise them. One student, Isabel, commented that "I seem to get more ideas now when I do mind maps now that I'm used to them. I didn't like them at the beginning of the year because I hadn't done them before."

Questions 4-6 related to idea organisers and are considered later. Question seven related to both mind maps and idea organisers and is also considered at a later stage.

<u>Question 8</u> Ease of choosing important information for mind mapping
Fifty percent of students found it very easy (rating of four or five) to choose the most important information to put on their mind maps, 40% indicated a moderate rating, 10% (2 students) found it quite difficult, while only one of the students indicated that it was very difficult. Some student comments described in relation to Question 2 are also relevant here.

<u>Question 9</u> Ease of remembering mind maps for tests
Fifty percent of students found it very easy (ratings of four or five) to remember mind maps for tests, 40% found it moderately easy, 10% found it quite difficult although no one found it very difficult.

Students elaborating on their ratings made both positive and negative comments. Several students made the comment that mind maps made no difference to their results as they didn't use them. Three negative comments were about finding it easier to remember words than pictures. (Students were asked to use pictures and symbols on their maps rather than words where possible.)

Four of the students making positive comments remarked that pictures and colours were easier for them to remember than words. Other positive comments by individuals were

> If you draw it you remember it (Sarah)
> If something took me a long time to do, I'll remember it (Jemma)
> If I have to do a picture I understand the idea better. (Jemma)

One more elaborate positive response from Karen follows

Karen: I can remember it because it's so clearly defined and it's colourful. It's easier to remember than sentences and it's quite structured with the headings.

RE: So do you actually have to process it and turn it into your own version?

Karen: Yes, that's why you always remember it. By reading the information over and over again to find the categories you understand what it's more about rather than just reading, taking abstract sentences and just trying to remember them.

This exchange points to a major advantage of mind mapping. Quite high order cognition is required to produce a well constructed map.

Question 10 is considered later.

<u>Question 11</u> Contribution of mind mapping to understanding the ideas in the topics
Forty percent of students felt the maps had helped them a lot (ratings of four or five), 25% indicated that the maps had helped moderately and 35% considered that the maps had helped them slightly. No students felt that the maps had been completely unhelpful in promoting understanding.

One student who chose a rating of five said that

> they explain things to you. Like last term we did one for animals. Drawing the cells helped you remember and understand. (Robin)

Several students who chose a rating of three pointed out that they chose this rating because they already understood the information so the maps didn't make a large contribution.

<u>Question 12</u> Contribution of mind mapping to helping understanding
No students chose a rating of five, although 22% of students indicated a rating of four. Fifty percent of respondents felt that the maps had been a moderate help in this area

while 22% indicated that mapping had been of some help (a rating of two). One student indicated that the maps hadn't helped her fit ideas together at all.

One comment related to this issue was

> It was very helpful in the Living Things unit – you could see how all the animal groups fit together. (Isabel)

Question 13 Contribution of mind mapping to confidence in ability to learn science
No students chose a rating of five, although 28% of students indicated a rating of four, 50% felt it had been of moderate assistance in boosting their confidence and 22% felt that maps had been slightly helpful in this regard. No one expressed the view that the maps had been of no help.

One student, Isabel, mentioned that she had only put a three because she was already confident, so that the mind map hadn't been that much help. This is an important point to keep in mind. Ratings for particular tools (such as mind maps) may be low, not because the strategies aren't helpful, but because students are already competent in them.

As expected, student views about mind mapping generally tended to follow the normal distribution. What is important, is that students responding to the questions with high or very high ratings have developed competence in a new and powerful 'tool for learning' which suited them (only two or three students had learnt mind mapping thoroughly prior to the SLS course).

6.2.2.1.b. Idea organisers

Questions 4-6, 14-15, and 17-19, relate to idea organisers. Results from these questions are summarised in Table 6.2.

Question 4 Perceived ability at using idea organisers
Twenty five percent of respondents indicated that they were doing the idea organisers quite well or very well. Fifty eight percent of students believed that they were doing them moderately well, 16% of respondents felt that they were producing work that was quite poor. No one felt that they were completing the organisers to a very poor standard.

Question 5 Problems with idea organisers

Lara mentioned that she loses them. Three students expressed difficulty in sorting out what is important and what should be on them. Seven students indicated that they couldn't cover all the points and get everything down. Two students said that they can pick up the main ideas but sometimes leave little things off which are tested. These problems are expected when students use summarising techniques.

One student said that idea organisers were better than mind maps to study from because she found them better set out. Three students said they had no problems and three others wrote "not much" when referring to how much difficulty they had in using them.

Question 6 Liking for idea organisers

No one answered that they liked idea organisers "very much" although 46% said "quite a lot", 15.5% expressed a moderate liking and 38.5% expressed negative reactions.

Lara commented that "I just hate them and usually don't have enough time to complete them". Karen complained that it was hard to choose the main ideas and that she found them time consuming. Three students reiterated that it was easy to miss out things.

Five people answered this question by expressing a preference for mind maps. Two of these mentioned that they preferred the mind maps because they were colourful and one student liked them because they are more spacious. Several students said that mind maps were easier to understand and remember than idea organisers.

Individual students made the following comments relating to idea organisers

> They get tiring (Ginia)
> I find them boring (Isabel)
> They are easy to study and learn from (Tilly)
> It sets out the important information (Nicola)
> I understand how to do them better than mind maps

They are good for looking over and for revision for a test. (Sarah)

It's more obvious. The main ideas and sub ideas are in front of you (Lauren)

Table 6.2 Student views about idea organisers in July

Question	Number of students completing question	Mean	Number and percentage of students choosing ratings least positive 1 2 3 4 5 most positive				
			1	2	3	4	5
How well are you doing idea organisers now (Q.4)	12	3.3	0 0%	2 16.5%	7 58.5%	2 16.5%	1 8.5%
How much do you like them? (Q. 6)	13	2.7	3 23%	2 15.5%	2 15.5%	6 46%	0 0%
How easily can you choose key information to put on them? (Q. 14)	14	3.4	1 7%	2 14.5%	3 21.5%	4 28.5%	4 28.5%
How easily do you remember your idea organisers for tests? (Q. 15)	15	3.1	0 0%	4 26.5%	6 40%	5 33.5%	0 0%
How much have idea organisers helped you in understanding the ideas in a topic? (Q. 17)	15	3.2	1 6.5%	5 33.5%	1 6.5%	6 40%	2 13.5%
How much have idea organisers helped you understand how the ideas in a topic fit together so that the whole unit makes sense? (Q. 18)	15	2.9	1 6.5%	5 33.5%	2 13.5%	6 40%	1 6.5%
Do you think that learning to use idea organisers has made you more confident in your ability to learn science? (Q. 19)	17	3.0	1 6%	3 17.5%	3 17.5%	8 47%	2 12%

Question 14 Ease of choosing the important information for idea organisers

Fifty seven percent of students found it quite, or very easy to do this, while 21.5% found it moderately easy to choose and 21.5 % of students found it quite, or very difficult, to select the key information. Once again, decisions about what to include when summarising are always difficult because students have to make judgements about the relative importance of material presented to them.

Question 15 Ease of recalling information from idea organisers in tests

Thirty three point five percent of students found it quite easy to remember while 40% found it moderately easy and 26.5% found it quite difficult to remember the information. No one found it very difficult or very easy.

Several students mentioned that they could remember mind maps better and four students said they couldn't remember idea organisers very well.

Positive comments from individuals were

> I understand how to do them better than mind maps (Natasha)
> I learn better from words (Tilly)
> They are quite easy to remember (Nicola)
> It's easier to remember one page of the idea organiser than 60-70 pages of the science book (Sarah)

This last comment indicates that the student has grasped one of the important justifications for teaching students to summarise.

<u>Question 17</u> Contribution of idea organisers in helping to understand ideas in science
Fifty three point five percent of students felt the organisers had been quite or very helpful in improving understanding, while 6.5% felt they had received a moderate benefit from them. A large proportion (40%) of the students had found the organisers quite unhelpful, or very unhelpful in improving understanding.

Relevant student comments relating to this question follow

> Copying out the ideas doesn't help me much (Isabel)
> I already understood it (Sarah)
> You have to understand the information in the first place to put it on the Organiser (Sophie)
> I understand the important ideas better (Tilly)
> It has clearly defined for me the main things if you do it properly (Karen)

One interesting interview exchange between Natasha and the researcher (RE) follows

> Natasha With the organisers you can discuss it with your partner and settle down to one thing.
> RE Do you mean an agreed answer?
> Natasha An agreed answer that we both feel has the same meaning….some meaning everyone understands.

This testing and modification of ideas through peer review was a key approach used in the SLS course and reflects the constructivist pedagogy employed by the researcher as described earlier.

<u>Question 18</u> Helpfulness of the idea organisers in understanding how the ideas in the text fitted together so that the topic made sense
Forty six point five percent of students felt that the organisers had been quite or very helpful while 13.5% of students considered them to have afforded moderate assistance in fitting the ideas together and 40% of students found them to be quite or very unhelpful.

<u>Question 19</u> Helpfulness of idea organisers in improving confidence in ability to learn science
A large proportion (59%) of students found them quite or very helpful in this way. This result is encouraging. One of the reasons the researcher implemented the SLS course was to improve the students' confidence in their ability. An additional seventeen point five percent found them to be moderately helpful while 23.5% found them quite or moderately unhelpful.

Some students' explanations for their ratings follow

> I didn't trust them (Bree)
> Sometimes I miss out information so I worry about the test (Isabel)
> I'm confident already (Isabel)
> It helped me. …mainly in tests (Tilly)
> I'm heaps more confident because I study more now (Sally)
> It gives me confidence rather than reading the whole book and trying to remember (Karen)

6.2.2.1.c Student reflections on the value of learning summarisation techniques

<u>Question 7</u> Reasons for learning summarisation techniques
Six students were not asked this interview question. Student responses follow

> To make it easier to study and learn (Tilly)
> It makes learning easier (Amanda)

> They are supposed to help us get all the main info. onto one sheet of paper, in as little words as possible (Bree)
> They make sure you study the right stuff (Isabel, Nicola)
> I think they are used to remind you about the booklets (text) and help you think about how to do a test and the organisers help to organise your study (Jemma)
> To help you remember (Lara, Sophie)
> To encourage us to get used to them and use them more often (Lilly)
> They help you organise the info. that you have learnt (Sally)
> I think it's easier to remember pictures and simple diagrams than lots of words and that exercise we did at the beginning of the year with remembering pictures and words – it was easier to remember pictures (Sarah)
> They help us learn and understand the important info. so we don't go over-board or under-board in studying (Sophie)

All of the students responded thoughtfully to this question. Some insightful comments were made by Karen

> Learning what to study and summarising. If we had an end of year test we'd be able to – well, it wouldn't be as much pressure because we wouldn't have to learn the whole book. We'd know what was in it and what were the main ideas that we had in the test.

These responses were very pleasing as one reason for designing the SLS course was to help students manage, and learn, from the huge amount of information they are presented with each school day. The researcher's objectives in teaching summarisation techniques were to help students:

- improve their understanding of the concepts
- prioritize information and select the main ideas
- aid memory, reduce revision time prior to assessments, and consequently reduce stress (i.e. to prevent students feeling "swamped")
- improve confidence in ability to learn science
- make linkages between concepts

6.2.2.1.d Comparison of student liking of mind maps and idea organisers

Forty six percent of students expressed a strong liking for idea organisers, whereas only 27% of students expressed a strong, or very strong liking for mind maps (Table 6.3). However more students (33%) indicated a moderate liking for mind maps compared to only 15.5% choosing this rating for idea organisers. Mean ratings were virtually the same (2.7 for mind maps and 2.8 for idea organisers).

Three students disliked both summarisation strategies. One student expressed a strong liking for mind maps and showed the lowest preference for idea organisers. This situation was reversed for one other student. The remainder of the students liked both strategies to a similar extent.

Table 6.3 Comparisons between liking of mind maps and idea organisers

Question	Mean	Percentage of students choosing ratings (where five is the strongest liking and one is the least positive result)				
		1	2	3	4	5
Q 3 How much do you like mind maps?	2.7	26.5	13.5	33	13.5	13.5
Q 6 How much do you like idea organisers?	2.8	23	15.5	15.5	46	0

6.2.2.1.e SLS Planners

The planners contained three sections (Appendix 3.4). The first section (Test Planner) required students to select a desired percentage result range (41-50%, 51-60%…) for the upcoming test and to record and prioritize commitments in the week leading up to the topic test. Students were asked to work out the time they would have for all homework for each night and the amount of this time they would allocate to science revision.

The second section (Study Diary) asked students to record the amount of time that they **actually** spent revising science and to indicate which revision strategies they used (on a list provided to them). The final section (Test Feedback) required students to reflect on their performance and compare their actual score with the score they earlier indicated they wanted. If the score was worse than they had wanted, they were asked to explain why this happened and to suggest what they could do in the next topic to improve their performance. Responses from students to questions about the planners are given in Table 6.4.

Table 6.4 Student views about Test Planner and Feedback sheets

Question	Number of students completing question	Mean	Number and percentage of students choosing ratings (where 5 is the most positive response and one is the least positive result)				
			1	2	3	4	5
How well are you doing SLS Planners (Q.20)	17	3.6	2 12%	1 6%	2 12%	9 53%	3 17%
How much do you like them? (Q.22)	17	3.1	1 6%	3 17.5%	7 41%	5 29.5%	1 6%
Do you think that using the SLS Planners sheets have made you more confident in your ability to learn science? (Q. 24)	14	3.0	2 14.5%	4 28.5%	2 14.5%	4 28.5%	2 14.5%

<u>Question 20</u> Perceived competence in doing SLS Planners

A large majority of students (70%) considered they were managing Test Planners and Feedback sheets quite or very well, two students (12%) moderately well, and only three students (18%) found them quite or very difficult to do. This reported degree of aptitude in using the planners indicates that their design was quite appropriate and accessible.

<u>Question 21</u> Problems in using SLS Planners

Problems cited follow:

> I forget to fill them out (Lara, Sophie, Steph)
>
> I do them, but forget to hand them in (Lauren)
>
> I don't ever look at them after I fill them in (Anna)
>
> I've lost a couple or I don't look at them because I change my plans all the time (Natasha)
>
> I change my view about importance (Nicola)
>
> They are irritating in that the difference between the time revising for tests that you think you need and the time you allow for, and the time you should do – there's a huge difference (Karen)

Hopefully, the students who made the last two comments may have gone on to improve their skills of setting priorities and managing time in the second half of the year.

Question 22 Liking for SLS Planners

Seventy six percent of students indicated a moderate liking or better for the Planners which is an encouraging result. Some student comments distinguished between the three sections of the planners – Planner, Study Diary and Test Feedback.

A range of student comments follow

> I don't have a problem with my grades, so they don't help me much. I already know how to plan things out (Sally)
>
> They don't help me to organise my study time (Bree)
>
> They're just a waste of time to me – they don't help much (Isabel)
>
> They're a pain in the neck to fill in and I just don't like being that organised (Natasha)
>
> They're quite good but sometimes I forget to fill in how long I study for (Sophie)
>
> The list of strategies gives you ideas for studying (Lauren)
>
> It helps you plan, you know how much you've got to do and how much time you've got to do it in (Amanda)
>
> It sets you out well and helps you to organise study and homework (Sarah)
>
> The Test Feedback thing is good, because it helps you review what your test did and you know what you should do next time (Karen)
>
> It helps me organise when I'm going to study and how much I have to study (Amanda)
>
> If I didn't use them I wouldn't study as much (Robin)
>
> Ticking the mark you want is good because before I actually do my test I look at this (indicated the list of possible strategies). I get ideas of what to do, so that's a good help (Lauren)

In one sweet and reflective comment a student said

> Writing down your activities lets the teacher know that you are actually doing some other things and if you have extra subjects, or if you like sports, like I do, then the teacher understands if you don't have much time.

Some more elaborative comments from interviews with Brittany and Karen follow

Brittany

RE What about ticking the mark you want? Does this give you a bit of motivation?

Brittany Yes, because it's only one in a hundred. It makes you think what you really want to get.

RE What about choosing the importance of the different activities you need to do?

Brittany I think that's really hard. I mean I know what I want but I can't really choose which is the most important.

RE What about the rest of the sheet, is it any help?

Brittany I like this bit (the list of strategies). This is good because you can find out what to do.

Karen

Karen The Test Feedback bit is good because it helps you review how your test went and to know what you should do next time.

RE Do you find you can act on that next time?

Karen Yes, and you think about that next time.

RE Can you give me an example of the sorts of things you mean?

Karen Well, if you didn't read a question properly and that was the reason you wrote that down, next time you read it more carefully.

RE So you were able to remember your comments when you studied for the next test?

Karen Yes, because they're in your file and that (refers to list of possible strategies) gives you ideas for studying.

RE So if you weren't doing the sheet would you be less organised and end up studying a bit less?

Karen Oh, yeah and I'd do everything on the last night. It helps you remember you've got a science test.

RE So does the timetable help you spread your study better?

Karen Yes and rating what's more important to you is good.

RE And that helps you?

Karen Even in other subjects.

Both of these conversations demonstrate that individuals feel differently about the various aspects of the planners.

It was pleasing to see the comments about students experimenting with different learning strategies listed on the Planners. One of the important desired outcomes of the SLS course was to have students experiment with a smorgasbord of strategies to find better ways of learning.

<u>Question 24</u> Effect of the SLS Planning sheets on confidence in ability to learn science
Forty three percent of students found them quite, or very helpful, 14.5% of students felt the strategy had been moderately helpful in increasing confidence, whereas, 43% of respondents found little, or no value in them. Comments included

> I don't use them much (Natasha)
> I've never done science tests before, so I'm not sure (Isabel)
> Because now I am better at organising my time and don't leave all the studying to the last minute (Sophie)
> Because it shows me different strategies (Lauren)
> Yes, it makes me have a timetable on what you can and can't do and what you can manage (Karen)

6.2.2.1.f Test Preparation and Completion Strategies

Questions 25 to 27 relate to test preparation and completion.

<u>Question 25</u> Recollections of class discussion on how to prepare for tests
Few students could recall the details of the discussion about how to prepare for tests The question was far too narrow in its focus on a 30 minute class discussion. Other work that should have been referred to in the question included improving test preparation skills by using the SLS Planners. Test preparation and completion strategies had also been addressed in the *Science Learning Strategies* booklet. Probably because the question referred directly to the class discussion only, twelve students replied "not much" or "nothing". Other individual student responses follow

> It was mostly about keeping a study timetable so you don't do it all on the one night (Lilly)

Don't start learning your science the night before the test (Steph)
Spread it out and don't do everything on the last night, so you don't panic. Have a good sleep and take some sugar with you in the test. Make sure you have everything you need (Karen)
How to organise time, have breaks in between study, have a quiet environment, highlight, draw mind maps, study a bit at a time (Sophie).

Several relevant exchanges from interviews follow:

<u>Lilly</u>

Lilly	Spreading study time out – don't do it all the night before.
RE	Did you used to leave it to the last minute?
Lilly	Yes
RE	And your better at that now?
Lilly	Yeah
RE	Was that because of what we talked about or do you think it is something that just happened?
Lilly	About half and half.

This discussion illustrates an important point - improvement in learning strategies happens naturally over time and should not just be attributed to the SLS course.

<u>Lara</u>

Lara	Things like having a reward. I do that, but I don't have breaks or anything. I read the book and do it over and over until I get it. I stay on one section till I get it.
RE	So, you feel like your style is comfortable for you and that suits you – it's the way you want to do it?
Lara	Yes

<u>Nicola</u>

RE	Do you try to spread your study more now?
Nicola	No, I just like to cram it in on the last night.
RE	O.K. and that's the style you feel comfortable with?

Nicola Yes, because my Mum, she's a teacher and she said some people find it easier to learn that way.

These two exchanges illustrate that these students felt free to choose whether to use learning strategies taught during the SLS course. They made a deliberate choice to reject a study strategy which had been taught in the SLS course and felt comfortable in expressing this to the teacher/researcher.

Question 26 Recollection of class discussion about how to do tests more effectively
Once again, this question was too narrowly focused on the discussion in class and ignored other work we had done on this topic. About half the group did not respond.

Six students said they could not recall anything much, four students referred to the benefits of keeping blood sugar up (which we had talked about) and two students could recall that we had looked at the value of staying relaxed during tests.

Question 27 Changes students had made to factors affecting test performance
A 20 minute brainstorming session had been held on this topic and a summary sheet produced with all student suggestions on it (Appendix 6.1). Some ideas were to get exercise, have regular meals etc. Copies of this summary sheet were distributed to students. They were told to highlight factors that they thought that they should change. Students were asked to implement these changes if practicable. After the next test, a brief follow up discussion occurred, to see what changes people had made and how effective they had proved. A range of student responses is presented

> I didn't need to change anything (Robin)
> Now I study heaps and go to the Tutoring Centre to revise and make sure I understand everything. (Sally)
> I started having breakfast. (Anna)
> Lots – Now I go to a quieter place to study, use a brighter light, spread my study more. (Bree)
> I spread my study out over the week and try to go to sleep early the night before the test. (Sophie)
> I found I worked better with music on (Natasha)

I plan my study over three or four days, not cramming it into one hour (Sarah)

Some interviews revealed more expansive comments relevant to this question follow

Lilly

RE	Did you make any changes?

Lilly	I changed rooms because there was, like, a lot of noise in one room, so I go to a quiet room

RE	Is that because of what we talked about or is that something that you just did?

Lilly	Yes, it was sort of after we'd done this (points to summary sheet)

RE	That exercise gave you the idea of changing?

Lilly	Yes

Amanda

Amanda	Oh, well, I sometimes will curse. I've got a younger brother, because he's always annoying me, but I just close my door and tell him not to come in, or I go to the library sometimes.

RE	And is that something you did because of what we talked about (indicates summary sheet)

Amanda	Yes

Lara

RE	Do you remember doing this? (indicate summary of factors affecting test performance)

Lara	Yes. That one. Study environment.

RE	What did you do about that?

Lara	Well, I went out into the study to do my work.

RE	And is that something you do regularly now?

Lara	Yes

RE	Because of this exercise (indicates test factors summary sheet)

Lara	Yes

RE	OK. And has that helped?

Lara	Yes, very much.

Alex

RE	What about the study environment? Have you been trying out different things, or do you think you are pretty well set up?
Alex	I try and do them when my sister goes out because that makes it easier.
RE	So that's been really because of that discussion (indicates summary sheet)
Alex	Yes
RE	Have you done anything like not cramming the night before so much?
Alex	I do little studies …..and the last three days I do a lot.
RE	And did you do it differently because of this work?
Alex	Yes, I used to study in one session and just the other nights not worry about it.

Karen

RE	Have you done anything differently about these factors? (indicates summary sheet)
Karen	Usually I go to a quieter place rather than by the TV.
RE	Is that because of this conversation (indicates summary sheet)?
Alex	It made me aware of the things that can help me.

6.2.2.1.g. Check Your Learning Charts (CLC)

Questions 29 to 32 relate to the Check your Learning Chart (CLC). Results are summarised in Table 6.5.

Question 29 Helpfulness of the Check your Learning Chart (CLC)

Four students (33%), of the twelve who responded, indicated that they didn't use the CLC, while 33% found the chart moderately helpful and 33% of the group found it quite or very helpful.

Student comments include

I don't use it (four students)

I would have asked questions anyway if I didn't understand something (Sophie)

It makes me aware of when other people need help so you know you're not the only one with the problem (Karen)

When you do the CLC its like, one to one (Lauren)

I haven't really understood all the things that we've been talking about and that really helped me, like with the FLE (a mneumonic related to levers)

It helped me solve something but I only used it once (Brittany)

Sometimes when I don't put anything up I just look at what other people have put up and when something interests me I just go over and join in (Alex)

Table 6.5 Student views about the Check your Learning Chart in July

Question	Number of students completing question	Mean	Number and percentage of students choosing ratings (where 5 is the most positive response and one is the least positive result)				
			1	2	3	4	5
How helpful have you found the Check Your Learning chart so far? (Q. 29)	12	2.8	4 33.5%	0 0%	4 33.5%	2 16.5%	2 16.5%
How much has the Check Your Learning chart helped you in understanding the ideas in the topic (Q. 30)	10	2.7	4 40%	0 0%	2 20%	3 30%	1 10%
Do you think that the Check Your Learning chart has made you more confident in your ability to learn science? (Q. 31	11	2.6	4 36.5%	0 0%	4 36.5%	2 18%	1 9%

One student, Natasha, rated the CLC as five. Her explanation follows

RE You found it very helpful? O.K. Why did you say five?

Natasha Because not the whole class has that problem so only a few people can go and just focus on one area that we have trouble with and pay more attention to it.

RE So you found when you put your name on it, you've gotten the help you needed?

Natasha Yes

The students seemed to find it much easier to understand a concept when it was presented in a small group or individually. Perhaps, as one students mentioned, if students voluntarily elect to participate in the small group explanation, they are likely to be very focused, giving full attention. It may be that they could be more receptive to the explanation of the concept, if part of their brain was not worrying about what others might think of them!

<u>Question 30</u> Effectiveness of the Check your Learning Chart (CLC) in helping students understand the ideas in the booklet
Forty percent of the 10 respondents found the charts only slightly helpful, while 20% found them moderately valuable, and 40% found them quite, or very helpful. Only two students elaborated about the question, probably because most students felt they would be repeating their answer to the previous question

> When you're in small groups, it's easier to understand (Alex)
> You can really get an understanding (Nicola)

<u>Question 31</u> Effect of the Check your Learning Charts in developing confidence
Thirty six point five percent of the respondents were not made more confident through using the CLC. The same percentage found that their confidence was moderately improved while 27% felt quite a lot, or a lot, more confident as a result of using the chart.

The low rate of response to the questions about CLC usage may have been because the students were not able to use this tool much as the relief teacher did not promote it's use. This suggestion is supported by the following exchange

<u>Alex</u>

RE	You chose a rating of three. Can you say why you chose this number? Is it partly because we haven't used it much?
Alex	Yes
RE	If we used it more, do you think that would help?
Alex	Yes

6.2.2.1.h Test Error Charts

Questions 33 and 34 relate to the Test Error Chart (TEC) (Appendix 6.2). Results are summarised in Table 6.6.

Question 33 Helpfulness of Test Error Charts

Sixty nine percent of the thirteen respondents considered them moderately helpful or better, 31% found them slightly helpful while no one chose the rating 'no help at all'.

Some comments from students are

> I don't need them because you already know what questions you got wrong and why you got it wrong (Sophie)
>
> After the tests I don't think about it (Alex)
>
> I don't like them. It's better having a talk with the teacher about your mistakes (Lauren)
>
> They didn't help much but they did make me think why I got it wrong (Isabel)
>
> I like to understand why I got it wrong because I don't like to make mistakes (Robin)
>
> I can look back at what I did wrong and try and undo it next time (Natasha)
>
> I know what to do and study next time (Bree)
>
> I have learnt from my mistakes (Sarah)
>
> I learn from certain mistakes e.g. I didn't understand something and I didn't find out what it meant (Sally).

Table 6.6 Student views about Test Error Charts

Question	Number of students completing question	Mean	Number and percentage of students choosing ratings (where 5 is the most positive response and one is the least positive result)				
			5	4	3	2	1
How helpful do you find the Error Chart (Q. 33)	13	3.1	0 0%	5 38%	4 31%	4 31%	0 0%
Do you think using the Error Chart has made you more confident in your ability to learn science? (Q. 34)	10	2.8	0 0%	2 20%	4 40%	4 40%	0 0%

Question 34 Effect of Test Error Charts on confidence in ability to learn science
Six of the ten respondents felt the charts improved their confidence moderately or better. Four students felt the charts had slightly improved their confidence. No one felt the TECs hadn't produced any improvement. Lilly, when asked if she would still use them if she had the choice whether or not to use them, replied "probably – if I'd done badly and I needed to know what I got wrong."

Question 35 is addressed later.

Question 36 Time spent studying learning strategies in other subjects
Four students did not complete this question on the Questionnaire and three were not asked during the interview.

Seven students responded 'nothing'. Other comments were

> No, not really. But in maths they use the same concept (the meaning of this comment was not clarified) (Lauren)
>
> We don't do these mind maps and other things in other subjects. (Jemma)
>
> Well in PVE (Personal and Vocational Education) we learnt time management. It had more to do with our lives than the change you are doing about school work (Natasha)

Several other students may have read this question incorrectly, thinking the question was asking if they used SLS's in other subjects. Some comments were

> The strategies (referring to SLS) have proved pretty helpful – especially in Maths where we have a lot to remember. (Sarah)
>
> Well test planning and feedback sheets were good and I use the strategies for other subjects. (Sophie)

Question 37 Importance of being taught learning strategies at high school
Student ratings are provided in Table 6.7. Five people were not asked this question in the interview and three students did not explain their rating. Two students made relevant comments during the interviews:

Alex

RE How important do you think it is to be taught learning strategies at high school?

Alex Five

RE Can you say why that is?

Alex Because if we didn't have it I don't think I would get my results.

Amanda

RE How important do you think it is to be taught learning strategies at high school?

Amanda Five

RE Can you tell me why that is?

Amanda I think it's important because if you're having trouble with something, and with the Learning Charts, if your having trouble, some teachers will say it again to you, but they'll say it in a hard way. And then you ask them again …but you still don't understand.

RE Its not helpful if they just repeat it?

Amanda Yes

RE OK. And do you think you will be able to keep doing some of these things next year?

Amanda Yes.

RE On your own?

Amanda Yes.

Table 6.7 Student views about the importance of learning strategy education

Question	Number of students completing question	Mean	Number and percentage of students choosing ratings least positive 1 2 3 4 5 most positive				
			1	2	3	4	5
How important do you think it is to be taught these learning strategies at high school? (Q. 37)	9	4.3	0 0%	1 11%	1 11%	1 11%	6 66.5%

One final student comment succinctly expresses a view that the researcher hoped all students had come to feel by the end of the intervention.

Brittany

RE — Overall, are you finding the SLS work beneficial? Is it a pain in the neck sometimes?

Brittany — Yes, but in the end it's better.

6.2.2.2. Tools for Learning Questionnaire - November

The second Tools for Learning Questionnaire was completed in November 1999. The intention of the questionnaire was to gather further information about student perceptions of the influence of the SLS on their learning strategy ability (questions 1-3 and 6-7), academic performance (questions 4, 5, 10 in Chapter 7) and performance attribution (questions 8 and 9 in Chapter 8). Questions 1-3 and 6-7 will be the focus of this section.

Question 1 Perceived improvement in learning strategy skills because of the SLS course

This was a general question asking students to reflect on what were the key outcomes from participation in the intervention. Responses from the selected students follow

> I am able to put all the information we need for the test in a short summary that is still understandable and useful. (Bree)
>
> Sticking to my study time as much as possible. The mind maps especially have helped me. (Lilly)
>
> I read my questions more carefully. (Kylie)
>
> I can summarise information easily using mind maps and diagrams. (Lara)
>
> I'm better at picking the more important information. (Sophie)
>
> Karen and Amanda did not respond to this question.

Comments from other class members follow (seven students left this question blank)

> I do mind maps better (Robin)
>
> I can pick the main ideas from the text so I know what to study (Sarah)
>
> I have learnt to summarise and can select appropriate information to study (Natasha)
>
> I have studied more and I have learnt new strategies (Gabby)

I'm good at mind maps and better at writing notes (Isabel)
Mind maps are great. They make me understand more and I like doing them (Annabel)
I've learnt mind maps and other learning strategies (Louise)
I do idea organisers (Tilly)
I study better because I write out all the main points and relevant things (Alex)
I know how to study better (Jemma and Hannah)

Most of these responses point to the improved ability to select important information and represent it with some form of graphic organiser, but only one student mentioned the improved understanding gained during this process. From experience in previous groups, and from comments from students in Class 5 reported elsewhere in this document, I believe that others in the class may have gained better understanding through participating in the program, although they haven't expressed this experience in response to this question.

Question 2 Perceived improvement at a learning strategy because of the SLS course
(1 No improvement 2 3 4 5 Very much improved)
Student responses are shown in Table 6.8. Fifty four percent of students indicated that they had benefited very strongly (a rating of 4 or 5) (mean = 3.0) from the SLS course in learning how to pick out the main ideas from text (strategy no. 3 in Table 6.8). Use of mind maps (strategy no. 2 in Table 6.8) averaged a rating of 3.3 with 46% of students rating their usefulness as very high (a rating of 4 or 5). The group of strategies relating to test planning (strategies number 6-9) scored average ratings between 2.4 and 2.7 indicating that students held the view that the SLS course had helped them learn the test planning strategies to a moderate degree.

Forty two percent of students in Class 5 felt that the course had strongly improved (rating of 4 or 5) their ability to ask for help (class mean of 2.7), check their understanding (class mean of 2.9), learn from test errors (class mean of 2.9) and use the objectives to help test preparation (class mean of 3.1).

The impact of the SLS course on improving the test preparation strategies 'Breaking revision into small sections' (mean class rating of 3) and 'Rewarding yourself after studying' (mean class rating of 2.9) was rated very highly by 46 and 50% of students, respectively. Thirty seven point five percent of students strongly attributed (rating of 4 or 5) improvements in the test planning strategy of 'Spreading study out to avoid cramming and improve memory' to the SLS work (mean class rating of 2.6).

Strategies 15-18 relate to test taking competencies. Fifty percent of students reported that the SLS course had strongly improved their ability to 'stay calm' (mean class rating of 2.7). The other strategies in this group were not viewed as favourably in terms of the SLS course improving their ability to use the strategies.

Table 6.8 Student perception of learning strategy improvement as a result of the SLS course

Strategy/ tool (n=24)	General learning strategies (Booklet)	Summarising (Mind maps or spider maps)	Picking main ideas from text	Summarising Idea organisers	Linking ideas (Concept map)	Setting goals (Test planner)	Setting priorities (Planner)	Test importance (Planner)	Planning study time (Planner)	Asking for help (CL Chart)
Strategy no.	1	2	3	4	5	6	7	8	9	10
Mean	2.5	3.3	3	3	2	2.5	2.4	2.7	2.6	2.7
% students rating 4 or 5*	16.5	46	54	29	8	33.5	29	33.5	29	42
% students rating 1	4	8	4	0	16.5	33.5	25	12.5	21	8
Strategy/ tool	Check understand (CL Chart)	Break revision into sections	Rewarding after studying	Spreading study (Booklet)	Staying calm (Discussions)	"Splash down" (Booklet)	Doing easy questions first	Guess before choosing	Learning from test errors (Errors sheet)	Using unit objectives (Booklet)
Strategy no.	11	12	13	14	15	16	17	18	19	20
Mean	2.9	3	2.9	2.6	2.7	1.8	2.2	2.3	2.9	3.1
% students. rating 4 or 5	42	46	50	37.5	50	12.5	29	16.5	42	42
% students rating 1	8	21	16.5	12.5	8	54	8	25	12.5	4

* Very much more skilled
** No improvement in strategies)

The only strategies that were not generally endorsed by students were the 'Splash down' technique and 'Concept mapping', producing mean values of 1.8 and two respectively. This result for 'Splash down' may be explained by the fact that the technique was not practiced and also that it is better suited to extended essay tests. The 'Splash down' strategy was also not endorsed in Section 7.1.5. Concept maps may not have been practiced enough either. More class time needed to be spent on teaching concept maps during the intervention. In past years the researcher observed that students had found concept maps helpful when sufficient time was spent in teaching and practicing them.

<u>Question 6</u> Importance of being taught learning strategies in science
Fifty five percent of the respondents chose a rating of 4 or 5, indicating strong support for the inclusion of learning strategy education in science. Although six students left this question blank, no one believed that it wasn't important at all for learning strategy instruction to be included in the science course and 28% of students responding indicated moderate support for its inclusion.

<u>Question 7</u> Inclusion of learning strategy education in other subjects
Nine of the 24 students answered simply "No", while eight students did not respond to this question. Other responses included

> Not really. In PVE (Personal Vocational Education) we did a little bit of stuff before test week, but not otherwise. (Brittany)
> Not very much. Only a bit in PVE.(Robin)
> In PVE but not consistent. (Ginia)
> We have learnt a bit about studying and note taking in Social Science and a little bit in English. (Isabel)
> PVE but less consistent. (Nicola)

The Personal Vocational Education material referred to was taught during weeks six to eight of the first term and weeks four and five of the second term. The topics covered in term one were previewing a text, skimming, scanning, identifying main ideas, note-making and summarising. All of this material was concentrated into three 50 minute lessons during Term one. The material used for examples was not subject specific and the explanations and examples were presented in dense text with limited opportunities for practise. For example, the summarising material was based on one piece of text from which students had to extract main ideas, list key words and paraphrase paragraphs. Two 50 minute periods during term two were devoted to learning about goal setting and time management. There was no ongoing reinforcement of these ideas during the rest of the year.

Of the 24 students who completed this questionnaire in November 1999, only four students referred to having done a small amount of learning strategy work in PVE, two students commented that they had done some in English and one student said she had learned a bit about studying and note taking in Social Science. It seems that no other subject involved a sustained, subject specific learning strategy program.

6.2.3 Student interviews

Year 8 students were interviewed at the beginning and end of 1999. The February interview was done in groups, as was a self-report interview of some Year 9 students at the beginning of 1999 who had participated in the 1998 trial of the SLS program. Class 5 students were interviewed individually in December. These end of year interviews are reported in Chapter 9.

6.2.3.1 February interview

Twenty one students were interviewed in February. Students were shown a copy of their Living Things booklet (a 112 page workbook that took the place of a textbook) which they would be completing over an eight week period. The students were asked to imagine that they had finished the unit and had one week to prepare for a test on all of the concepts covered in the Living Things booklet.

Student responses have been reported fully in this section. Unfortunately, these interviews were done in the hectic first few weeks of the school year and the explanation for the low numbers of responses for some questions was not recorded. It could have been that not all students were asked every question or that only some students chose to respond to some of the questions.

The script used to introduce the interviews, the questions asked, and student responses to the questions follow.

Script:

Thanks for agreeing to do the interview. I'm trying to get a picture of how Year 8s go about learning science. Please try and tell me what you really do. There are no right or wrong answers. Suppose we had finished all of the Living Things Booklet and you had a test on it in 1 weeks time.

<u>Question 1</u> Techniques for assuring understanding of ideas

I read the book, read the questions, try and think of the answer then go and ask a smart person (Alex). (Similar responses were given by Karen, Anna, Lauren, Sally)

Read over the booklet. If I don't know the meaning of a word I look it up (Hannah)

Test myself on one bit before I go onto the next thing. I also make up questions and answer them (Chrissie)

Check through several times (Lilly)

Write points down (Robin)

Just keep reading (Tilly)

<u>Question 2</u> Action taken if an idea is not understood

Ask the teacher or parents (Alex, Sophie, Annabel, Amanda, Sarah)

Read through book and get Mum to help me with bits I don't understand. If I don't understand in class I ask questions (Brittany)

Twelve of the seventeen responses to Questions 1 and 2 referred to students using the important strategy of asking for assistance from others when they don't understand an idea.

<u>Question 3</u> Actions taken to remember ideas and to test memory

On the first study day I make notes on the main topics. Then I read these every night and test myself. I keep reading through the book to make sure I understand. Then I put it away and say it in my head. I do this a few times Then I read a bit more of the book. I do the same thing on the next night but also go over the stuff from the first night. I also get friends to test me because Mum and Dad are busy (Natasha)

> I read and cover, say it in my head over and over and then test and check if I got it right. If I got it wrong, I'd read the section again, write it down over and over until I get it right (Sophie, Annabel, Sarah, Anna, Robin, Sally, Hannah)
> Things or words I can't remember, I write in order and use the first letters of each thing to make up a word. Then I practise saying it in my head until I get it right (Alex)
> Sometimes I highlight. I write notes and get Mum to test me (Brittany)
> I read through, highlight things I don't know. The next night I go through the things I didn't know again and try and understand them. Next day, I make up some questions. I make up a sheet of questions for each day and put those in the next day's session as well (Laura)
> I try a different strategy each time. I write out a branching list, cover and recall, dot point notes, make up questions, draw pictures (Lauren)
> I write questions on slips of paper, put them in a bag and draw them out (Louise)
> I test myself until I know it and try and answer it without looking. I also get a friend to test me. I also read revision questions and write the answer without looking. I also make up questions (Ginia)
> I test myself every night and make up questions I think will be in the test (Alex)
> Test myself (Hannah)

Students mentioned a broad range of strategies aimed at understanding and remembering ideas. Self testing and repetition was a common approach as was answering questions. However, only two students mentioned taking notes and only one student (Lauren) mentioned using diagrams and summaries to help retention of concepts and detail. Few students mentioned highlighting. Generally, the absence of cognitively demanding strategies aimed at promoting deep learning was of concern.

<u>Question 4</u> Number of days test revision is spread over and hours of study each night
Many of the 14 students who responded to this question reported spreading their learning over several days rather than 'cramming' on the evening before the test. The least spread was over two days (Robin) ranging up to a week for 30 minutes per night for a topic test (Laura).

Question 5 Techniques used for understanding and remembering

Make up a song (Laura)

We used Never Eat Soggy Wheat-bix (mnuemonics) (Chrissie)

Get Mum to test me (Karen)

Mneumonics don't work for me. I just memorise key sentences and then look back, cover and test. (Ginia).

Laura, Bree, Karen and Chrissie also commented that they cover and test)

Few students responded to this question. This is of concern because it is important to be able to remember basic information to facilitate higher order thinking. It is likely that the students felt they had responded adequately in Question 3 which was similar.

Question 6 Work done in primary school on how to understand, learn and remember science

Last year we could put anonymous questions on paper into a box so we wouldn't look stupid. Then the teacher would write the answers on the board. I also use mneumonics. We also did flow charts (Sarah)

We learnt flow charts (Annabel)

The day before a test the teacher used to revise in class with us (Karen)

We used an A3 sheet divided into 8 squares with the main subtopics and points. We also watched Behind the News (BTN) and practiced taking down the main points and then writing a report from them. We also learned poems. (Brittany)

The teacher plays a tape or video of BTN. You take down the main points and write an essay from them. We did some mind mapping but nothing about how memory works (Lilly)

Some mind mapping, nothing about how memory works (Anna)

BTN and mind mapping (Tilly)

Mind mapping (Amanda, Ginia, Chrissie, Robin)

We learnt mind mapping but I didn't get it. It didn't work for me. (Lauren)

We didn't do any except "look, cover, check" for spelling (Sophie)

Tests in primary school were really easy so you didn't really have to remember much (Alex)

Nothing (Laura, Bree, Steph, Louise)

> We got no help learning how to learn. We just had to learn things off by heart in Jakarta (Natasha)

Some interesting strategies for helping students to pick out main ideas and prioritise information were reported by these students (e.g. flow charts). Seven students mentioned having done mind mapping while another seven students reported receiving no help to understand, learn and remember science.

Question 7 is considered in Chapter 8.

6.2.3.2 Year 9 interviews 1999

A group of students who had been in the pilot study in 1998 were encountered by the researcher in the first few days of 1999. They were asked to tape some comments about their experiences in the Year 8 trial intervention. The group of four students was provided with a tape recorder and asked to reflect on the learning strategy work they had trialed in 1998. No further direction was given and the researcher left the room to encourage them to speak candidly. The students took it in turns to make their comments. The interviews are reported in full.

> <u>Paula</u>
> We did mind maps, concept maps, how you should study for tests and how you should revise. The mind maps really helped because the pictures are easier to remember than words. You condense everything onto one sheet.
>
> I didn't understand concept maps as much as mind maps. We wrote key words and had to join them up with ideas. The mind maps were better. They were really helpful.
>
> The record sheets were for knowing the marks you wanted for the test and how you should study and what you did when you studied and how long you studied and what other tests and work you had. Also how much time you spent on homework and revision. They gave you a chance to plan your time more. They really helped.

Adele

We learned all about study stuff. I haven't used it this year so it was kind of a waste of time, although at the time it was really useful eg. time planning. The mind maps were cool - the pictures made them easy and they were quick to do. I didn't understand the concept maps much because we didn't spend much time on those. The study planners were really good. They helped us think more about our studying. You had to be realistic about it.

Sue

Before we did a test without mind maps we didn't do as much revision. Before we started using the study planners, you didn't know what marks you were aiming for so it didn’t help you. The stuff we did about thinking, it helped you to think positively about things and not think "I'm going to mess this up".

Bess

The Check Your Learning Chart really helped when we stuck stickers on things we didn't understand. Then we had it explained so we weren't just learning facts, we were learning what things actually meant. It really helped.

The students were generally very supportive of the SLS course. A year after participating in the trial during 1998, the students were able to recall most aspects of the program without prompting and provided mainly positive feedback about it.

6.2.4 The *Science Learning Strategies* booklet

Students in Class 5 were provided with *Science Learning Strategies*, a booklet produced by the researcher (Appendix 4.2) that provided information to students about each of the strategies described. Table 6.9 lists the topics addressed in each of five learning strategy categories. Figure 6.5 illustrates the type of information provided in the booklet.

6.2.4.1 Competency ratings for Class 5 students

Students scored each item on a scale of one to five (in the small squares in the booklet illustrated in Figure 6.5) during August and again in November. A score of one indicated that the student felt she was not proficient at that technique, and a score of five indicated that the student considered herself highly proficient. The mean competency ratings for Class 5 students are shown in Table 6.10.

Perceptions of competence improved in four of the five strategy categories in the interval between August and November. The Organising category showed the greatest improvement (11%) followed by Taking Tests (9%), Test Preparation (7%), and Learning (6%) categories. There was a 1% drop in the perception of their ability to Manage Stress. These results are pleasing although it must be kept in mind that improvement in the strategies may have occurred over time irrespective of the intervention.

Table 6.9 Learning strategies described in the *Science Learning Strategies* booklet

Organizing	**Test preparation**
Filing materials	Planning your study time
Bringing equipment to class	Deciding how important the test is
Organizing your study time	Revising summaries
Setting goals	Working out what the test will cover
Setting priorities	Breaking revision into small sections
Completing home work and class work	Rewarding yourself after study
Managing stress	Memorizing
Self confidence	Testing yourself
Having fun	Forming a study group
Asking for help	Avoiding cramming
Taking responsibility for learning	**Taking tests**
Knowing your strengths and weaknesses	Staying calm
Eating well	Reading test directions
Getting plenty of rest and exercise	Splash down
Avoiding harmful substances	Highlighting key ideas
Learning	Answering easy questions first
Deep processing	Checking answers
Selecting the main idea	Getting your test back
Summarizing	
Checking understanding	

6.2.4.2 Competency ratings of selected students

The booklets of seven students were analysed in detail. The method of selection of six of these students was a product of an interview in November, 1999, based on responses to an inquiry about what percentage students thought the Science Learning Strategy (SLS) course had affected their science results on average during the year. Student responses fell into percentage groups - 0%, 5%, 10%, 20%, 25%, 30% - and one student from each of these groups was chosen at random for detailed scrutiny of her booklet ratings. Because these six students were moderate to strong academically, a seventh student, Amanda, was chosen randomly from the less able students and included in the analysis. The students chosen in this way will henceforth be referred to as the *selected students*.

Table 6.10 Mean of actual ratings expressed as a percentage of total possible ratings for students in Class 5 in different learning categories

Strategy category	August %	November %
Organising	67	78
Managing stress	79	78
Learning	60	66
Test preparation	65	72
Taking tests	58	67

Lara

In both August and November, Lara (an A grade student) rated her competence lower than the class average in the Organising, Managing Stress and Test Taking categories. In August, Lara's achieved a rating total which was 47% of the highest possible rating total, for the items included in the Organising category, compared to a mean rating of 67% for the class (see Tables 6.11 and 6.12).

By November, her score in this category had increased significantly to be within 5% of the November group mean of 78%. In particular, her ratings for 'Organising study time', 'setting priorities' and 'completing work' aspects of the Organising category (see Table 6.12) improved from ratings of one, on the five point scale, to ratings of five, indicating she considered herself to be very competent in these areas by November.

Lara's ratings in the Managing Stress, Learning and Test Preparation aspects of the Organising category were close to mean group values in August. However, her score of 45% for the Test Taking category was low compared to the class average of 58%. Her score in this category did not improve by November when she scored 42% compared to the group November average of 67%. She rated her competence at the lowest point on the scale in August and November in four of the five aspects of the Taking Tests category.

Lara's November rating score of 70% for the Learning category was 10% higher than in August and slightly higher than the November class average of 66%. However her November ratings for Managing Stress and Test Preparation categories were lower than her scores in August and considerably lower than the mean scores for the class in November. In spite of this variability, Lara perceived that her science results improved by an average of 30% because of the SLS intervention.

Lilly

In November, Lilly (a B grade student) considered that her science results improved 25% on average during the year because of her participation in the SLS intervention. Lilly's category rating totals were well above the class averages in all categories in both August and November. Lilly improved her ratings in November for the Learning and Taking Tests categories. However ratings in the Managing Stress and Test Preparation categories were lower in November than in August. Overall, Lilly considered herself to be very competent in all five learning strategy categories.

Bree

Bree (an A grade student) indicated in November that her science results had improved by 20% on average during the year because of the SLS course. Bree's ratings fell below the mean percentages for four of the five categories in both August and November. The exception was her Managing Stress category rating, which improved from 72% to 87% by November, a score above the class average of 78%. Her Taking Tests category rating was only 40% in August compared to a class mean of 58%. By November, her rating had improved to 60% compared to the average class rating of 67%. By November, Bree also significantly improved her ratings in the Learning and Test Preparation categories.

Karen

In November, Karen (an A+ student) considered that her science results improved 10% on average during the year. Karen generally rated her competence slightly lower than the mean for the group, with the exception of the Managing Stress and Learning areas. In the Managing Stress category, her rating was slightly higher than average (85% in November versus a group mean of 78%). Her August rating of 50% for the Learning category was 10% lower than the group average, although by November her rating improved to be 5% above average.

Sophie

Sophie (also an A+ student) demonstrated above average ratings and steady improvement in all categories between August and November, with the exception of one low August rating. Sophie rated her competency at 58% compared to the mean value of 65% in the Test Preparation area.

Table 6.11 Mean competency ratings in each skill category for selected students

STRATEGY	Lara		Lilly		Bree		Karen		Sophie		Kylie		Aanda	
	Aug	Nov	Aug	Nov	Aug	Nov	Aug	Nov	Aug	Nov	Aug	Nov	Aug	Nov
Organising	47	73	83	83	63	66	73	77	83	90	62	80	60	73
Managing stress	75	62	90	80	72	87	80	85	80	85	77	72	65	68
Learning	60	70	70	75	50	65	50	75	60	70	70	45	60	65
Test preparation	67	58	82	74	48	66	64	68	58	84	74	82	58	74
Taking tests	45	42	70	82	40	60	50	62	70	80	75	78	50	65

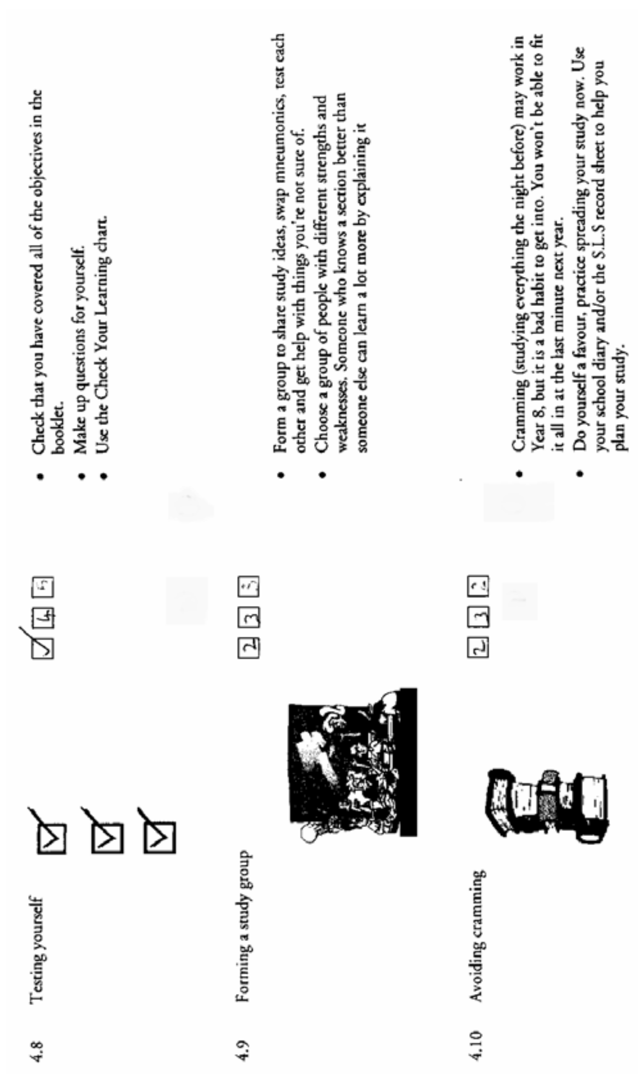
By November, Sophie had improved in this area and scored 84% which was well above the class mean of 72%. In spite of these perceived improvements, Sophie stated in November that her science results had only improved by an average of 5% because of her participation in the intervention. This may have been because she was already a high scoring student.

Kylie

Kylie (an A student) did not believe that the SLS course had any effect on her test results. Kylie's competency ratings were quite variable, with some poor scores and some very pleasing scores. Her lowest rating total in August of 62% was 16% lower than the class mean. In November, her Learning area score dropped to 45% from 70% in August while her Test Taking score in August of 75% was 17% above the group mean of 58%.

Amanda

Amanda (a C grade student) considered that the SLS course had improved her scores by 10%. In August, Amanda's ratings were around 7% lower than the class means in the Organising, Test Preparation and Taking Tests categories. Her worst ratings were in the Managing Stress category. In August her competency rating for this area was 12% below the class average of 79%. By November, her rating for Test Taking was still 10% below the class average of 78%. Amanda's ratings for the Learning category were equivalent to the class averages in both August and November and her perceptions of her competency in the Test Taking and Test Preparation were very close to the class averages. Amanda improved her rating for the Organising category by 13% from August to November, although her rating of 73% was still five percent below the class mean of 78%. By November, Amanda had achieved a rating of four or five in 20 of the 36 aspects examined. In August she had only indicated these ratings in seven aspects.



4.8 Testing yourself

- Check that you have covered all of the objectives in the booklet.
- Make up questions for yourself.
- Use the Check Your Learning chart.

4.9 Forming a study group

- Form a group to share study ideas, swap mneumonics, test each other and get help with things you're not sure of.
- Choose a group of people with different strengths and weaknesses. Someone who knows a section better than someone else can learn a lot more by explaining it

4.10 Avoiding cramming

- Cramming (studying everything the night before) may work in Year 8, but it is a bad habit to get into. You won't be able to fit it all in at the last minute next year.
- Do yourself a favour, practice spreading your study now. Use your school diary and/or the S.L.S record sheet to help you plan your study.

Figure 6.5 Pages 10-11 from Science Learning Strategies booklet

Table 6.12 Mean competency ratings for all learning strategies for selected students

	STRATEGY	STUDENT Lara		Lilly		Bree		Sophie		Karen		Kylie		Amanda	
		Aug	Nov	Aug	Nov	Aug	Nov	Aug	Nov	Aug	Nov	Aug	Nov	Aug	Nov
Organis.	Filing materials	5	2	4	3	3	3	4	4	5	5	5	5	4	4
	Bringing equipment	5	4	4	5	5	5	5	5	5	4	5	5	4	4
	Organis. study time	1	5	5	5	3	3	1	4	3	2	4	3	3	4
	Setting goals	1	1	4	4	3	3	5	5	3	4	4	4	2	4
	Setting priorities	1	5	4	4	4	3	5	4	4	4	3	3	2	3
	Completing work	1	5	4	4	1	3	5	5	2	4	4	4	3	3
Managing	Self confidence	1	2	4	3	3	4	1	4	4	4	3	5	3	3
stress	Having fun	5	5	5	5	3	5	5	4	5	5	4	4	3	3
	Asking for help	1	3	5	5	4	5	5	5	4	4	4	3	3	3
	Respons. for learn.	4	4	5	4	4	3	5	5	4	4	3	2	3	3
	Strengths & weak	5	4	5	4	3	5	5	5	3	4	2	2	3	4
	Eating well	4	1	4	3	4	4	5	4	3	4	5	4	4	4
	Rest & exercise	5	1	4	4	3	4	1	3	4	4	5	4	3	4
	Avoid harmful subs.	5	5	4	4	5	5	5	4	5	5	5	5	4	3
Learning	Deep processing	1	3	4	3	3	3	1	3	1	3	4	3	3	3
	Selecting main idea	1	5	4	4	1	2	1	4	3	4	4	2	3	4
	Summarising	5	3	3	4	3	5	5	3	3	4	3	2	3	2
	Checking understan.	5	3	3	4	3	3	5	4	3	4	3	2	3	4
Test	Planning study time	4	4	4	4	2	4	1	4	3	2	3	2	3	4
Prep.	Judge import.of test	5	5	4	4	5	4	5	4	5	4	5	5	4	5
	Revising summaries	5	4	4	4	2	4	1	4	3	3	4	4	3	3
	What test will cover	5	5	4	4	1	3	4	4	3	3	4	5	4	4
	Revising small sect.	4	3	5	3	1	3	1	4	4	4	4	5	2	4
	Reward after study	1	1	4	4	4	5	5	5	5	5	5	5	3	4
	Memorizing	1	1	5	3	3	4	5	5	4	4	5	4	2	4
	Testing yourself	3	3	5	4	1	2	5	5	3	4	5	5	4	5
	Study group	1	1	2	3	1	1	1	3	1	2	1	3	1	1
	Avoiding cramming	1	2	4	4	4	3	1	4	1	3	1	3	3	4
Taking	Staying calm	1	1	4	4	5	4	5	5	4	3	3	2	3	3
tests	Reading test directions	1	1	5	5	1	4	5	5	3	4	5	5	3	4
	Splash down	1	1	2	3	1	1	1	1	1	2	1	1	1	1
	Highlight key ideas	4	3	5	5	1	1	1	3	1	2	3	5	1	3
	Guess before choosing	1	1	3	5	3	1	1	3	1	3	3	3	3	4
	Easy questions first	5	5	1	3	1	3	5	5	3	4	5	5	3	4
	Checking answers	4	3	4	4	5	5	5	5	4	4	5	5	3	3
	Getting test back	1	2	4	4	3	5	5	5	3	3	5	5	3	4

As a group, the seven selected students made 41 improvements of two or more points in particular learning strategies between August and November. However, there were nine occasions on which scores worsened by two or more points. Five of the seven selected students gave themselves the lowest rating of one for the ‘Splash down’ technique in the category ‘Taking tests’, in August and November. This low rating was probably due to the fact that very little time was spent on the technique and many students may have found it too time consuming to use in tests The poor student opinion of this strategy is reinforced in Chapter 7 (Section 7.1.5). In retrospect, the researcher would not include this topic in the SLS course. Students also perceived little value in both August and November in forming study groups. This is likely to be because there was no time left in class, due to curriculum pressure, for study groups to form. By November, three of the seven students reported a score of three for this strategy, possibly indicating that after learning about the value of this approach, students were prepared to give it a try.

In August and November all seven of these students rated themselves highly (a score of four or five) on the items ‘Coming to class with everything needed’ and ‘Deciding on the importance of a test’. Six students gave themselves ratings of 4 or 5 in August and November for the strategy ‘Avoiding harmful substances. Five of the seven were consistent in achieving 4 or 5 for the strategies ‘Having fun’ and ‘Rewarding themselves after studying’.

In considering these results, the selected students generally perceived that they had improved at using most of the techniques over the three months between August and November, although there was a high degree of variability.

6.3 Summary of Chapter 6 - Response to Research Question 2a: Student perception on the effects of the SLS intervention on learning strategy utility

Student perceptions of the effect of the SLS course on learning strategy ability in science were measured by a number of instruments:

Class 5 specific measures:

<u>Interviews </u>(see Section 6.2.3)

February - The February interviews were designed to provide a ‘snapshot’ of student learning strategy competence prior to the intervention. The interviews revealed that the students were good at asking for assistance from others (an important element of the SLS course) and commonly used self-testing and repetition as ways of remembering ideas. There was a noticeable absence of more cognitively demanding but rewarding methods (such as concept and mind mapping) to process and remember ideas. Numerous students reported spreading their study time out rather than 'cramming' the night before an assessment. Some students reported receiving limited help with learning strategies in Year 7. As one student reported – "we got no help learning how to learn".

In December, nine students were interviewed individually and results are discussed in detail in Chapter 9. Seven of the nine students interviewed reported positive effects of the SLS on learning strategy ability. Two students reported no benefits of the SLS course on learning strategy competence.

Year 9 students - The comments of the students who participated in the 1998 trial SLS intervention were very positive in stating that various aspects of the program had helped them to improve their learning strategy ability.

<u>Tools for Learning Questionnaires</u> July and November (see Section 6.2.2)
The November Tools for Learning Questionnaire directly probed how much the SLS work contributed to student aptitude with each learning strategy. High levels of support were described by students for many of the Science Learning Strategies. An average of more than forty percent of students chose ratings of four or five to describe positive aspects of most of the strategies. Particular strategies rated 4 or 5 by more than 40% of students were mind map summarising, picking main ideas from text, the CLC strategy, breaking revision into sections, using rewards after studying, staying calm, learning from test errors and using unit objectives to determine knowledge. Further details of student perceptions of learning strategy improvement as a result of the SLS course are provided in Table 6.8. The only strategies not generally endorsed were the 'Splash down' technique and 'Concept mapping'. As previously mentioned, not enough time was spent on concept mapping to allow students to become proficient and the 'Splash down' technique was not well suited to the style of assessments at this school.

<u>*Science Learning Strategies*</u> booklet (see Section 6.2.4)
Although the students' ratings in the *Science Learning Strategies* booklet were quite variable, the selected students generally perceived that they had improved at using

most of the techniques over the three months between August and November. Considering Class 5 scores overall, perceptions of competence improved in four of the five strategy categories (Organising, Learning, Test preparation, Taking tests) in the interval between August and November. Improvement did not occur in the Managing stress category as competence was already quite high in August.

In responding to Research Question 2a, it can be said that students as a whole perceived that the SLS course did improve their learning strategies over the course of the year. The different measurement instruments used (interviews, Tools for Learning Questionnaires and the *SLS* booklet ratings) revealed similar results, triangulating information and confirming the following findings:

1 Individual students preferred, and did well with, different learning strategies.
2 Everyone found some improvements, and many reported strong improvements in their learning strategy ability, that they attributed directly to the SLS course.

It is important to note that learning strategies also develop (or regress) without intervention over time.

Chapter 7

Parent and teacher perceptions of the effects of the SLS course on student ability to apply learning strategies to science: Response to Research Questions 2b & 2c

7.1 Introduction

In this chapter, parent perceptions of the effects of the intervention on student proficiency at applying learning strategies to science were ascertained by a Parent Questionnaire, described Sections 7.2.1, and a parent telephone survey described in Section 7.2.2. Section 7.3 provides a response to Research Question 2b relating to parental perceptions.

Teacher perceptions of the effect of the SLS course on student ability to apply learning strategies to science were divined by Student Questionnaires, described in Section 7.4.1, the LASSI-HS, detailed in Section 7.4.2 and through SLS assignments described in Section 7.4.3. The discussion in Section 7.5 answers Research Question 2c relating to teacher perceptions of the effect of the SLS program on student ability to apply learning strategies to science.

7.2 Parent perceptions of the effects of the SLS course on student ability to apply learning strategies to science: Response to Research Questions 2b

Parent perceptions were measured by a questionnaire in February and a telephone survey in December.

7.2.1 Parent Questionnaire

In February 1999, parents of all Year 8 students completed a Parent Questionnaire that closely resembled the Student Questionnaire (Appendix 5.3). However, the planned end of year version of this questionnaire was not completed and parents' views of the effect of the SLS course on learning strategy ability, academic performance and causal explanations students give for performance, were measured by a telephone interview described in Section 7.2.2. The February Parent Questionnaire did, however, provide across treatment group comparisons and triangulation of data from the February Student Questionnaire. Questions 1-5 of the Parent Questionnaire provided information relevant to Research Question 2b (parent perceptions of the effect of the SLS course on student learning strategy proficiency).

Questions 1-3 Student interest, ability and motivation

In comparing parental responses to items about student interest, ability and motivation, of students in Classes 1-4 to those in Class 5, strong similarities can be seen (Figure 7.1).

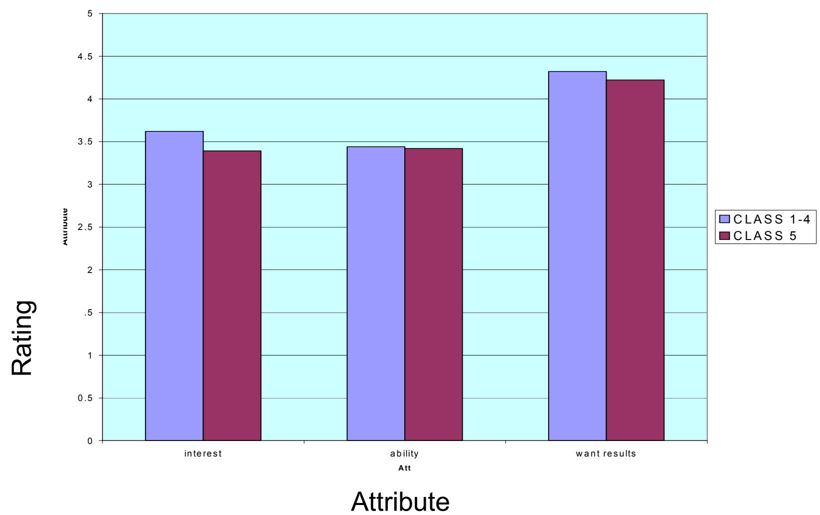


Figure 7.1 Mean parent ratings (on a five point scale) for Questionnaire items 1-3 in February 1999 for students in Classes 1-4 and Class 5

Parent perceptions of interest levels were quite strong with a mean of 3.4, on a five point scale, for parents of students in Class 5, and 3.6 for those in Classes 1-4. Both groups of parents rated their daughters' science ability at a mean 3.4. The student group as a whole reported a slightly lower mean of 3.2 when rating ability. Parents of students in both groups rated high mean levels of motivation – 4.2 for Class 5 and 4.3 for Classes 1-4. These high levels of motivation are likely to be related to the fact that the school is a high fee paying institution. High levels of motivation were also reported by the students in the Student Questionnaire with a mean rating of 4.5 for the year group.

Question 4 Awareness of daughters' learning strategies

The fourth question probed parent perception of their awareness of the strategies their daughters used to prepare for tests in science. Class 5 parents rated their awareness at a mean of 3.2 while parents of students in Classes 1-4 felt less aware, with a mean of 2.9 (not significant at $t = -0.800$, $\alpha = 0.05$).

Question 5 Study patterns and strategy use

Perusal of the parents' perceptions of the total time their daughters spent preparing for science tests and the spread of study over time reveals parents perceiving a great diversity of study approaches. This diversity was similar to that reported by the student cohort. Parent perceptions of times spent studying for science tests ranged from zero to seven hours with a mean of two hours and a mode of two hours. This was reportedly spread over a mean of 2.9 days and a mode of 2 days. Student perception of time spent studying for science tests was a mean of 2.2 hours and a mode of one hour spread over a mean of 3.4 days with a mode of 3 days.

Comparison of parents' perceived use of study strategies by their daughters in Classes 1-4 and Class 5 are illustrated in Figure 7.2. The similarity is quite striking. Few notable differences were observed other than that the parents of students in Class 5 perceived that their daughters used the strategy 'copied notes from text' more commonly (53%) than did parents of students in Classes 1-4 (35%). (By contrast, in the Student Questionnaire, only 42% of Class 5 members reported 'copying notes from text' while 51% of students in Classes 1-4 mentioned using this strategy.) Forty seven percent of parents of students in Classes 1-4 believed that their daughters 'had regular breaks during a study session', while only 30% of Class 5 parents had observed their daughters using this strategy. (This pattern was repeated in the Student Questionnaire with 44% of students in Classes 1-4 using the strategy and only 29% of Class 5 students using it). Apart from these examples, parents from Classes 1-4 and Class 5 nominated moderately similar perceptions about strategies used by their daughters.

7.2.2   Parent Phone Survey - December 1999

Parents of 21 students completed a phone survey (Appendix 6.3) of their perceptions about aspects of the SLS course. The survey was conducted over a three day period in December 1999. Parents of three students were not available to complete the phone survey within the survey period.

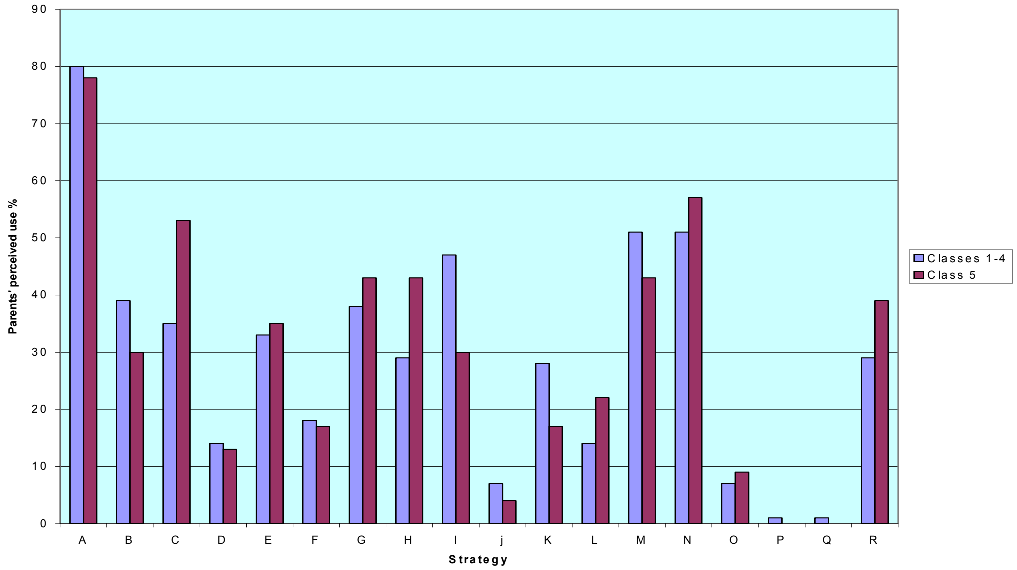


Figure 7.2 Parent perceptions of percentage of students using different study strategies in February 1999 in Classes 1-4 and Class 5

Key to figure 7.2

	Strategy		
A	Read text	J	Use rewards
B	Underlined or highlighted text	K	Revised previous day's work before starting new section
C	Copied notes from text	L	Made up and answered questions
D	Made dot point notes from text	M	Got someone to test self
E	Notes in own words	N	Asked for help
F	Mneumonic	O	Drew a mind map
G	Learnt small section at a time	P	Redrew mind map from memory
H	Tested each section before learning next section	Q	Drew concept map
I	Regular breaks	R	Revision sheet

Comparison of strategy use perceived by parents and daughters (Figure 7.3) reveals that students indicated that they used every strategy more than their parents had realised.

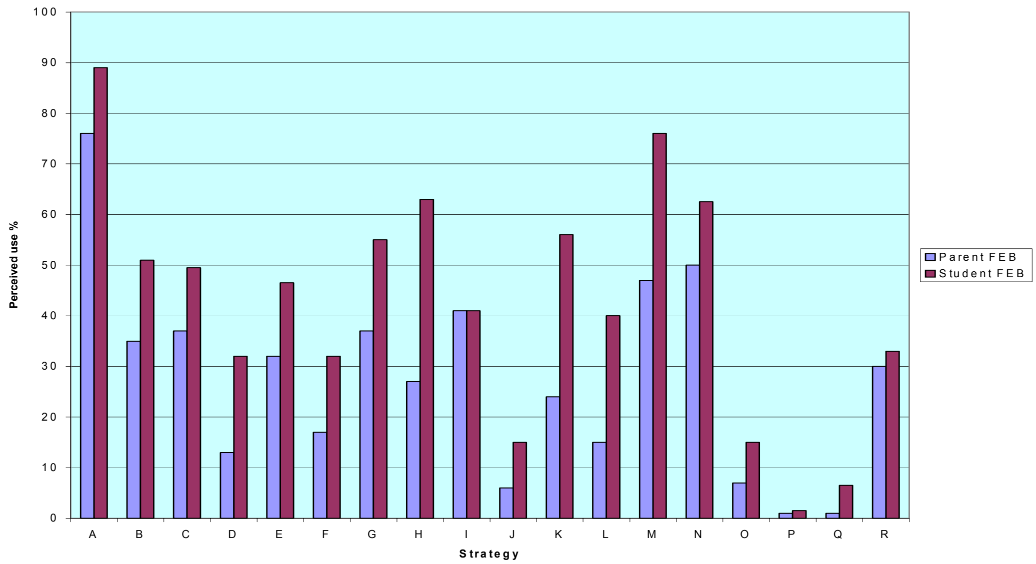


Figure 7.3 Perceived strategy use by parents and students of all Year 8 students in February 1999.

In the parent phone survey, questions one and two were asked in order to gauge the degree of communication between the parents and students about the SLS course.

<u>Question 1</u> Awareness of student participation in the SLS program

Question one asked parents if they were aware that their children had participated in the SLS course during the year. Most of the 21 parents interviewed were aware that their daughters had been taught a series of learning and study strategies, as part of the Year 8 science course. Two parents said that they were unaware, even though they had been provided with information about the SLS course and had given their signed consent for their daughters to participate at the beginning of the year.

<u>Question 2</u> Student communication about the SLS program

Question two probed the extent to which students had conveyed information about the intervention program to their parents. On a scale of one to five, where one is ‘told them nothing’, and five is ‘told them everything about the SLS course’, seven parents chose a rating of one (told them nothing). Seven parents nominated a rating of two (that students had given them some information), and five chose a rating of three (that students had informed them to a moderate degree). Only two parents felt that students had given them quite a lot of information about the SLS course (a rating of four) and no parents indicated a rating of five.

It was intended that responses to the first two questions would help to establish the reliability of parent answers during the rest of the phone survey. How could someone who had been told nothing about the program, reliably answer the remaining questions? In fact, some parents who had low levels of communication with their daughters about the intervention, were able to give detailed behavioural descriptions of how their daughter's learning strategies in science had changed during the year. For example, Louise's parents mentioned that she 'took to working in the library after school. She improved her ability to summarise and got better results than expected.' Louise's parents were aware she was participating in the SLS program and were able to observe her improved sense of control and independence. For these reasons, observations from other parents who had been told nothing about the program by their daughters, were considered valid.

<u>Question 3</u> Perceptions of daughter's development of student learning strategy competence over the year.

In response to question 3, seven parents were able to give some detail about how their daughter's study and learning strategies had changed over the year as a result of the SLS program:

Annabel's parent	More clarity in setting out topic. Better grasp by setting it out. Better understanding.
Stephanie's parent	Mind mapping is fantastic.
Louise's parent	Took to working in the library after school. She improved her ability to summarise and got better results than expected.
Sophie's parent	Mind maps did help her. She stopped to save time.
Brittany's parent	She started using symbols and mneumonics.
Bree's parent	She now reads her notes more.
Sarah's parent	Now she uses lots of diagrams, plans and spreads her study.

Inconclusive comments were:

Stephanie's parent	She doesn't talk about school.
Anabel's parent	Quite thorough I think.

Lilly's parent	We notice general changes.
Karen's parent	They were already good.
Jemma's parent	She does the least amount she has to do unless we push her

Eight parents reported that they were unaware of any changes. This included selected students Amanda, Lara and Kylie.

Question 4 relates to Research Question 3 and will be discussed in Chapter 8.

Question 5 Effect of the SLS program on student confidence

Unfortunately the wording of Question 5 did not specify confidence in science learning. Parents may have interpreted this question as relating to their daughter's confidence in her general ability at school. It is less presumptuous to assume that improvements they noticed related to confidence in science learning due to the SLS program. Five parents indicated that they were not aware of changes in confidence levels. One parent answered that the SLS program had produced a very large improvement in confidence (a rating of five). Five parents, including those of Lara and Bree, felt their daughter's confidence had improved quite a lot (a rating of four). Two parents, including Lilly's, felt there had been moderate improvement. Kylie's parent noted that she was already confident. One other parent made the same comment. One parent said that her daughter loses confidence easily.

Questions 6 and 7 relate to Research Question 4 and will be discussed in Chapter 9.

7.3 Summary of Section 7.2 Responding to Research Question 2b

Parent Questionnaire February

Because the parents did not complete a corresponding Questionnaire in December, this instrument did not reveal any effects of the SLS course on learning strategy ability. It did however provide useful evidence to support student responses to the February Student Questionnaire.

Telephone survey

The telephone survey conducted at the end of 1999 did reveal answers to Research Question 2b. Most parents were aware that their daughters were participating in the

SLS course. A third of the 21 parents contacted cited positive changes to their daughters study and learning strategies due to the SLS program. An example of a parent's comment is "More clarity in setting out topic. Better grasp by setting it out. Better understanding." About a third of the parents were unaware of any changes resulting from the program. This may have been because a proportion of the parents indicated that their daughters did not tell them anything about the SLS program. The remaining parents made inconclusive comments. Parents did not report any negative effects of the intervention on their daughters' learning in science.

7.4 Teacher perception of effect of the SLS course on student ability to apply learning strategies to science Response to Research Question 2c

The discussion in Section 7.4 addresses Research Question 2c and includes discussions about the Student Questionnaires, the LASSI-HS and student use of learning strategy 'tools'.

7.4.1 The Student Questionnaires – February and December

Questions 4i to 4iii from the Questionnaire elicited information related to Research Question 2c. Some of these results have been discussed in comparison with responses to the Parent Questionnaire (Section 7.2.1).

Question 4i Total time spent studying for a topic test

At the beginning of the year there was a small difference between Classes 1-4 and Class 5 ($t = -0.427$, not significant at $\alpha = 0.05$) in the total time students spent studying for tests (in hours) with students in Classes 1-4 nominating a mean of 2.2 hours and Class 5 students nominating a mean of 2.4 hours. By December, the hours spent studying for tests increased slightly for both groups with students in Classes 1-4 nominating a mean of 2.5 hours and Class 5 responding with a mean of 2.4 hours. These results suggest that the SLS course did not influence the students in Class 5 to increase total hours spent studying. One explanation may have been that topic tests in Year 8 do not demand a great deal of revision time.

Question 4ii Number of days over which test revision is spread

In February, Class 5 members spread their test revision time over a period of 3.1 days compared to students in Classes 1-4, who spread their study over a period of 3.5 days.

Tick any of the following strategies you used to study for this test:

a☐Read text	j☐ Rewarded myself after studying each section
b☐Underlined or highlighted the text	k☐Went over the work from the day before to make sure I
c☐Copied notes from the text	still remembered it, before starting to learn a new section
d☐Made dot point notes from the text	l☐Made up questions and answered them
e☐Made notes in my own words from the text	m☐Got someone else to test me
f☐Made up a mneumomic (eg.**N**ever **E**at **S**oggy **W**heatbix) to help me remember things	n☐Asked for help if I didn't understand something
g☐Learnt a small section at a time	o☐Drew a mind map
h☐Tested myself until I knew a section before learning the next section	p☐Learnt to re-draw the mind map from memory
	q☐ Drew a concept map
i☐Had regular breaks during a study session	r☐ Did a revision sheet

Figure 7.4 Question 4iii from the Science Learning Strategies Student Questionnaire

(This difference was not significant at $\alpha = 0.05$, $t = 1.013$). By December, the mean for Classes 1-4 had decreased by 0.4 days to 3.1 days, while the mean for Class 5 dropped by 0.1 days to 3.0 days. The SLS course was intended to encourage Class 5 students to extend revision over a number of days but the mean number of days for both treatment groups in February was already over three days and little change occurred over the year.

<u>Question 4iii</u> Students' use of test preparation strategies.

In this question, students were provided with a list of strategies (see Figure 7.4) that could be used to study for a test. These questions gathered data relevant to Research Question 2c – teacher perceptions of the effect of the SLS course on ability of students to apply learning strategies to science.

The strategies listed for selection in Question 4iii involve varying degrees of cognitive involvement and have been arranged into two halves of this continuum, one half requiring a lower level of cognitive manipulation (e.g., reading text) and the other half involving a greater degree of metacognition (e.g., drawing a concept map). By comparing the type of strategies used in February and December, changes in learning strategy use were discerned by the teacher.

7.4.1.1 Lower level cognitive strategies

The differences in strategy use between Classes 1-4 and Class 5 at the beginning of the school year are presented in Figure 7.5, and at the end of the year in Figure 7.6. Notable differences (greater than 15%) were that in February, 59% of students in Classes 1-4 registered use of the beneficial strategy ‘learning a small section at a time’, compared to only 37.5% of students in Class 5. Forty four percent of the students in Classes 1-4 used the helpful strategy ‘having breaks during a study session’ compared to only 29% of Class 5 students.

Smaller differences were that fifty percent of Class 1-4 students ‘copied notes from the text’ compared to 42% of Class 5 students. Class 5 students ‘revised work from the previous day before starting to learn a new section’ more commonly (67%) than did students in Classes 1-4 (53%). The strategy ‘asked for help if I didn’t understand something’ also was used by a higher proportion of students in Class 5 (83%) than in Classes 1-4 (74%).

In summary, at the start of the year, Classes 1-4 used the desirable strategies ‘learning a small section at a time’ and ‘having breaks during a study session’’ more commonly than did students in Class 5. Class 5 students made more use of the low level strategy of ‘copying notes from the text’. Class 5 students made more use of the desirable strategies ‘revised work from the previous day before starting to learn a new section’ and ‘asked for help if I didn’t understand something’.

Over the course of the year, Class 5 students substantially increased their use (by more than 10%) of the strategies ‘learnt a small section at a time’ and ‘rewarded myself after studying each section’. Smaller gains occurred for the strategies ‘read text’ (6.7%) and ‘had regular study breaks during a study session’ (6.5%) (see Figure 6.12).

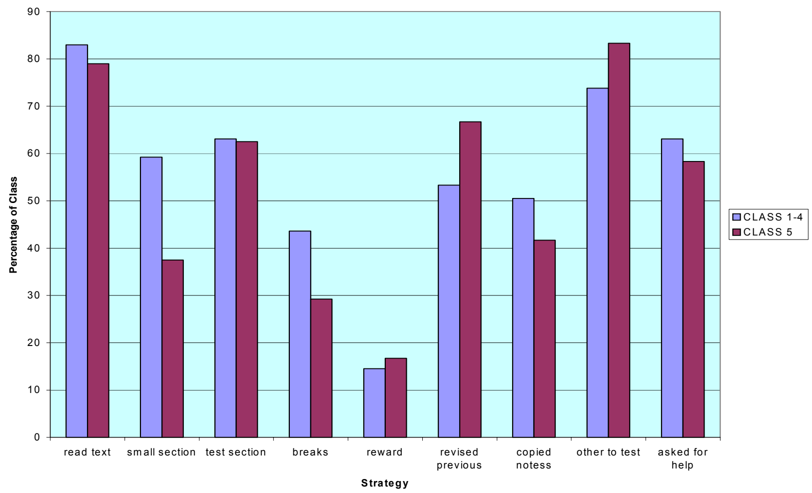


Figure 7.5 Difference in strategy use by Classes 1-4 and Class 5 in February

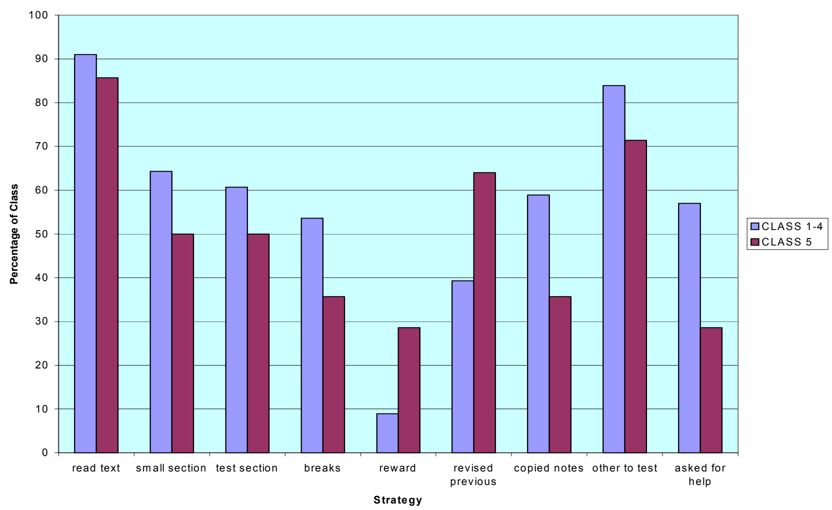


Figure 7.6 Low level strategy use in December for Classes 1-4 and Class 5

By December, students who had experienced the intervention radically reduced their use of the strategy of 'asking for help if I didn't understand something' by 29.7% (Figure 7.7). This large change may reflect the fact that the Class 5 students have been encouraged to become more independent learners as the year progressed and may have replaced this with other strategies. Students in Classes 1-4 only reduced the use of this strategy from 63% in February to 58% in December. Further evidence for this view of students in Class 5 becoming less dependent on low level strategies is the drop of 11.9% in 'getting someone else to test me' and the drop of 6% for copying notes from the text. A reduction in usage by 10% occurred for the strategy 'tested myself on a small section before learning the next section'. Other evidence for this lowered dependency is described in the next section.

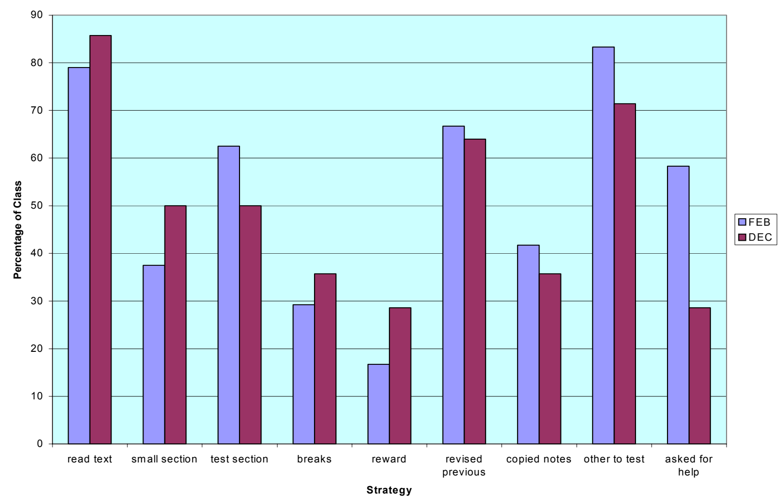


Figure 7.7 Low level cognitive strategy use by Class 5 students in February and December

7.4.1.2 Higher level cognitive strategies

The differences in use of higher level strategies between Classes 1-4 and Class 5 at the start of 1999 are illustrated in Figure 7.8.

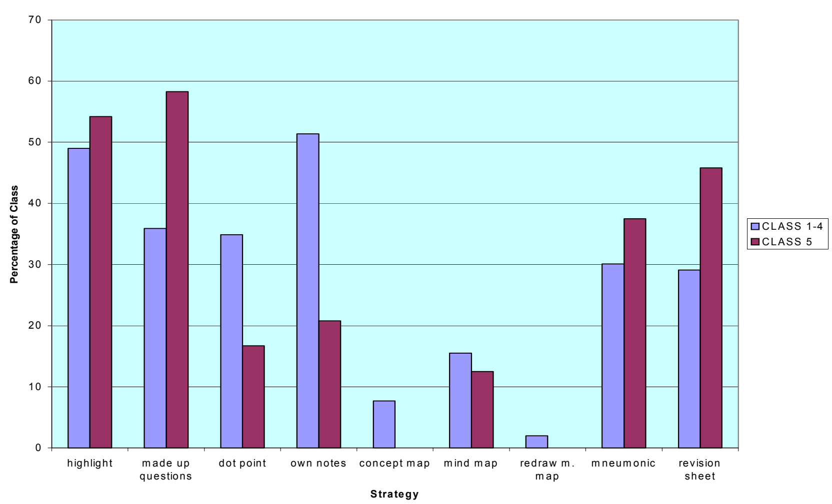


Figure 7.8 Use of higher level strategies in Classes 1-4 and Class 5 in February

Some major differences between the groups are that 35% of students in Classes 1-4 were using dot point summaries in February, while only 17% of Class 5 students were using them. The most obvious difference between the classes is in the use of the strategy ‘made notes in my own words from the text’. At the beginning of the year, 51% of students in Classes 1-4 were using them compared to only 21% of Class 5 students.

Other differences are that students in Class 5 were making much more use of the strategies ‘made up questions and answered them’ and ‘did a revision sheet’ in February than were students in Classes 1-4. More students (37.5%) in Class 5 were using mneumonics to aid memory than were students in Classes 1-4 (30%). A greater proportion of students in Class 5 used revision sheets (46%) than did students in Classes 1-4 (29%).

Students in Class 5 did not use concept maps at the beginning of the year while 8% of students in Classes 1-4 used them. There was very little difference between the groups in the use of mind maps. Fifteen point five percent of students in Classes 1-4 drew them and 12.5% of Class 5 students used them. Both groups showed quite high usage of highlighting text – 49% and 54% for Classes 1-4 and Class 5, respectively. By December, both groups had increased their usage of highlighters dramatically so that over 85% of students were using them in both groups (Figure 7.9).

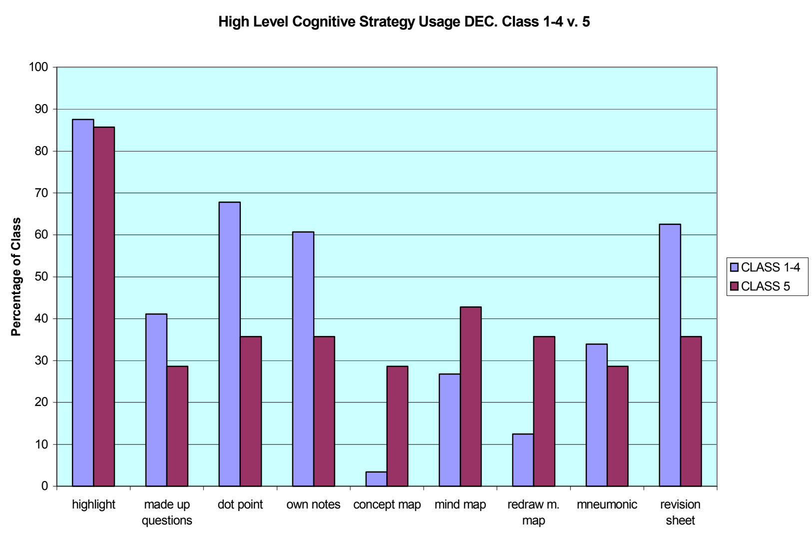


Figure 7.9 High level cognitive strategy use in December by Classes 1-4 and Class 5

By the end of the year, the percentage of students in Class 5 using the strategy ‘made up questions and answered them’ fell sharply to 29% which was 12.5% below the percentage of students using it in Classes 1-4. In December usage by Class 5 students of the strategies ‘made dot point notes from the text’, and ‘made notes in my own words from the text’ was well below the usage recorded for students in Classes 1-4. By contrast, Class 5 usage of the more cognitively demanding learning strategies‘ drew a concept map’, ‘drew a mind map’ and ‘learnt to re-draw the mind map from memory’ markedly exceeded usage of these strategies by students in Classes 1-4.

Figure 7.10 illustrates that students in Classes 1-4 increased their usage of all strategies except for the use of concept maps. Increases greater than 30% occurred for the strategies ‘underlined or highlighted text’, ‘making dot point notes’ and ‘doing a revision sheet’. Increases of around 5% occurred in the use of the strategies ‘made up questions and answered them’, ‘made up a mneumonic’. Students in this class increased their use of the strategies ‘made my own notes from the text’ and ‘drawing mind maps’ and ‘redrawing mind maps from memory’ by around 10%. Concept map usage dropped from 8% in February to 3% in December.

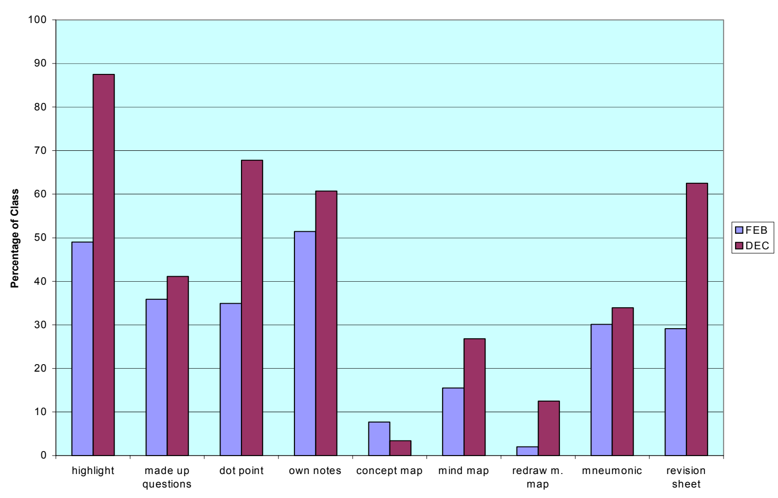


Figure 7.10 High level cognitive strategy use in Classes 1-4 in February and December

Changes in the use of strategies over the year for Class 5 are illustrated in Figure 7.11. Students in Class 5 increased their use of highlighting (mentioned previously) by

38.5%. Other large increases occurred in use of the strategies concept mapping, drawing mind maps and redrawing the mind map from memory. Development of these strategies was strongly encouraged during the intervention as they involve a higher degree of cognitive engagement. Use of concept mapping increased from 0% to 29%.

Decreases of about 10% occurred for the strategies 'made up a mneumonic' and 'did a revision sheet'. These strategies may well have been displaced by the use of concept maps and mind maps.

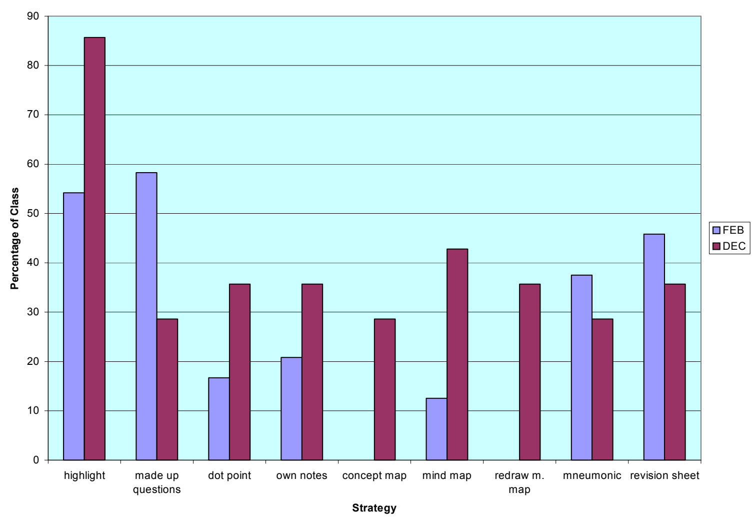


Figure 7.11 High level cognitive strategy use in Class 5 in February and December

7.4.2 The Learning and Study Strategies Inventory-High School Version (LASSI-HS)

As described in Chapter 4, the Learning and Study Skills Inventory – High School version (LASSI-HS) was trialed in the pilot study in 1998, and used again during the intervention in 1999. Scales measured by the cross curricular LASSI-HS are Attitude (ATT), Motivation (MOT), Time Management (TMT), Anxiety (ANX), Concentration (CON), Information processing (INP), Selecting the Main Idea (SMI), Study Aids (STA), Self Testing (SFT) and Test Strategies (TST). All ten scales are considered in this discussion, as they are relevant to the strategies addressed in the SLS course. Values reported are percentile equivalents of raw scores.

The developers of the LASSI-HS, Weinstein and Palmer (1990), contend that students with a high percentile rank on a scale are likely to be relatively able in that aspect of learning, and conversely, students with a low percentile rank on a scale are likely to be weak in that area. They also assert that scores on the LASSI-HS can be improved with learning strategy education.

7.4.2.1 Background changes occurring without the intervention

In examining background changes in learning strategies occurring **without** the intervention (Classes 1, 2, 4, 5) in the 1998 pilot study, falls in LASSI-HS scores occurred over the year on all scales (refer to Table 7.1) except for the INP and STA scales which showed slight improvements of 1.5% and 1.2% respectively. The largest falls over 1998 occurred in the CON and the TMT scale of 11.3 and 9.3% respectively. These two falls were statistically significant ($t = 2.236$ and $t = 2.760$ respectively, $\alpha=0.05$).

Table 7.1 Changes during 1998 in LASSI-HS percentile equivalents for students **not** participating in the intervention.

Mean percentile equivalents	**ATT**	**MOT**	**TMT**	**ANX**	**CON**	**INP**	**SMI**	**STA**	**SFT**	**TST**
MAY-All classes n=53	51.2	61.7	58.2	58.4	66.0	50.4	60.8	51.9	59.8	56.4
NOV-Classes 1,2,4,5 n=91	47.5	56.2	48.9	51	54.7	51.8	57.5	53.1	52.1	50.6
Change over 1998	-3.7	-5.5	-9.3	-7.4	-11.3	+1.5	-3.3	+1.2	-7.7	-6.0

This pattern was similar for students **not** receiving the intervention (Classes 1-4) in 1999 (refer to Table 7.2). The best result was a small improvement over the year of 6.5% in the STA scale, while the worst result was a drop of 7.9% in the TMT scale. Reductions occurred in five scales, small improvements occurred in three scales, while there was no change in two scales.

Table 7.2 Changes during 1999 in LASSI-HS percentile equivalents for students **not** participating in the intervention (Classes 1-4)

Mean percentile equivalents-	**ATT**	**MOT**	**TMT**	**ANX**	**CON**	**INP**	**SMI**	**STA**	**SFT**	**TST**
FEB. Classes 1-4 n=91	36.4	62.5	66.9	56.2	66.4	50.7	33.3	52.5	43	45
DEC. Classes 1-4	36.4	60	59	57	58.8	50.7	33.6	59	42.4	43
Change over 1999	0	-2.5	-7.9	+0.8	-7.6	0	+0.3	+6.5	-0.6	-2

These decreases are surprising as at least some of the study strategies were expected to improve noticeably over the year because of student maturation (Weinstein & Palmer, 1988).

7.4.2.2 Changes for the class receiving the intervention in 1999

The class receiving the intervention (Class 5) showed some quite negative changes over the course of 1999 (Table 7.3), the worst being the fall of 15.2% in the TMT scale. Other disappointing falls occurred in the INP (-10.6%), STA (-12.0%), and SFT (-11.5%) scales. Very small improvements were made on the ANX scale and the TST scale (+1.9% and +1.5% respectively).

Table 7.3 Changes during 1999 in LASSI-HS mean percentile equivalents for students participating in the intervention (Class 5)

Mean percentile equivalents-	ATT	MOT	TMT	ANX	CON	INP	SMI	STA	SFT	TST
FEB. Class 5 n=26	32.8	58.2	60.3	50.8	58.3	47.2	32.9	54.8	40.7	38.8
DEC. Class 5	29.6	56	45.1	52.7	55	36.6	26.7	42.8	29.2	40.3
Change in percentile equivalents over 1999	-3.2	-2.2	-15.2	+1.9	-3.3	-10.6	-6.2	-12.0	-11.5	+1.5

The LASSI-HS results are surprising and disappointing because they do not reflect the demonstrated gains achieved in learning strategies in a science context that may have been fostered by the SLS course. The results from the LASSI-HS contradict perceived advances in science learning strategy capability for Class 5 students described in Chapter 6 and Section 7.4.3 of this chapter. These gains include improving levels of motivation and attitude and use of study aids as measured in the Student Questionnaire. Student ratings in the Questionnaire for interest, ability, wanting the best results improved for Classes 1-4 and Class 5 over 1999. Other examples of improvements in study strategies are provided later in this chapter.

It is possible that the SLS strategies gained were non-transferable to other subjects and were therefore not picked up in the cross-curricular LASSI-HS. Even so, the degree of decrease in strategies revealed by the LASSI-HS over the year, particularly in the TMT and STA scales was not expected. The worsening end of year LASSI-HS scores may well have been due to factors outside the science classroom.

Concern about another aspect of the LASSI-HS relates to the very large variations in mean percentile equivalents across heterogeneous classes in the April 1998 results (Table 7.4). In 1998, the largest variation in class means of 30.7% occurred in the TST scale, while the smallest variation was in the CON scale of 15.5%.

Table 7.4 Variation in LASSI-HS means across all classes in the 1998 pilot study

Scale	Minimum class mean percentile equivalent	Maximum class mean percentile equivalent	Variation between class mean percentile equivalents
ATT	39.4	59.1	19.7
MOT	51.1-	78.5	27.4
TMT	50.5	69.9	19.4
ANX	51.5	70.4	18.9
CON	55.6	71.1	15.5
INP	34.9	60.5	25.6
SMI	44.9	67.8	22.9
STA	38.5	58.4	19.9
SFT	47.9	76.6	28.7
TST	40.5	71.2	30.7

Similarly, in the December 1999 LASSI-HS, the smallest difference between classes not receiving the intervention (Table 7.5) was 13.1% in the ATT scale, while the greatest was 33.1% in the TST scale. Despite the reliability and validity of the LASSI-HS described in the literature cited in Chapter 4, the very large variations in mean percentile equivalents revealed across heterogeneous classes in this study do undermine confidence in the instrument as it has been applied in this situation. Another possible explanation for the excessive variation is that only Year 9 norms were provided with the LASSI-HS documentation to convert raw scores to percentile equivalents, whereas the students in this study were a year younger. This may have some effect although one author of this instrument condoned use of the scales for children of this age (Weinstein,1998, personal communication).

Table 7.5 Variation in LASSI-HS means for classes not receiving the intervention in December 1999

Scale	Minimum class mean percentile equivalent	Maximum class mean percentile equivalent	Variation between class mean percentile equivalents
ATT	29.2	42.3	13.1
MOT	48.5	66.2	17.7
TMT	45.1	62.5	17.0
ANX	44.4	67.2	22.8
CON	40.1	68.2	28.1
INP	36.6	56.8	20.2
SMI	26.6	43.4	16.8
STA	42.7	65.5	22.8
SFT	29.2	44.6	15.4
TST	28.0	61.1	33.1

7.4.2.3 Comparison of LASSI-HS scores for Class 5 and Classes 1-4 in February and December 1999

At the beginning of 1999, Class 5 students had lower scores (i.e. rated themselves as slightly less skilled) than students in Classes 1-4 on all scales except STA, where Class 5 students reported a mean score of 54.8%, 2.5% higher than the mean for Classes 1-4 (Table 7.6). None of these differences were significant (α = 0.05).

Table 7.6 Percentile equivalents of raw scores for Classes 1-4 and Class 5 in February 1999

Mean Percentile Equivalent	ATT	MOT	TMT	ANX	CON	INP	SMI	STA	SFT	TST
FEB. Classes 1-4	36.4	62.5	66.9	56.2	66.4	50.7	33.3	52.5	43	45
FEB. Mean Class 5	32.8	58.2	60.3	50.8	58.3	47.2	32.9	54.8	40.7	38.8
Difference between means for Classes 1-4 and Class 5 in February	-3.6	-4.1	-6.6	-5.2	-8.1	-3.5	-0.4	+ 2.4	-2.4	-6.1

By the end of the year (Table 7.7) statistically significant differences (α = 0.05) occurred in four of the LASSI-HS scales. The STA rating for Classes 1-4 was 16.3% higher than the score for Class 5 (t = 2.780), and Classes 1-4 reported higher mean ratings than Class 5 students on all other scales. The second largest significant difference occurred in the INP scale where the December mean for Classes 1-4 was 14.1% higher (t = 0.458). T values for the other significantly different scales were SFT, 2.834, and for the TMT scale, 2.388. These results are difficult to explain in the light of other measures of perceived student learning strategy ability referred to earlier.

Table 7.7 Percentile equivalents of raw scores for Classes 1-4 and Class 5 in December 1999

Mean percentile equivalent	ATT	MOT	TMT	ANX	CON	INP	SMI	STA	SFT	TST
DEC . Classes 1-4	36.4	60	59	57	58.8	50.7	33.6	59	42.4	43
DEC Class 5	29.6	56	45.1	52.7	55	36.6	26.7	42.8	29.2	40.3
Difference between means for Classes 1-4 and Class 5 in December	-6.8	-3.6	-13.9	-4.2	-3.8	-14.1	-6.9	-16.3	-13.2	-2.7

Despite their poor performance in the LASSI-HS, students in Class 5 gained an average final mark for science of 81.8%, which was 3.6% higher than the mean achieved by students in Classes 1-4. While this difference is not statistically significant, it shows that the poor performance on the LASSI-HS by Class 5 students was not reflected in their science results. Participation in the SLS course appears to have had at the very least, no deleterious effect on student results in science. This perception is essential if parents, students, teachers and the school administration are to support the

SLS intervention. The many other benefits of the SLS course are described in following chapters.

7.4.3 Assessment of Student Learning Strategy assignments

Students completed numerous SLS assignments (to assess their competence at using a number of learning strategy 'tools') collectively worth a total of 10% of the final mark for science. Students in other Year 8 science classes completed assignments not related to SLS for their 10% class work mark.

7.4.3.1 Dot point summaries

First attempt – Two weeks into the first Term, students were asked to produce a dot point summary of a 10 page section of the text. They were instructed to use key words. The mean score out of ten for this first task was 7.3. These summaries were marked, commented upon and returned to the students the following day. Results are provided later in Table 7.8. Only two students made use of colour (a recommended strategy), and six neglected to use headings. These students were given feedback suggesting they incorporate colour and headings to aid understanding and recall. Three students produced notes that were 'highly wordy', one produced notes that were 'quite wordy' and two summaries included 'some excess words'. Only one student laid the notes out poorly. On average only one concept was missed by each student (the content of the text section was quite simple). Overall, students in the class were quite adept at summarising text in this first effort.

Students were required to produce a second dot point summary of ten pages of the text after receiving feedback about their first attempts. The mean score out of ten improved by 0.8 to 8.1 and the mean number of missed concepts per student dropped from one to 0.75. No one produced 'highly wordy' dot point notes, two students produced 'quite wordy' notes and only two students used some extra words, indicating most of the students understood how to use key words effectively at this stage.

Most students made suggested changes in their second summary. For example, the number of students avoiding the use of colour dropped from 17 to 10. Only four students avoided using colour in both attempts and two students went from using no colour to using limited colour. Two students left off headings in both summaries.

A number of students included new shortcomings into their second dot point precis. For example, while only six students failed to use headings effectively in the first summary, ten students made poor use of headings in the second attempt. This deficiency was of concern and students were given feedback to address this problem. An example of a sound dot point summary is provided in Appendix 3.3.

7.4.3.2 Mind maps

Students completed four mind maps between February and September, 1999. In October, students selected the summary form of their choice and 12 students (46% of the class) chose to complete a fifth mind map. The maps were assessed for use of colour, layout, use of symbols, accuracy, coverage and economy (as few words as possible). Scores for the mind maps are provided in Table 7.8.

The mind maps summarised larger amounts of text than the dot point summaries and consequently, the average numbers of missing concepts was higher. The highest mean of 2.5 missed concepts was from the Living Things B map. This section of text was more complex than that summarised in the Living Things A map (a mean of 1.3 concepts missing). Accordingly, the mean score of the Living Things A map of 8.3 was higher than the 7.5 mean score achieved for the Living Things B map. The mean scores for the May and September maps were 8.7 and 8.4 and the means of missing concepts were 1.5 and 1.7, respectively.

Twelve shortcomings (other than missed concepts) were noted for the Living Things A map while only seven were identified in the Living Things B map. The standard of mind mapping by March was very pleasing and by May marks were only lost for missed concepts. Layout, use of colour and symbols, accuracy, coverage and economy of wording were accomplished to a high standard. Only one person used 'some extra words', a tendency which was carried through from her dot point notes.

The 12 students completing a fifth mind map in October maintained a high standard with a mean of 9.4 and a mean of 0.6 missed concepts. A well developed mind map is provided in Appendix 3.5.

7.4.3.3 Idea organisers

Students completed three idea organisers, two in May and one in August. Seven students chose to do another idea organiser in October. By May, the students were using very sound summarisation skills and only one student used 'some extra words' on one occasion. The skills developed in economy in wording probably transferred from mind mapping. The mean scores for the two organisers done in May and the August organisers were 7.5, 7.8 and 7.4. These means are lower than the mean scores for the mind maps. This was due to an increase in students missing concepts in the idea organisers, (averaging 2.2 missed concepts) which was higher than for mind maps (1.7 missed concepts on average). One explanation for this trend is that mind maps allow students a 'birds eye view' of the topic and missing components may be more obvious. A moderately well constructed idea organiser is shown in Appendix 3.7.

7.4.3.4 Concept maps

Only two concept maps were completed by the students and only one of these was collected for assessment. Students were very competent at describing the links between concepts (mean score of 9.5) and a mean of only 0.6 concepts were omitted. Appendix 3.6 illustrates a well developed concept map.

7.5 Summary of Section 7.4 Responding to Research Question 2c

<u>Student Questionnaire</u> February and December

<u>Question 4i</u> and <u>Question 4ii</u>

The total time and number of days spent preparing for topic tests was probably not influenced very much by the SLS program. A mean of 2.3 hours was spent at the beginning and end of the year by both treatment groups and this was spread over a mean of three days, again for both groups. The spread over three days in February was desirable, and on average no change was required.

<u>Question 4iii</u>

By the end of the year, Class 5 students reduced their use of strategies requiring lower levels of cognitive engagement and increased their usage of the higher level cognitive strategies, particularly highlighting, making dot point notes, and the demanding, but rewarding, strategies of constructing mind maps, idea organisers and concept maps. Students in Classes 1-4 increased dramatically their use of highlighting text and greatly

Table 7.8 Learning strategy performance

	Dot Point /10 completeness, setting out, economy		Mind Maps /10 colour, layout, symbols, accuracy, coverage, economy			
	Living Things A -Feb	Living Things A Feb	Living Things A Feb	Living Things B March	Heat May	Chemistry 1 Sept
Stephanie		6 NH*, MC	10	10		
Lara	5 NC, NH	5 NH, NC, MC, poor setting out	9.5 MC	7 MC	8 MC	
Chrissy	7 NC, NH, MC	9 NC	8.5 MC, error			7.5 MC
Isabel	8 NH, SEW	9 NC	10	7 MC	10	10
Annabel			6 MC	6 MC	9.5 MC	9.5 MC
Jemma	8 NC, MC	7 NH, MC, SEW	7.5 MC		7.5 MC	
Anna	8 NC, MC	9 NC	7.5 MC	7 MC, poor layout	8 MC	8.5 MC
Robin	8 NC, MC	8 NH, MC	5 MC, poor layout, error			
Lilly	9 NC	10	9 MC	9.5 layout slightly cluttered	9 MC	6.5 ran out of time to finish it
Natasha	6 NC, Highly wordy (HW)	7 Quite wordy (QW), MC	7.5 MC	6.5 MC		6 MC
Brittany	9 NC	9 NC	10	7 MC, poor layout	10	10
Sophie	10	8 MC	10	10	10	8.5 MC
Gabby		8 NH, MC	7.5 MC	7 MC	8 MC	8.5 MC
Tilly	7 NC, SEW, MC	8.5 NH, MC	8 MC, poor use of symbol	6 SEW, MC		6.5 Idea Organiser SEW
Karen	9 NC	10	6.5 MC, poor layout, error	8.5 MC	9 MC	10
Alex		5 MC, NH, NC, SEW	10	8.5 MC		
Lauren	5 NC, NH, hard to read, MC	9 NH	6.5 MC, error	5 MC, poor use colour, error	6 MC	8.5 MC
Ginia		9 NC	9.5 Poor layout (cramped)	7 MC		8.5 MC
Skye	4 NC, NH, HW, MC	6 QW, MC	8.5 MC			9 MC
Bree	7 NC, NH, HW		8.5 MC		8.5 MC	9.5 MC
Amanda	8 NC, MC	9.5 MC	6 MC, error, poor use of symbol	8.5 MC	9 MC	
Hannah		8.5 hard to read, some colour	9 SEW	8.5 MC	8 MC	7.5 MC
Nicola	8 NC, MC	8.5 hard to read, some colour	10	8 MC	9 MC	7.5 MC
Louise		7 MC, NH	5.5 MC, poor use of symbol	6.5 MC	9 MC	8 MC
Sarah	7 NC, QW	9 NH	10	6.5 MC		
Sally	5 NC, MC, poor layout	9 Some colour, MC	10	7 MC, poor layout	9.5 MC	10 MC
Mean score/10	7.3	8.1	8.3	7.5	8.7	8.4
Mean MC	1	0.75	1.3	2.5	1.5	1.7

* NH no heading, NC no colour, MC missed concept, QW quite wordy, HW highly wordy, SEW some extra words

Table 7.8 – continued Learning strategy performance

	Idea Organisers /10 layout, symbols, accuracy, coverage, economy			Choice of summary method – in class exercise – reminder of colour, layout, economy etc. given /10	Concept Map /10
	Heat 7-May	Heat 24-May	Tinkering 9-Aug	Chemistry 2 15 Oct	Tinkering 6-Aug
Stephanie	8 MC			9 Mind map (MM), MC	10
Lara	7 MC		8 MC	9 MM, MC	10
Chrissy			7 MC	10 Dot point (DP)	
Isabel	7 MC	8.5 MC	10	9 MM, MC	10
Annabel	8 MC		6 MC	10 MM	
Jemma			5 MC	6.5 Idea organiser (IO) MC, HW	8 MC
Anna	8 MC	7.5 MC	7 MC	10 IO	9 MC
Robin				10 IO	
Lilly	8.5 MC	3.5 MC	7 MC	10 MM	8 MC
Natasha	7 MC		3 MC	9 MM, MC	8 MC
Brittany	10	9 MC	10	10 IO	10
Sophie	8.5 MC	9 MC	10	10 IO	10
Gabby	8.5 MC		8 MC, SEW	8.5 MM, MC	10
Tilly				9.5 MM, SEW	8 MC
Karen	8 MC	10	7 MC	10 DP	10
Alex	8 MC			5 DP, MC	
Lauren				9 DP, MC	
Ginia	7 MC			10 MM	
Skye	8 MC		7 MC	10 DP	10
Bree	8 MC	6.5 MC	8 MC	10 MM	10
Amanda			8 MC	9 MM, MC	
Hannah	7.5 MC	8.5 MC	8 MC	9 DP, MC	
Nicola	8 MC	8.5 MC	7 MC	9 MM, MC	10
Louise		6.5 MC	6 MC	10 IO	10
Sarah	8 MC		8 MC	10 IO	
Sally				10 MM	
Mean score/10	7.5	7.8	7.4	9.3	9.5
Mean missed concepts	1.9	2.2	2.6	MM 0.6, DP 1.3, IO 0.1	0.6

increased use of the less cognitively demanding strategy of taking dot point notes. These students increased their use of revision sheets and slightly increased use of mind maps to around 27%. Use of concept maps by students in Classes 1-4 fell over the year to 3.5%.

Students in Class 5 appeared to develop more cognitively demanding strategies than students in Classes 1-4 which are conducive to increased understanding and better retention of science concepts.

LASSI-HS

Background changes occurring in classes not receiving the LASSI-HS intervention in 1998 and 1999 included falls over the year on all but two scales during 1998 and all but three scales over 1999.

Class 5 (which experienced the intervention) results were quite negative and unexpected. Small improvements occurred in two scales, ANX and TST. Falls occurred on all other scales except for INP and STA which remained steady. These changes were disappointing and do not reflect the improvements in Class five students' learning strategies reported elsewhere in this chapter (Sections 7.4.1 and 7.4.3) . These negative results from the LASSI-HS, however, were not reflected in the end of year academic results in science of Class 5, which slightly exceeded those of Classes 1-4.

Student Learning Strategy assignments

Dot point summaries - Students demonstrated good skills in producing dot point summaries in their first attempt. The mean score increased on the second attempt from a score of 7.3 out of 10 with a mean of one missed concept per student, to a mean of 8.1 with 0.75 missed concepts per student. Most students made suggested changes in their second dot point summary. A common fault in both dot point summaries was the poor use of headings.

Mind maps - This problem did not recur in student mind maps. Students completed either four or five mind maps and with practise, layout, use of colour and symbols, accuracy, coverage and economy of wording of the mind maps improved to a high standard. In later maps marks were only lost for missing concepts (an average of 1.75 missing concepts per student).

Idea organisers – The three idea organisers produced in May and August were of a very high standard in terms of layout, use of symbols, accuracy, coverage and economy. The idea organisers were produced at around the time that these factors improved in students' mind maps. The feedback to students about these factors may have transferred from producing mind maps to idea organisers. Students on average left out more concepts from Idea organisers (mean of 2.25 concepts) than from mind maps (mean of 1.75 missed concepts). It is suggested that the mind maps require a more holistic view of the topic and missed concepts may be more obvious than for idea organisers.

Concept maps – Students only submitted one concept map for assessment, so it is not possible to gauge improvement due to the SLS program.

In responding to Research Question 2c (teacher perception of the effect of the SLS course on student ability to utilise learning strategies in science) it can be said that the teacher/researcher observed that the SLS program did facilitate some student learning strategies improvement. As the year progressed, students began using more cognitively demanding strategies (that promote deeper learning). With regard to performance of SLS assignments, students improved their competence at dot point summaries and mind map construction with coaching and practise. The initial quality of the students' idea organisers (introduced in May) was pleasing and could reflect a transference of skills developed earlier in mind mapping. Results from the LASSI-HS however, contradict these teacher perceptions and provide disconfirming evidence about the benefits of the SLS program.

7.6 Summary of Chapter 6 and 7 - Responding to Research Questions 2: Student, parent and teacher perceptions of the effects of the SLS course on student ability to apply learning strategies to science.

Detailed answers to Research Questions 2b and 2c have been provided in Sections 7.3 and 7.5 of this chapter. Overall, the viewpoints of students, parents and teacher/researcher in relation to this question reinforced each other. Students reported that the SLS course had improved their ability to use at least some of the learning strategies effectively (refer to Chapter 6). A third of parents interviewed by telephone in December supported this view by citing positive changes to their daughter's study and learning strategies as a consequence of participation in the SLS program. (Another third of parents were unaware of any changes and a third made inconclusive comments.) The teacher/researcher observed that students participating in the intervention developed their ability to use cognitively demanding summarisation and synthesis strategies over time. Students were able to see the usefulness of the tools, in spite of the extra effort required, in assisting their learning. Students in Classes 1-4, who did not participate in the SLS program, continued to use less demanding, less fruitful learning strategies.

Neither students (Chapter 6), parents nor the teacher/researcher described any negative trends in facility with learning strategies for student participation in the SLS course with the exception of the December LASSI-HS results. Results from the LASSI-HS provided disconfirming evidence to the teacher about the benefits of the SLS course in terms of improving learning strategy competence. The LASSI-HS results contradict perceived improvements in science learning strategy capability for students in Class 5 described in Sections 7.4.1 and 7.4.3 and in Chapter 6 (Section 6.3).

Chapter 8

Student, parent and teacher perceptions of the effects of the Science Learning Strategies program on academic performance: Response to Research Question 3

8.1 Introduction

It was vital to demonstrate that there were no ill effects for students participating in the SLS program in terms of their academic performance. This issue is examined from the viewpoint of students in Section 8.2 and 8.3, parents in Section 8.4 and 8.5 and of the teacher/researcher in Section 8.6 and 8.7. An overarching response to Research Question 3 is provided in Section 8.8.

8.2 Student perceptions of the effect of the SLS course on academic performance (Research Question 3a)

Student perceptions of the benefits of the SLS course in relation to their academic performance are described in Sections 8.2.1 – 8.2.6.

8.2.1 Student Questionnaire - February and December

Question 5 of the Student Questionnaire asked students to indicate which mark range they most often achieved in science tests during their previous year of schooling. This information is relevant to Research Question 3a. Figure 8.1 compares the perceptions of science performance of Class 5 students with those of students in Classes 1-4 at the beginning of the year.

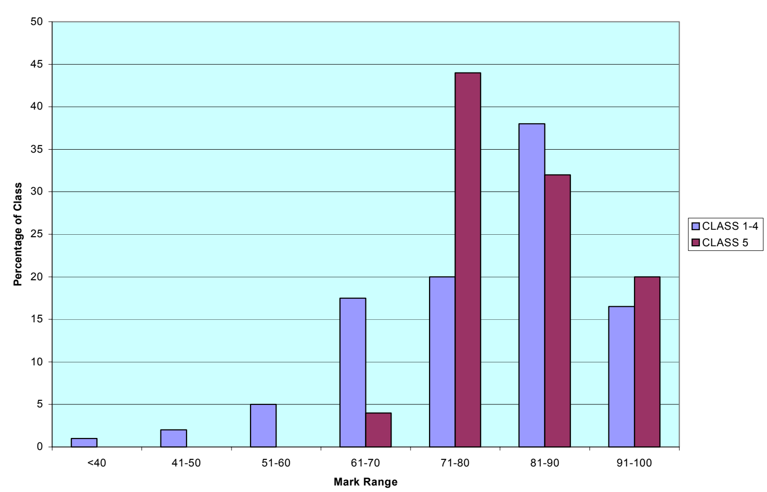


Figure 8.1 Perception of Year 7 science test scores in Classes 1-4 and Class 5 in February

Fifty four percent of students in Classes 1-4 perceived their Year 7 results as falling between 81% and 100%. A similar number (52%) of Class 5 students perceived their results as falling within this range. Of the students nominating this mark range, however, 4% more of the Class 5 students placed themselves in the 91-100% bracket than did students in Classes 1-4. The majority of Class 5 students (44%) placed themselves in the 71-80% mark range while only 20% of students in Classes 1-4 did so. A small group (4%) of students in Class 5 nominated the 61-70% range, compared to 17% of students from Classes 1-4.

Students in Classes 1-4 nominated a greater range of test scores with eight percent of the students in Classes 1-4 rating their test scores as falling between 40% and 60%. No Class 5 students rated their scores so low.

By December (Figure 8.2), students in Classes 1-4 had improved their ratings to the point that no students ranked themselves as achieving marks below 61% during Year 8. However the percentage of students in the top two mark ranges decreased by 4% over the year.

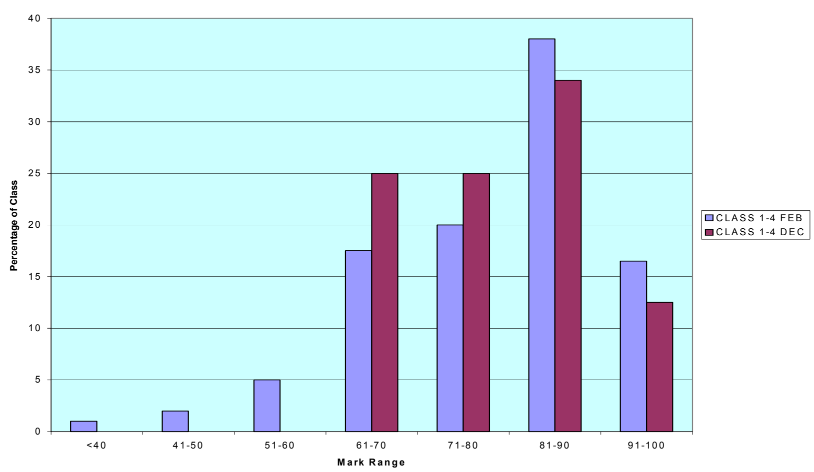


Figure 8.2 Perception of Year 8 science test scores in Classes 1-4 in February and December

Changes in the responses of students in Class 5 over time are illustrated in Figure 8.3. Many of the students (22%) shifted their perceived ranking from 71-80% to a higher range. The proportion of students ranking themselves in the 81-90% range increased from 32 to 50%. There was also a slight increase (1.5%) ranking themselves in the top mark range. This upwards trend was reflected in the increase of ability rating (described previously) over the year for students in Class 5.

A comparison of the December ratings of students in Classes 1-4 and Class 5 (see Figure 8.4) shows that by the end of the year students in Class 5 had generally higher perceptions of their ability ratings than did students in Classes 1-4.

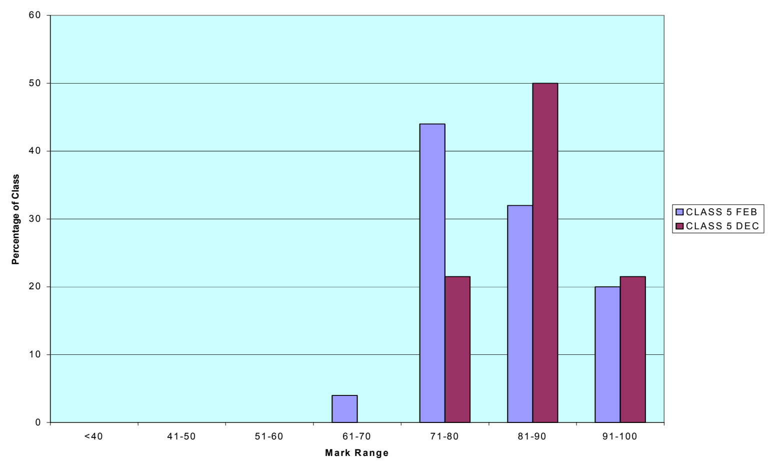


Figure 8.3 Perception of Year 8 science test scores in Class 5 in February and December

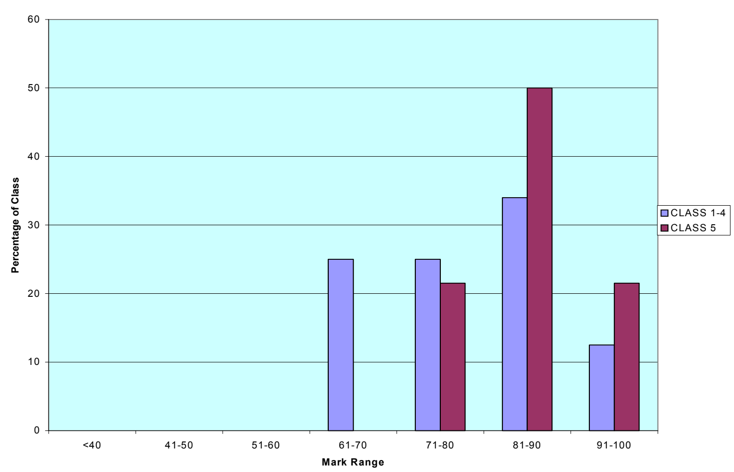


Figure 8.4 Perception of Year 8 science test scores of Classes 1-4 and Class 5 in December

8.2.2   June Tools for Learning Questionnaire

The June Tools for Learning Questionnaire is presented in Appendix 4.3

Question 10 Effect of mind maps on test results

A rating of one indicated that the maps had made marks much worse, a rating of five indicated that the maps had made no difference to their scores and a rating of ten indicated that the maps had improved their results a lot. A summary of student ratings about effects of mind mapping and other learning tools on test results is provided in Table 8.1. No students chose a rating less than five in any questions (ie. the 'tools' was not perceived to have a negative effect on anyone's scores).

In relation to mind mapping, no-one chose a rating of 9 or 10 on a ten point scale, while 55% of students indicated that the maps helped their results to a moderate degree (a rating of seven or eight), and 30% of students indicated that mind mapping had made no, or very little improvement in their results (ratings of five or six). One student's comment about her rating of five was that she forgot to use them. Three students who chose a rating of six mentioned that they only remembered bits of the maps.

Ratings of seven were accompanied by these comments:

> My test marks have gone up heaps because mind maps really help me (Steph)
>
> They didn't play a huge part but some colourful pictures were easy to remember so I remembered the words that went with them (Sophie)
>
> They've made a difference because they've made me do a bit more study than I usually would (Isabel)

Ratings of eight were accompanied by the following comments:

> I'm not very good at studying and they probably improved me and helped me quite a bit because I usually just study the last night. I used to just go through the book and just try to think of what I've read. (Karen)
>
> I think they help me because if I do a mind map, it makes me look through all of my booklet and try to remember everything for the test, and I remember it. (Alex)

Question 16 Effect of the idea organisers on test results

A summary of student ratings on a ten point scale, about effects of using idea organisers on test results is provided in Table 8.1. On the scale, 10 is the most positive response, 5 indicates that the strategy makes no difference and 1 means that the strategy made their results much worse.

No students chose a rating of nine or ten. Fifty percent of students indicated that the organisers helped their results to a moderate degree (a rating of seven or eight) while 44% indicated that the idea organisers had caused no, or very little, improvement in their results. One student said that they did not help her. Four students chose a rating of six and mentioned that they made a bit of a difference. One student who chose a rating of seven said they were very clear to study from.

Table 8.1 Student perception of how much learning strategies improved science results

Strategy/tool	No. of students completing item	Mean	Percentage of students choosing ratings*			
Rating			9&10*	8	7	5 & 6**
Summarising – Mind maps (Q. 10)	20	6.5	0	20	35	30
Summarising – Idea organisers (Q. 16)	16	6.6	0	12.5	37.5	44.0
Test Planner & Feedback sheets (Q. 23)	14	6.1	7	14	14	64.5
Test Factors (Q. 28)	7	7.4	14	28.5	43	14
Check your Learning Chart (Q. 32)	11	6.8	9	36	18	36
Learning from Test Errors sheet (Q. 35)	11	6.4	0	0	54.5	43

*Where 10 is the most positive response, 5 indicates that the strategy makes no difference and 1 means that the strategy made their results much worse.
**Ratings of 9&10 and 5&6 have been grouped for ease of description

Ratings of eight were accompanied by the following comments

> It made me study (Nicola)
>
> They make me organised to study. Also, just writing the info. down helps you learn and understand. (Steph)

This last comment reflected the fact that students were asked to paraphrase material when using mind maps and idea organisers rather than just copy text. Paraphrasing generally requires and promotes student understanding of concepts and information.

<u>Question 23</u> Effect of Test Planning and Feedback sheets on test marks.
A large majority of students (64.5%) indicated the Planners had only a slight positive impact, or no impact (ratings of five or six), on their test results (Table 8.1). This may

have been because the Test Planner and Feedback sheets were only used intermittently (prior to tests). Students found much more value (with regard to improving test scores) in using summarising strategies (mind maps and idea organisers), probably because they were continuously using them.

Nevertheless, 28% of students found the Planners had a moderately positive effect on their test scores and 7% found them to have had a very beneficial influence on results. No one indicated that using the Planner had any negative impact on test scores.

Few students offered an explanation for their rating, although Lilly, who chose a rating of eight said the Planners “make me do more study and I do it in different ways”. Nicola, who also choose a rating of eight, remarked that the Planner “makes me stick to the task”. Sophie chose a rating of nine and commented “I think I’ve improved quite a lot in science because now I know how long I should study for”.

<u>Question 28</u> Perceived effects on performance of the discussions about managing factors that influence test performance
Only seven responses were given to this question. The researcher neglected to ask for a rating in six interviews and six students omitted this question in the Questionnaire. The Questionnaire was very long (37 questions) and student responses become less frequent from this question onwards. This may have been because some students could not complete the questions in the time allowed. More likely explanations are that the drop in responses may have been because students were becoming fatigued or losing interest and/or motivation in finishing the survey.

Of the seven responses, one student gave a rating of ten, two students chose a rating of eight, three chose a rating of seven and one student, a rating of six.

<u>Question 32</u> Effect of the Check your Learning Chart on test marks
Only one student said the charts had improved their results a lot (a rating of nine or ten). Six students (54%) felt the charts had moderately improved their test results and four students (36%) felt the charts had resulted in little or no improvement to their test scores.

Question 35 Effect of Test Error Charts on test results
Forty three percent of the 11 respondents considered the charts to have produced only a slight or no improvement, while 54.5% believed the charts had produced moderate improvement in test results. No one gave a rating higher than seven. Student comments follow

> I don't make the same mistakes now - I learn how to fix it (Steph)
> I don't make silly mistakes any more (Sarah)
> I study more. Sometimes I used to just skip things and say to myself that I know them when I don't really (Lilly)

8.2.3 November Tools for Learning questionnaire

Question 3 Contribution of learning 'tools' to science results
The highest mean class rating of 4.1 on a scale of one to five, was for the strategy 'Using the objectives to work out what the test will cover' (strategy no. 20 Table 8.2). Thirteen students (54.1%) rated the contribution of this SLS strategy to their science results as 4 or 5 on a scale of 1 – 5 (has helped results a lot). The class mean rating of 3.6 for the strategy 'Learning from test errors' (strategy no. 19) and the fact that 11 students (46%) gave this strategy a rating of 4 or 5 indicates that students felt it was very helpful.

Twelve students (50%) rated the contribution of the SLS strategies 'Learning to pick the main ideas from text' and 'Summarising using mind maps', to improving their results as very high (a rating of 4 or 5). These two strategies had an average class rating of 3.2 which indicates a general acceptance of the strategies as helpful in improving results. Nine students (37.5%) felt that learning to draw 'concept maps' had not helped their results at all, although five students (20.8%) felt that learning this strategy had improved their results a lot (a rating of 4 or 5).

In the test planning strategies (strategies 6-9) ten students felt that learning the strategies 'Setting goals' and 'Planning your study time' had not helped their results at all. The most useful strategy in this group was 'Deciding how important a test is'. Eight students (33.3%) believed that learning this strategy had helped their results a lot. The mean class rating was 2.8. However, four students (16.6%) felt that learning this strategy had not helped their results.

In the strategies related to revising for a test (strategies 12-14) the most helpful in terms of improving results was the strategy 'Breaking revision into small sections'.

The mean class rating was 3.1 and eight students (33.3%) rated the strategy four or five (helped to improve their results a lot).

Of the test completion strategies (number 15-18), 10 students (41.6%) felt that implementing the strategy 'Staying calm' helped their results a lot. The mean class rating was 3.1. Students were emphatic that the 'Splash down' strategy did not contribute to their results with 12 students (50%) saying that it had not helped at all. Eight students (33.3%) felt that the strategy 'Asking for help' had improved their results a lot and the mean class rating of 3.2 indicates that it had broad general acceptance as something worth doing.

Table 8.2 Student perception of how much strategies contributed to science results in December 1999 (n=24)

Strategy/tool	General learning strategies booklet	Summarising mind map or spider maps	Picking main ideas from text	Summarising idea organisers	Linking ideas concept map	Setting goals Test planner	Setting priorities Planner	Test importance Planner	Planning study time Planner	Asking for help C.L. Chart
Strategy no.	1	2	3	4	5	6	7	8	9	10
Mean	2.2	3.2	3.2	2.5	2.3	2.0	2.5	2.8	2.5	3.2
No. students rating 4 or 5*	2	12	12	8	5	3	6	8	6	8
No. students rating 1**	5	5	2	6	9	10	7	4	10	0

Strategy/tool	Check understanding C.LC	Break revision into sections	Rewarding after studying	Spreading study Booklet	Staying calm Discussions SLS booklet	"Splash down" SLS booklet & discussion	Doing easy questions first SLS booklet discussion	Guess before choosing. SLS booklet & discussion	Learning from test Errors sheet	Using unit objectives SLS booklet & discussion
Strategy no.	11	12	13	14	15	16	17	18	19	20
Mean	3.1	3.1	2.8	2.9	3.3	2.3	3.1	2.9	3.6	4.1
No. students rating 4 or 5	6	8	7	6	10	4	7	6	11	13
No. students rating 1	4	2	3	6	2	12	3	6	1	0

* Has helped results a lot

**Has not helped results

<u>Question 4</u> Overall effect of SLS course on science results

Question four asked students "overall, how much would you say the SLS work we have done has affected your science results on average during the year?" Student responses fell into the percentage groups 5% (4 students), 10% (5 students), 20% (6 students), 25% (2 students) and 30% (1 student). Only two (8.3%) of the 24 students who completed this questionnaire responded that the course "had no effect on my marks". No-one considered the course had made their marks worse.

Forty five percent of the students who answered this question considered that the SLS course had improved their science results on average during the year by 20% or more, 40% of students received that their marks had improved between five and 10 percent, as a result of completing the SLS course while only two students (10%) considered that the course had had no effect on their results. Four students did not respond to this question.

As previously mentioned, the researcher decided to follow in-depth the progress of one student from each of the percentage groups they had nominated as being the extent of their improvement (5, 10, 20, 25, 30%) because of the program. One student from each group was chosen at random. If there was a lack of data for that student, another student was selected from within that percentage group. These students are referred to as the selected students.

<u>Question 5</u> Instances when SLS work helped in a particular test and the percentage by which students' marks improved as a result.Comments from the selected students in response to this question were encouraging

> The Chem (sic) test. I made a mind map and learnt a lot while making it. The test asked questions that I wouldn't have been able to answer if I hadn't made a mind map. It made a lot of difference – about 20%. (Lilly)
> The Check Your Learning Chart <u>always</u> helped me. (Bree)
> The objectives have helped me by about 5%. I can't think of any tests in particular. (Sophie)
> Remembering the phylum names using pneumonics. (Lara)
> The Chemistry test. The mind map helped by about 5-10%. (Karen)
> Bits of SLS have helped overall. No difference in marks. (Kylie)

Comments from other students

> On a test at the beginning of the year. A mind map I made really helped me by about 30%. (Sarah)
> When we used mind maps with colours and pictures. It worked by about 10%. (Steph)
> For every test I now write out notes and summarise ideas. (Alex)

For Chem (80%) and Animals. (Nicola)
It worked well – by 10%. (Tilly)
Can't think of any special ones but generally 5%. (Isabel)
It worked very well and improved in all tests by 20%. (Annabel)
It made a lot of difference – about 20%. (Robin)
The Chemistry test. I got 99%! (Ginia)
Remembering phylum names – 5%. (Louise)

There were no negative responses to this question although eight students left it blank. Overall, student responses to this question were very encouraging. Lilly's point that "I made a mind map and learnt a lot while making it" reinforces the value of this strategy. Mind mapping requires students to manipulate material cognitively, synthesize it and develop an overview of how the different concepts in a topic interrelate. Mind mapping involves students in using Gardner's visual/spatial intelligence (Gardner & Hatch, 1989), as well as logical/mathematical intelligence and thus caters for a broad range of learning styles.

8.2.4 December Interviews

Ten students were interviewed in December about the SLS intervention. Full transcripts are provided in Appendix 7.1. These students indicated that the SLS program had improved their results by the percentages given in Table 8.3.

Table 8.3 Improvement in scores due to the SLS program

Student	Percentage
Jemma	0
Isabel	5
Karen	10
Amanda	10
Brittany	10
Natasha	20
Lilly	25
Steph	30
Lara	30-40
Lauren	40

8.2.5 Student perception of usefulness of test strategies - The Test Taking Strategies Questionnaire

Test taking strategies were introduced to the students by reading through the relevant sections of the *Science Learning Strategies* booklet (pp. 28-32) and conducting several class discussions about the strategies, and the experiences of students using them.

In relation to Research Question 3b (student perceptions of the effects of the SLS course on academic performance), the students completed a Test Taking Strategies Questionnaire (Appendix 4.5) the day after completing a topic test in November. For each strategy, the students were asked whether or not they used a strategy in the most recent test and were prompted to explain why. The students were also asked whether or not they had heard of the strategy before it was discussed in class. The degree to which each strategy had helped with test results was probed on a scale of zero to five. On this scale, a score of zero indicated they had not used the strategy in the particular test, while a score of one indicated that the strategy hadn't helped and a rating of five indicated that a strategy had been a very big help in maximising test results.

The results are summarized in Table 8.4. The strategy 'Reading test directions' was used by every student in Class 5 and all students had heard of this strategy prior to reading about it in the *Science Learning Strategy* booklet. The students indicated an average rating of 3.2 on describing helpfulness of the strategy at improving test results.

Nearly everyone in the class used the strategy 'Checking test answers' and everyone had heard of it previously. The researcher expected that these two strategies would be well used by students and that students would have been aware of the strategies by the start of Year 8.

Most students (81%) had heard of the strategy 'Answer easy questions first' before they read about it, while only 63% used it in the test. This strategy received a mean score of 3.1 on the scale measuring 'helpfulness with test results'.

A majority (59%) of students had not heard of the strategy 'Guess before you choose' and despite covering it in class, only 37% of students used it in the test. The mean helpfulness score was 2.3 which indicates that it had proved to be of some value for the students who used it. This average (2.3) was also returned for the 'Highlighting key ideas' strategy and while 79% of students had heard of this strategy, only 55% of the students used it.

The simple fact of knowing about a strategy does not imply that it will be used. The objective of the SLS intervention was to expose students to a range of strategies so that they could experiment and find out which ones best suited their learning style. The utilisation of the different test taking strategies is influenced by a number of factors such as level of knowledge about the strategy, student preference, the amount of time available during the test, the nature and content of the particular test, test preparation style and student confidence. Any helpfulness score over the value of one indicates that the strategy had been of some benefit.

Table 8.4 Test taking strategy use for Class 5 (n=24)

Strategy	Percentage (%)				Mean on scale 1-5
Splash Down	Use Splash Down Yes	Use Splash down No	Heard of Splash down Yes	Heard of Splash down No	How helpful n=6
	10	90	15	85	1.7
Highlight key ideas	Use highlighter Yes	Use highlighter No	Heard of highlighting Yes	Heard of highlighting No	How helpful n=15
	55	45	79	21	2.3
Guess multiple choice	Use guess? Yes	Use guess No	Heard of guess Yes	Heard of guess No	How helpful n=10
	37	63	41	59	2.3
Answer easy questions first	Use easy answers Yes	Use easy answers No	Heard of easy answers Yes	Heard of easy answers No	How helpful n=14
	63	37	81	19	3.1
Check answers	Use check answers Yes	Use check answers No	Heard of check answers Yes	Heard of check answers No	How helpful n=17
	94	6	100	0	3.5
Read test directions	Use check directions Yes	Use check directions No	Heard of check directions Yes	Heard of check directions No	How helpful n=17
	100	0	100	0	3.2
Staying calm	Worrying thoughts Yes	Worrying thoughts No	Heard of staying calm Yes	Heard of staying calm No	How helpful n=15
	58	42	74	26	2.2

For the ‘Staying calm’ strategy, students were asked whether or not they had had any worrying thoughts in the test. If they had worrying thoughts, they were asked to describe what strategies they had used to help stop the negative thoughts and also, where, or when, they learnt these strategies. Fifty eight percent of students indicated that they did experience worrying thoughts during the test. The strategies used to stop negative thoughts proved somewhat effective, with a mean of 2.2 on the helpfulness scale. Some students described using breathing techniques and several attempted to challenge negative thoughts.

The strategy that was least familiar to the students was the ‘Splash down’ technique in which several minutes are taken by a student at the beginning of a test to write, and/or draw, a skeleton of the knowledge they have, which is relevant to particular questions. This strategy can be helpful because students then don't need to worry about forgetting to include the material. The six class members who used this technique rated it an average of 1.7 on the helpfulness scale. In the framework of the series of short 40 minute science tests completed in Year 8, it may be that students felt this strategy was too time consuming. One student commented "It would be a waste of time because I remember the stuff I would have written down". This strategy is much better suited to essay writing exams of extended duration where it is reassuring for the candidate to get memory prompts down on paper.

8.2.6 Test taking strategies used by selected students

Bree

Bree used a highlighter (Table 8.5) when reading test questions and rated this a four on the scale of one to five, indicating helpfulness. She also answered easy questions first (rated three for helpfulness), checked her answers (rated four) and read the test directions (rated four). Bree did experience negative thoughts during the test and challenged these thoughts using techniques she attributed to learning in the SLS course.

Amanda

Amanda used a highlighter (rated two, answered easy questions first (rated two), checked her answers (rated three) and read test directions (rated three). Amanda did not have worrying thoughts during the test.

Karen

Karen used a highlighter (rated four), answered easy questions first (rated three), checked answers (rated five) and read test directions (rated five). She did not experience worrying thoughts during the test.

Lilly

Lilly used a highlighter (rating of four), used 'Guess before you choose' (rating of three), checked her test answers (rated four) and read test directions carefully although this was not helpful to her. Lilly did experience worrying thoughts during the test and found that the strategies learned in the SLS course had helped her test results (rated four).

Kylie

Kylie used a highlighter (rated three), answered easy questions first (rated five), and checked her answers (rated five). Kylie did have worrying thoughts during the test and gave a helpfulness rating of three for the strategies learnt to overcome this anxiety.

Sophie

Sophie used a highlighter (rated two), checked her test answers (rated 5) and read test directions (rated four). She did have worrying thoughts during the test and didn't find the suggested strategies helpful at all.

Lara

Lara used a highlighter (rated two), answered easy questions first (rated 3) and read test directions (rated two). Lara did have worrying thoughts in the test and didn't find the relevant strategies helpful.

Bree

Bree was the only one in this group of selected students who implemented a strategy (using a highlighter to identify key information in test questions) as a result of having learnt about it in the SLS course.

Two other class members began using the 'Answer easy questions first' strategy after learning about it in class. One student reported using 'Splash down', another started using a highlighter and a third began to use the 'Guess before choosing' strategy as a result of the SLS course.

8.2.6.1 Comments on test taking strategy instruction

In relation to student perception of the effectiveness of the SLS course in improving academic performance (Research Question 3a), the test taking instruction in the course appeared very limited in encouraging students to take up strategies they hadn't previously heard of. However, so little time was spent on learning these strategies that it was no surprise to find that so few students were using them. Students at the end of Year 8 probably had already identified strategies which suited them, and may have felt no need to try other approaches. Another possibility is that the SLS material may have reinforced and encouraged students to use Test Taking strategies they may have previously known about but not used. The instrument did not probe this possibility. In retrospect, test taking strategies should have been introduced earlier and more thoroughly in the SLS course.

Table 8.5 Test taking strategies used by selected students

STRATEGY					
Splash Down	Use Splash Down Yes	Use Splash down No	Heard of Splash down Yes	Heard of Splash down No	How helpful on a scale of 1-5
		Amanda, Karen, Sophie, Lilly, Bree, Lara, Kylie	Kylie	Amanda, Karen, Sophie Lilly, Bree, Lara	Sophie 1
Highlight key ideas	Use highlighter Yes	Use highlighter No	Heard of highlighting Yes	Heard of highlighting No	How helpful on a scale of 1-5
	Amanda, Kylie Karen, Sophie, Lilly Bree, Lara		Amanda, Kylie, Karen Sophie, Lilly, Bree, Lara	Bree	Amanda 2, Kylie 3, Karen 4, Sophie 2, Lilly 4, Bree 4, Lara 2
Guess multiple choice	Use guess Yes	Use guess No	Heard of guess Yes	Heard of guess No	How helpful on a scale of 1-5
	Lilly	Amanda, Kylie, Karen, Sophie, Bree, Lara	Kylie, Lilly	Amanda, Karen, Sophie, Bree, Lara	Lilly 3, Bree 1
Answer easy ques. first	Use easy answers Yes	Use easy answers No	Heard of easy answers Yes	Heard of easy answers No	How helpful on a scale of 1-5
	Amanda, Kylie, Karen, Bree Lara	Sophie, Lilly	Amanda, Kylie, Karen, Sophie, Lilly, Bree, Lara		Amanda 2, Kylie 5, Karen 3, Lilly 2, Bree 3, Lara 3
Check answers	Use check answers Yes	Use check answers No	Heard of check answers Yes	Heard of check answers No	How helpful on a scale of 1-5
	Amanda, Kylie, Karen, Sophie, Lilly, Bree	Lara	Amanda, Kylie, Karen, Sophie, Lilly, Bree, Lara		Amanda 3, Kylie 5, Karen 5, Sophie 5, Lilly 4, Bree 4, Lara 2
Read test directions	Use check directions Yes	Use check directions No	Heard of check direct. Yes	Heard of check direct. No	How helpful on a scale of 1-5
	Amanda, Kylie, Karen, Sophie, Lilly, Bree, Lara		Amanda, Kylie, Karen, Sophie, Lilly, Bree, Lara		Amanda 3, Kylie 5, Kare 5, Sophie 4, Lilly 1, Bree 4, Lara 2
Staying calm	Worrying thoughts Yes	Worrying thoughts No	How helpful on a scale of 0-5		
	Kylie, Sophie, Lilly, Lara	Amanda, Karen, Bree	Amanda 3, Kylie 3, Karen 0, Sophie 1, Lilly 4, Bree 0, Lara 1		

8.3 Summary of Section 8.2 - Response to Research Question 3a: Student perception of the effect of the SLS course on academic performance

In July, 55% of students indicated that mind maps helped their academic results to a moderate degree (a rating of 7 - 8). Moderate ratings were given by 50%, 28%, 71.5%, 54% and 54.5% for idea organisers, test planners, test feedback sheets, the

CLC and learning from test error strategies, respectively. Thirty percent of students indicated that mind mapping had produced no, or very little improvement (ratings of five or six) in their results. These ratings were also given by 44%, 64%, 14%, 36% ,43% and 43% for idea organisers, test planners, test feedback sheets, the CLC and the learning from test error strategy, respectively.

Test taking strategy instruction generally proved insufficient (as described in Sections 8.2.5 and 8.2.6) to improve perceptions of academic performance. No students indicated that the test taking instruction had detrimental effects on academic performance.

By December, student responses to a request for percentage test score improvements due to SLS program, fell into the percentage groups 5% (4 students), 10% (5 students), 20% (6 students), 25% (2 students), 30% (1 student), 30-40% by one student and 40% by one student. Only two (8.3%) students responded that the course "had no effect on my marks". No-one considered the course had made their marks worse.

8.4 Parent perceptions of the effect of the SLS course on academic performance (Research Question 3b)

Parent perceptions were measured by two instruments - the Parent Questionnaire and the telephone survey.

8.4.1 Parent Questionnaire

The Parent Questionnaire (Appendix 3.2) was administered at the start of the year although the planned December version was not conducted. Because of this, the parent perceptions of effect of the SLS program on academic performance were not measured by this instrument. The results however, are useful to compare with student responses in the February Student Questionnaire.

<u>Question 6</u> Parent perception of Year 7 science performance

This question, relating to Research Question 3b, investigated parent perceptions of their daughter's science results in the previous year (Figure 8.5). Reflecting the pattern of the February Student Questionnaire, parents of students in Classes 1-4 rated their daughters as achieving better science scores than did parents of students in Class 5. Thirty eight percent of parents of Class 5 students rated their daughters as achieving science marks at or below 70% during Year 7, while only

23% of parents of students in Classes 1-4 did so. Forty percent of parents of students from Classes 1-4 considered their daughters' results were above 80% while only 26% of Class 5 parents perceived this.

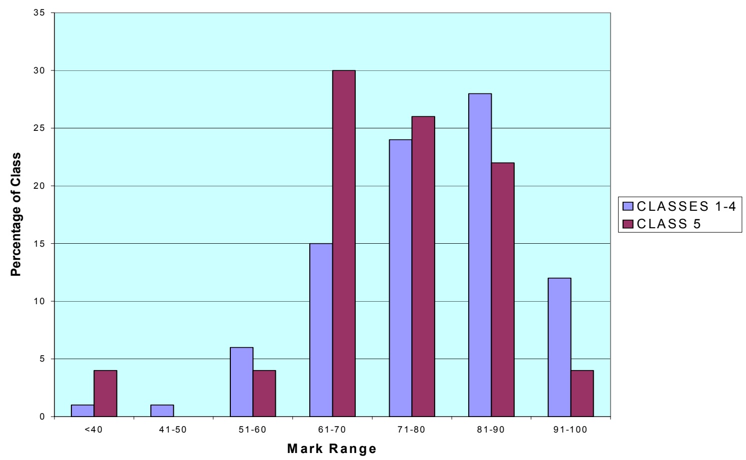


Figure 8.5 Parent perception of Year 7 science test scores in Classes 1-4 and Class 5 in February 1999

8.4.2 Parent Phone Survey

The parents of 21 students were interviewed by telephone in December (as described in Chapter 6. Question four of the Parent Phone Survey (Appendix 6.3) relates to Research Question 3b, which probed the perception of parents of the effect of the SLS program on student academic performance in science. The question asked parents how much effect they considered the SLS course had on their daughter's science results.

Four parents did not respond to this question and six did not know if there had been any effect. Kylie's parent considered the course had a very positive effect on her science results (the parent chose a rating of five on a five point scale). Parents of four students were quite positive (rating of four) about the academic impact of the program (including the parents of Bree and Lara). Two parents believed the intervention had moderately improved their daughter's results (ratings of three). Lilli's parent reported "some" effect and Karen's parent noted that her results were "always very good". One other parent felt that her daughter's science results were "staying steady".

8.5 Summary of Section 8.4 - Responce to Research Question 3b: Parent perceptions of the effect of the SLS course on academic performance

In answer to Research Question 3b, the parents of eight students (38% of those interviewed) believed that the SLS had a positive effect on their daughter's performance in science. Several of these parents reported very positive effects. No parents mentioned that the SLS program had caused a drop in science performance.

8.6 Teacher perceptions of the effect of the SLS course on academic performance in science (Research Question 3c)

Question 3c asked what perceptions of the effects of the embedded learning strategies course on student science achievement are held by the teacher/researcher.

The teacher's perception of the academic performance of the students was formed by examining their science achievement. Science achievement for the year was measured as an average percentage of the marks achieved over five topics. Grades allocations were based on the average percentages achieved by the students.

Each topic mark was derived from a mini-feedback test (20% of the final mark), a major end of topic test (70%) and a mark for class-work (10%). For students in Classes 1-4, the class-work included assignments and practical laboratory work. For students in Class 5, the class-work included learning strategy tasks such as test planning and feedback sheets, dot point note-taking, and constructing mind maps.

A sixth topic (Biology 2) was completed at the end of the year. Results for this topic were not included in the final mark for 1999, although these marks were considered when grouping students into classes for the following year.

8.6.1 The distribution of final grades

The distribution of final grades for the five Year 8 classes is given in Table 8.6 and shows that Class 1 students had not performed as well as the students in the other four classes. None of the students achieved an A+ and 14 of the 26 students (54%) received a C grade or lower. It was surprising to find such a distinctive difference in performance because the classes were arranged to be heterogeneous. Class 5 students were awarded three A+ grades against an average of 1.8 A+ grades for Classes 1-4. Class 5 students received slightly fewer (by 0.8) A grades than the average of 7.8 awarded to students in Classes 1-4. However, Class 5 students achieved ten B grades compared to the average of 7.2 received by students in Classes 1-4. Twenty Class 5 students received a grade of B or better while an average of 17 students in Classes 1-4 achieved grades in this range. Fewer students in Class 5 received the lower C and D grades than the mean for the rest of the Year group. An average of nine students in Classes 1-4 received grades C or D while only five students in Class 5 received these lower grades. From these results, the researcher formed the view that the SLS course appears to have had some positive effect on students grades although there was no statistically significant difference in percentage terms ($t = -1.183$, $\alpha = 0.05$).

Table 8.6 Distribution of grades in Classes 1-5 at the end of 1999

	Grade				
Class	A+	A	B	C	D
8sc1 (n=26)	0	4	8	12	2
8sc2 (n=26)	3	13	4	6	0
8sc3 (n=25)	2	10	5	8	0
8sc4 (n=26)	2	4	11	8	0
8sc5 (n=26)	3	7	10	5	0
Mean number of each grade for classes 1-4	1.8	7.8	7.2	8.5	0.5

8.6.2 Topic scores and final percentages

Table 8.5 shows topic scores and the final percentages achieved at the end of the year for Classes 1-4 and Class 5. Class 5 students achieved an average of 81.81 compared to the 79.25 average for students in Classes 1-4. This slight difference is not statistically significant ($t = -1.047$, $\alpha > 0.05$). However, as Porter (1988) argues, even though something is not statistically significant, for many individual students, it can be educationally significant.

Table 8.7 shows that Class 5 topic averages are slightly higher by between 1.5 and 4.2%, than Classes 1-4 in all but one topic. The Chemistry 1 result for Classes 1-4 was 0.6% higher than for Class 5.

Table 8.7 Mean scores for students in Classes 1-4 and Class 5

Class	Biology 1	Heat	Machines	Chem 1	Chem 2	Year Mean %
Classes 1-4	78.9	75.0	80.7	85.1	77.8	79.2
Class 5	80.5	77.2	83.5	84.5	82	81.8

In considering these results, the difficulty of each topic should be taken into account. The Class 5 and Classes 1-4 averages plotted in Figure 8.6 show that the results for students in Classes 1-4 and in Class 5 reflect the same pattern. The Heat test appears to have been the most difficult while the best performances were on the Chemistry 1 test. The Biology 1 and Chemistry 2 tests produced similar results. The Machines topic resulted in scores midway between the Biology 1 and Chemistry 1 topic.

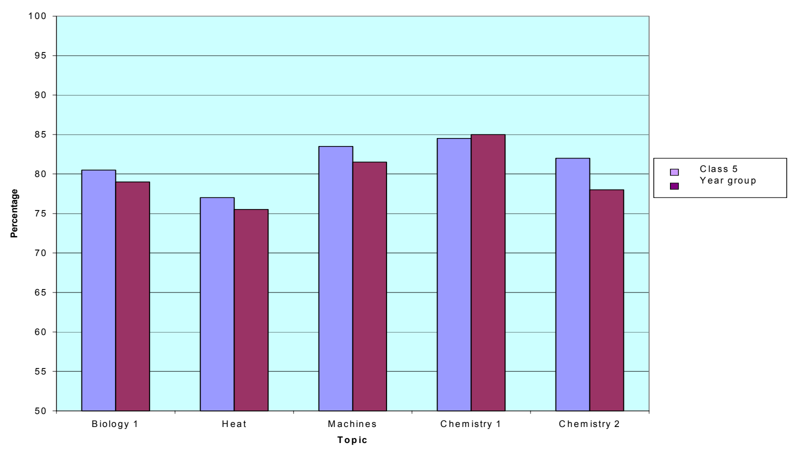


Figure 8.6 Comparison of topic scores (%) for Class 5 and the rest of the Year group (Classes 1-4)

8.7 Summary of Section 8.6 - Response to Research Question 3c: Teacher perceptions of the effects of the SLS course on academic performance

In review, the teacher/researcher's perception of the effect of the SLS course on academic performance was that more students in Class 5 achieved higher grades (20 students achieving a B grade or better) than did the students on average in the remainder of the Year group (16.8 B grades or better). While not statistically significant, this is an encouraging trend. Students in Class 5 had a slightly higher mean final year percentage than did students in Classes 1-4, although this was not significant ($t = -1.047$, $\alpha = 0.05$). These performances indicate that, at the very least, student participation in the SLS program has not been detrimental academically.

8.8 Summary of Chapter 8 - Response to Research Question 3: Student, parent and teacher perceptions of the effects of the Science Learning Strategies program on academic performance

At the end of the year, of the 22 students in Class 5 that responded to a request for a perceived percentage change in science test scores because of participation in the SLS course, 4 students suggested a percentage improvement of 5%. Other ratings of 10%, 20%, 25%, 30%, 30-40% and 40% improvement were given by 5, 6, 2, 1, 1 and 1 students respectively. Only 2 students responded that the program had no effect on their marks. No-one felt that their marks had been made worse. These responses indicate that most students did perceive some positive effect of the SLS course on their science marks and 23% of students perceived that it had produced major positive influences on their marks (25% or more improvement).

A substantial proportion of parents (38% the 21 interviewed) believed student performance in science had been enhanced as a result of participation in the SLS program. Several parents described major improvements, while no parents reported falls in academic performance caused by participation in the program.

Encouraging trends in academic performance of students were noted by the teacher/researcher, although these were not statistically significant. No students developed a negative trend in academic performance over time.

Overall, in triangulating viewpoints about Research Question 3, both students and parents perceived gains in academic performance in science as a result of student participation in the SLS program. The teacher/researcher however found no statistically significant effect.

Chapter 9

Student, parent and teacher perceptions of the effects of the SLS course student performance attribution: Response to Research Question 4

9.1 Introduction

The term performance attribution refers to students defining causal explanations for their performance. Most students, at some point in their schooling, are disappointed with aspects of their academic performance. For students achieving less than their desired results in science, it is less harmful for students to blame factors that are under their control such as poor learning skills or low effort, than blaming low innate ability (Nauta, Epperson & Waggoner, 1999; Weiner, 1983). The SLS program aimed to produce in students a greater feeling of control over their science performance through training in goal setting and in how to attribute performance realistically. It was hoped that students would increasingly feel that they had control over some aspects of their science performance, so that their perceived competence, performance and motivation would be enhanced.

This chapter reports on the perception of students, parents and teachers of the effect of the SLS program on performance attribution. Sections 9.2 and 9.3 relate to student perceptions, Sections 9.4 and 9.5 relate to parent perceptions and Sections 9.6 and 9.7 detail teacher perceptions. Section 9.8 contains a summary of the Chapter and a response to Research Question 4.

9.2 Student perception of the effect of the SLS course on performance attribution (Research Question 4a)

Student perceptions were measured by two instruments –the November Tools for Learning Questionnaire and the Student Questionnaire.

9.2.1 November Tools for Learning Questionnaire

Questions 8-10 in the November Tools survey were open-ended to allow students to explain their answers more fully. The questions asked were:

Question 8 Effect of the SLS course on clarifying understanding of reasons for results

Question 9 Effect of the SLS course on increasing feelings of confidence in science

Question 10 Effect of the SLS course on increasing feelings of control of performance in science

Student responses are presented in Table 9.1. Many of the students gave a rating from one to five, where five is the most positive response, and one indicated that there was no benefit.

Table 9.1 Student responses to questions 8-10 of the November Tools for Learning Questionnaire

Student number	Q 8 Has the SLS course helped you understand why you get results?	Q9 Has the SLS course made you feel more confident?	Q10 Has the SLS course made you feel more in control of your performance?
Lara	I understand what I have done wrong - 5	Yes, I understand how to understand -5	5
Lilly	3	5	4
Karen	4	3	4
Bree	Yes because I see that study always helps and with SLS I know how to sudy	Yes because I know it is helping me to do better and helping understand how to study	Yes, because now I know that I can study more easily, so I am more confident about my results
Sophie	No, because I don't use much of it except for the objectives	Not really see Question eight	It helped because I knew what would be in it (objectives) but not otherwise.
Amanda	3	3	4
Kylie	Sort of . When I fill in the Reasons for Errors chart, it makes me think why I got things wrong or right – 3	Some of the activities, like Splash Down, I can't do and then I get worried because I can't do it	Not really, because I worry about handing in mind maps and things on time that I don't have much time to study
Tilly	Yes, it makes me think more about the questions I got wrong –4	Only a small amount -2	It has made me try harder when I study for tests.
Nicola	If you get a bad mark, then just by looking at the sheet, you can see why you got it wrong –3	Yes it makes me feel more confident - 5	Yes, it gave me more of an understanding about the topic - 4
Natasha	Yes because by doing the mind maps, it has shown me how to select appropriate info and not waste my time on things not important	Yes, I learned how to stay calm and do what I know.	Yes, by doing all of these extra activities, I feel that I am in charge of my marks
Robin	Yes, it shows me how to work better -3	Yes, I have more confidence because I feel that I have more skills to use	Yes, in some ways, it helped me study more
Annabel	Yes, I think if I got a wrong answer then it was because I didn't study and that if I got a good mark I studied well	It has helped, some things	It has made me understand importance
Sarah	Yes, because I understand the course and what is expected of me	Yes, now I feel better about going into a major test	Yes because I can organise myself
Ginia	3	2	No response
Gabby	It hasn't really given me more of an idea of why I get the results I get. It just helps me prepare for the test and during the test	No, I am still nervous when going into a test and I worry about handing in maps on time	I think it has in a way. I study more before a test so I'm not as nervous

Table 9.1 continued

Brittany	3	4	4
Louise	I normally don't not know an answer, I just get silly mistakes	4	3
Isabel	It has helped me with the errors sheet	Not really, I felt confident before	It's helped me study more
Hannah	4	Sometimes	
Alex	Yes because I didn't know there were different strategies I could use to help me. When I did, they helped me	About the same, but I know how to study well now and how I like which is good	Yes, because if I study hard I can improve my results.
Steph	4	3	3
Stephanie	No, the SLS doesn't help me understand it better	I'm still stressed about some tests, but knowing the techniques that we have learned has been helpful	Sort of, I feel more organized with the SLS techniques
Jemma	Because it was annoying doing it so I didn't give my best work for it.	Because it helped me a bit -3	No because I haven't really paid attention to it
Lauren	3	4	4

Note: Students responding to these questions sometimes limited their response to a number on a scale from one to five (where five is the most favourable response) because they were used to doing so in other questionnaires. Other students gave only statements and some students gave both.

In responding to Question 8, six of the 24 students answered "yes" directly and four students implied "yes" through the phrasing of their responses e.g., "when I fill in the Reasons for Error chart, it makes me think why I got things wrong or right". Four students simply provided a rating of four, presumably implying that the course had helped them a lot to understand why they got their results.

Four students provided a rating of three indicating moderate support for the assertion that the SLS course had helped them understand why they got their results. For the 13 students who provided a scale rating, the mean was 3.5. indicating an overall favourable response.

Only two students gave negative responses to this question. Stephanie said the course didn't help her understand why she got her results and Jemma commented that it was "annoying doing it so I didn't give my best work for it". Jemma did not really address the question with this response. Overall though, the responses to Question 8 indicated that the SLS course had helped students understand the reasons for their science results. The positive responses to Question 8 are encouraging. Students generally found the strategies helpful in explaining their science performance, consequently giving them the opportunity to change or modify learning behaviour rather than feeling helpless.

In responding to Question 9, relating to confidence levels, 11 students responded simply with a rating value. Of these, two students gave a strongly positive rating of five in response to this question, three students responded with a rating of four and four students responded with a rating of three. Six students answered “yes” to the question and provided explanatory detail. Lara’s response that “I understand how to understand“ was most gratifying. This phrase was the motivating ideal in the development and implementation of the SLS program. Four students replied “not really” or words to that effect, and two student provided a rating of two indicating that the course had offered a small benefit to them in terms of improving confidence.

Only two students responded in a negative way to this inquiry. Kylie replied that “some of the activities like ‘Splash down’, I can’t do and then I get worried because I can’t do it.” Gabby said that “No. I am still nervous going into a test and I worry about handing in maps on time”. For the 11 students who provided a scale rating, the mean was 3.9 indicating a good level of acceptance of the value of the strategies in improving confidence. Overall, in response to Question 9, 18 of the 24 students considered the SLS course had a positive effect on their confidence in learning science.

In response to Question 10 relating to control of performance Lara responded with simply a rating of five. Four other students responded with a rating of four and two students provided a rating of three. Six students answered “yes” and provided explanatory detail e.g., Natasha commented that “by doing all of these extra activities, I feel that I am in charge of my marks”.

Several students reported positive effects on motivation. For example, Tilly remarked that “it has made me try harder when I study for tests”. Six students implied slight to moderate support for the program e.g., Stephanie commented “sort of, I feel more organised with the SLS techniques”. Two students expressed negative feelings about the value of the course in helping them to feel in control of their learning. Jemma replied “no, because I haven’t really paid attention to it” and Kylie said “not really, because I worry about handing in mind maps and things on time that I don’t have much time to study. Both of these students had also responded negatively to either Question 8 or 9.

In response to Question 10, 20 of the 24 students indicated that the SLS course made them feel more in control of their science performance.

9.2.2 Student Questionnaire - February and December

This questionnaire provided information addressing Research Question 4a.

Question 6

Students were asked about their level of satisfaction with their performance during science tests, and also the factors they ascribe their performance to (attribution).

Performance attribution is very important. It has been demonstrated (Nauta, Epperson & Waggoner, 1999) that, after controlling for academic ability, female students who attribute their science results to factors they can control, such as effort and study strategies, are more likely to continue their science studies than are students who attribute the cause of their mistakes to their own perceived lack of ability. One intention of the intervention was to increase student's sense of control over their science performance, so that they would persist at attempting to maximise their performance and participation in science.

Figure 9.1 compares the Student Questionnaire responses of students from Classes 1-4 and Class 5 at the beginning of the year. Sixty four percent of students in Classes 1-4 indicated that they usually got the test result that they wanted during Year 7. By contrast, only 46% of students in Class 5 felt this way about their results from the previous year. The number of students who were dissatisfied with their results (they usually did not get the results they wanted) was similar in both groups (between 15 and 20%). Twice as many Class 5 students (30%) than Classes 1-4 students indicated that they only sometimes got the results they wanted.

Patterns of attribution were similar for the two groups at the beginning of the year. In both groups, few students (around 8%) rated themselves as having natural science ability. A greater proportion (around 15%) of students in both groups indicated that they didn't have much science ability. Many more students (from both groups) attributed their results to the fact that they put as much effort as possible into their science study, a common pattern for girls. Fifty eight percent of students in Classes 1-4 held this view compared to 50% of students in Class 5. Numbers of students claiming to have put in little effort were quite low (8% of Class 5 students and 11% of students in Classes 1-4). The proportion of students satisfied with their facility with learning strategies and habits in Classes 1-4 in February was 25% and 27% for students in Class 5. Eight percent of Class 5 students and 11% of the rest of the year group claimed to have poor study strategies and habits.

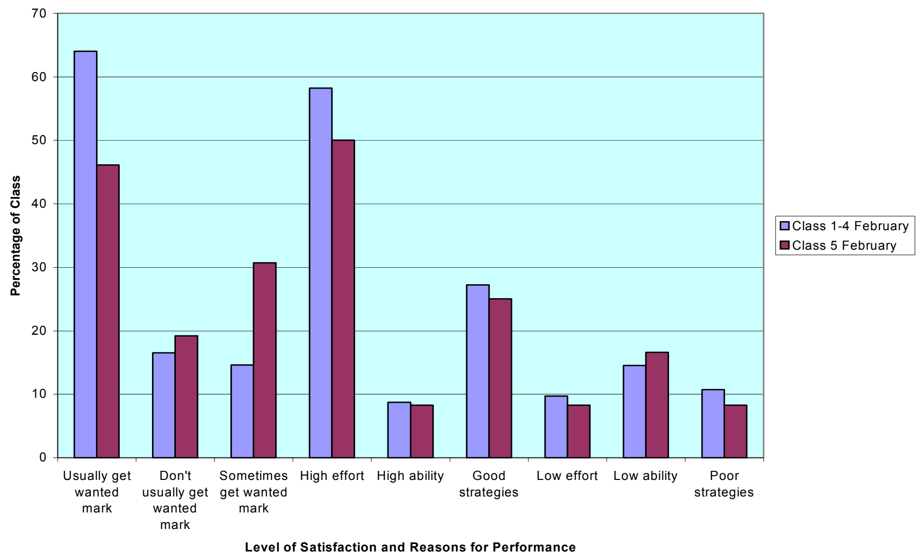


Figure 9.1 Satisfaction and attribution for Classes 1-4 and Class 5 in February

Over the year, the level of satisfaction with results of Class 5 students rose dramatically from 46% at the start of the year to 78.5% in December, as shown in Figure 9.2. The proportion of dissatisfied students (who usually did not get the results they wanted) fell from 19% to 7%. The proportion of students who only sometimes achieved the results they wanted dropped from 30% to 14% over the year.

Class 5 performance attributions also changed considerably by the end of the year. In December, more students considered themselves to have natural science ability (a rise from 8% to 14%). The number of students claiming that they did not have good study strategies and habits fell from 8% to 0% by December. The proportion of Class 5 students confident about their learning skills, rose from 25% to 35.5% in December. The percentage of students attributing disappointing results to low ability fell from 18% to 7% by the end of the year. At both the beginning and end of the year, 50% of Class 5 students indicated that they put in a high degree of effort.

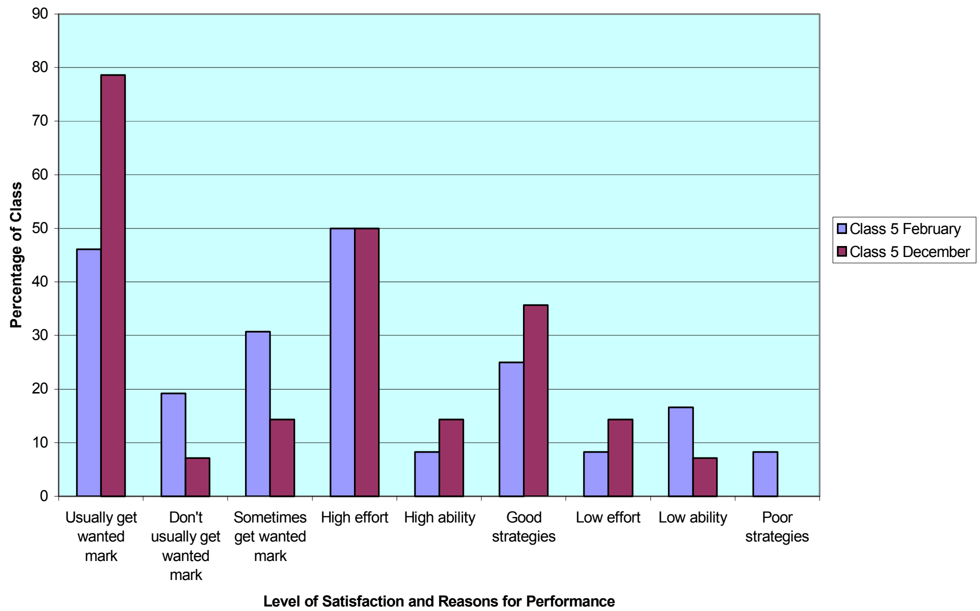


Figure 9.2 Satisfaction and attribution for Class 5 in February and December

By contrast, students in Classes 1-4 showed small variation over the year in their level of satisfaction with their results (Figure 9.3). The proportion of students indicating that they usually got the results they wanted only rose slightly from 64% to 67%. (By this time of the year, 78.5% of Class 5 students were expressing satisfaction with their test results.) The proportion of students in Classes 1-4 dissatisfied with results rose by five percent, while the level of dissatisfaction with results for students in Class 5 fell by 14% over the year.

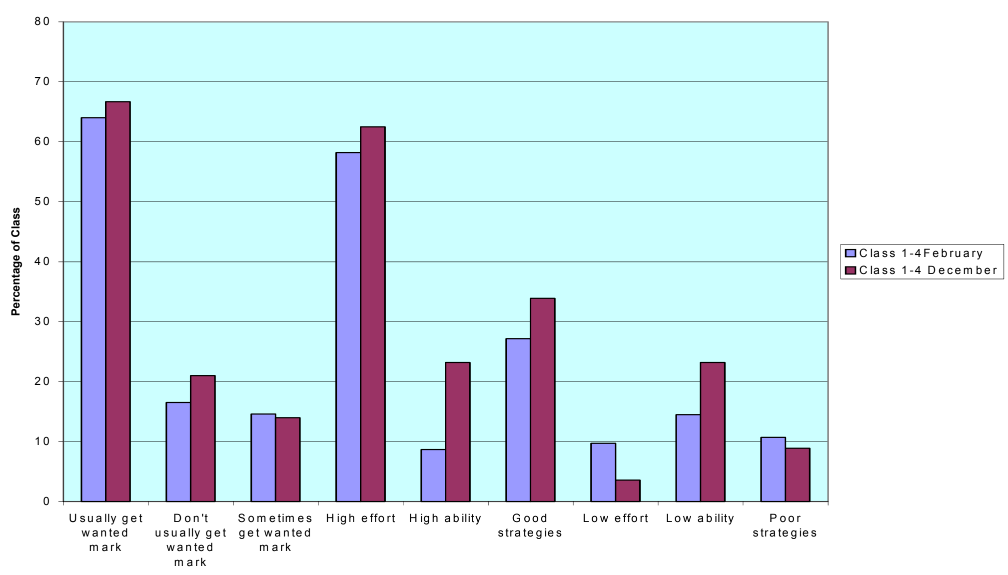


Figure 9.3 Satisfaction and attribution for Classes 1-4 in February and December

By December, more students in Classes 1-4 attested to putting in maximum effort, 62.5%, while in February, 58% did so. There was an increase from 27% to 34% in the number of students indicating that they had good strategies and habits for studying (similar to the improvement in Class 5). The percentage of students in Classes 1-4 responding that they have natural science ability rose from 8.5% in February to 23% by the end of the year. As mentioned previously , the proportion of students in Classes 1-4 attributing disappointing results to low ability rose by 7% whereas it decreased by 11% for students in Class 5.

The differences between Classes 1-4 and Class 5 at the end of the year are illustrated in Figure 9.4. In December, the proportion of students in Class 5 who were satisfied with their test performance (78.5%) was more than 10 percent higher than for Classes 1-4. As mentioned previously, fewer Class 5 students expressed dissatisfaction with their test results (7% of Class 5 students compared with 21% of students in Classes 1-4.) Similarly, fewer Class 5 students (50%) attributed their test performances to putting in a high level of effort, compared to 62.5% of students in Classes 1-4. The proportion of students in Class 5 indicating that they had not put in enough effort was 10% higher (14.5%) than the proportion of students in Classes 1-4. No Class 5 students considered that they had poor learning strategies, while 9% of students in Classes 1-4 believed this to be the case.

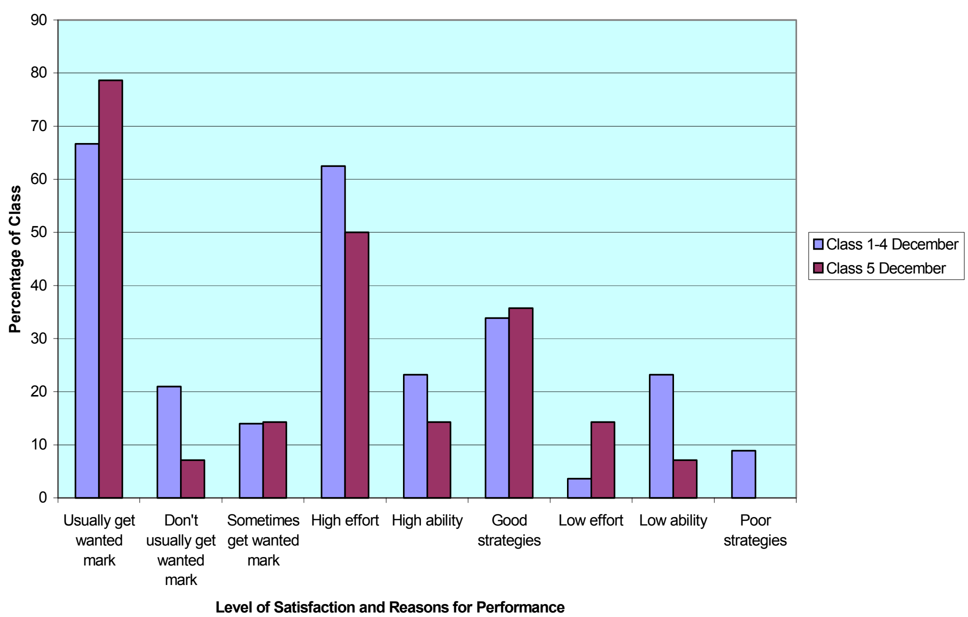


Figure 9.4 Satisfaction and attribution for Classes 1-4 and Class 5 in December

A similar proportion (around 35%) of students in both groups indicated that their learning strategies had improved by December. Fewer students in Class 5 (7% compared to 23% for students in Classes 1-4) indicated that they didn't have much science ability.

9.3 Summary of Section 9.2 - Response to Research Question 4a: Student perception of the effect of the SLS course on performance attribution

The intervention appears to have contributed to some positive changes in student perceptions of ability and performance attributions of Class 5 students, revealed by both the November Tool for Learning Questionnaire, and the December Student Questionnaire. A major increase in satisfaction with science performance occurred and perceptions of ability and learning strategy competence increased over the year. Attributions of success to good learning strategies rose by 11%. Effort attributions remained steady in Class 5 students. Attributions to low ability fell considerably (from 18% to 7%). These figures are pleasing as intentions of the intervention were to increase level of satisfaction with performance in science and to encourage students to attribute performance to governable learning strategy competence rather than to low ability. (Students were already demonstrating high degrees of effort.)

As described, the same responses were not observed for students in Classes 1-4. Effort attributions started high and increased slightly over the year to be about 12% higher than for Class 5 students. Attributions to low ability rose from 15% to 23%, while dropping from 18% to 7% for Class 5 students. Level of satisfaction with science performance only increased by two percent and was lower by 13% than the Class 5 mean in December. Level of dissatisfaction rose by 4% for students in Classes 1-4 by December whereas it dropped by 8% for students in Class 5. Attributions of success to good learning strategies did improve over the year to reach 34%, similar to the level for Class 5 students.

9.4 Parent perception of the effect of the SLS course on performance attribution (Research Question 4b)

This question was investigated with two instruments – the Parent Questionnaire and the Parent phone survey.

9.4.1 Parent Questionnaire February

Question 7

Parents from all Classes were asked to describe their daughters' belief about their science performance and to suggest causal explanations their daughters' might hold for their science results.

As shown in Figure 9.5, fewer Class 5 parents (30%) considered that their daughters were satisfied with the science results they got in Year 7 than did parents of students in Classes 1-4 (46%). This deficit reinforces the finding of the February Student Questionnaire that 18% more students in Classes 1-4 were satisfied with their end of Year 7 science scores than were students in Class 5.

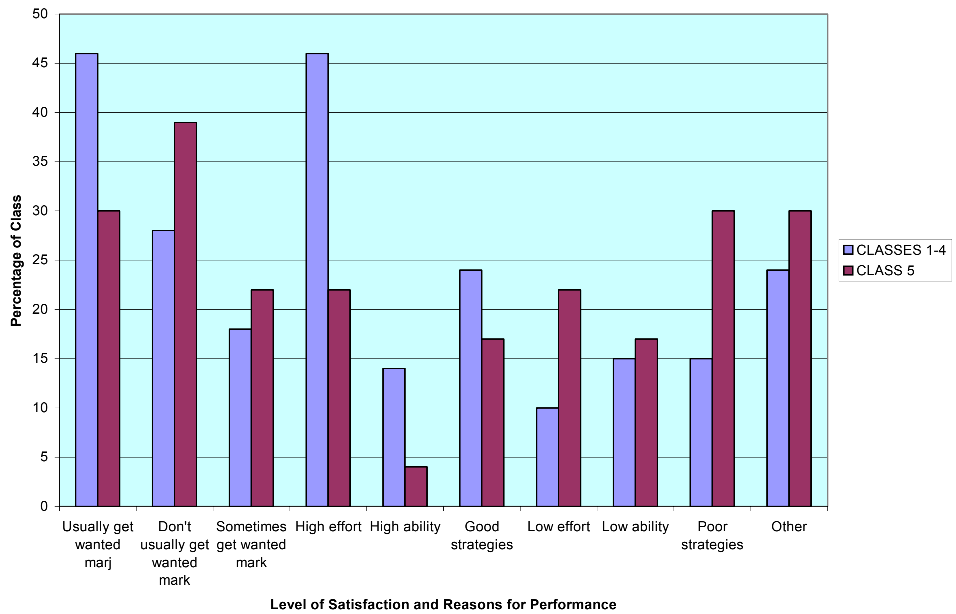


Figure 9.5 Parent perception of end of Year 7 attributions for science performance in Classes 1-4 v 5 in February 1999

Thirty nine percent of Class 5 parents believed their daughters were dissatisfied with the previous year's science performance while only parents of 28% of students in Classes 1-4 thought so. Parents of Class 5 students describe their daughters' explanations for pleasing Year 7 science results as being much less positive than parents of students in Classes 1-4. The differences were that 22% fewer parents of Class 5 students believed they put in as much effort as they could (versus 46% for parents of students in Classes 1-4), 10% fewer credited themselves with having high ability (4% against 14%) and 7% fewer (17% compared to 24%) considered they had good strategies and habits for studying.

Parents of Class 5 students describe their daughters' explanations for disappointing Year 7 science results to be much more negative than parents of students in Classes 1-4. Parents indicated that 12% more Class 5 students than students in Classes 1-4 believed that they don't put in enough effort (22% versus 10%), 2% more (17% against 15%) believe that they don't have much science ability and 15% more (30% compared to 15%) think that they don't have good study strategies and habits.

9.4.2 Phone Survey

Questions 6 and 7 of the Parent Phone Survey sought information relevant to Research Question 4b. This research question examines parents' views about the effect of the intervention on student perception of reasons for achievement of their results (ie. performance attribution).

Question 6

Parents were asked what their daughters would have blamed for any disappointing science results in Year 7. Two parents did not answer this question; two parents said their daughters always got good results; and two parents didn't know what their daughter attributed their performance to. Three parents indicated that lack of effort would have been blamed for disappointing results in Year 7; two parents felt their daughters would have blamed carelessness in the past; and one parent said her daughter did not do tests in Year 7.

No one believed their daughters would have blamed disappointing results in Year 7 on poor learning strategies. Nine parents (45%) reported that their daughters would have blamed poor performance in Year 7 on a lack of ability. This large proportion is worrying. As mentioned earlier (Nauta, Epperson & Waggoner, 1999), girls are more likely to apply themselves in science if they attribute their science results to factors they can control, such as effort and study strategies, rather than to innate ability.

Question 7

Parents were asked if there had been any change over the year in what their daughters attributed their results to as a result of the intervention.

Sophie's parent did not answer this question. Robin's parent said that she didn't have tests in the previous year, but was now likely to blame disappointing results on a hard paper (a factor outside her control). Two students (Lara and Jemma) were believed to blame causes outside their control (i.e., lack of ability) at both the beginning and end of the intervention.

Another student Steph, who is reported to have achieved a moderate improvement in science results, was thought by the parent to have blamed poor results the previous year on low ability. At the end of the year she was reported to be likely to say "I got a good mark, but I don't know how I got it".

Brittany's parent commented that her daughter believed her learning strategies got better over the year. Lilli's parent believed that at the start of the year she would have blamed poor performance on lack of ability, while by the end of Year 8 she would blame lack of preparation (i.e. a poor learning strategy) which is within the control of the student. Lilli's parent believed that her confidence and results had improved moderately because of the SLS program. Karens's parent stated that her daughter would change her attribution for any drop in results from lack of effort at the beginning of the year, to poor learning strategies (lack of planning) at the end of the year.

Several parents made comments attributing other affective changes noticed in their daughters to the SLS course. Three parents mentioned that their daughters felt more in control of their performance and more confident at the end of the year. One parent reported that her daughter had stopped saying "I'm stupid", (which she did say at the start of the year). Lara's parent said that if she doesn't understand she will now ask (seeking help was a strategy taught in the SLS course) and that she is much more confident. The parent also remarked that there was a 'cascade effect'. This meaning of this remark may have described a generalisation of the improvements to other aspects of their daughter's schooling.

Annabel's parent thought she had moved from blaming poor results on low ability to being "very happy, improved self-esteem. It (SLS work) has generalised to other subjects." Kylie's parents described her as very confident throughout the year, and continuing to attribute disappointing results to carelessness (a factor within her control). One student, Chris, was believed by the parent to have maintained her opinion that any disappointing results were due to lack of effort.

9.5 Summary of Section 9.4 - Response to Research Question 4b: Parent perceptions of the effects of the SLS course on performance attribution

The information from the Parent Questionnaire supports the results of the February Student Questionnaire in which Class 5 students were far less satisfied with their science performance in Year 7, less positive about the degree of effort put in and their ability and slightly less positive about the quality of their study strategies and habits than students in Classes 1-4. Overall, in the February Questionnaires, few female students and parents attributed results to high ability. A great majority indicated the belief that intense effort was the reason for their satisfactory results rather than high ability.

In reviewing responses to the parent phone survey question investigating attributions for results their daughters might have given at the end of Year 7, 45% of Class 5 parents indicated that poor performance in Year 7 would have been blamed on a lack of ability. Three parents (15%) indicated lack of effort would be blamed. No one believed their daughters would have blamed poor learning strategies. These results are disturbing, though not surprising for girls, and suggest the need for programs such as the SLS course to help students form more realistic causal explanations for their performance.

In the question relating to changes in attributions as a result of participating in the intervention, eighteen parents responded. Four parents (22%) indicated that at the end of the intervention, their daughters blamed factors outside their control (e.g. low ability, hard paper) for disappointing results. Two parents made positive, general comments not specific to the question. Six parents (33%) described their daughters as attributing results to factors under their control at the end of Year 8.

These results need to be interpreted with care. It is possible that positive changes in performance attribution were due to natural maturation even though the parents attributed them to the SLS course.

9.6 Teacher perception of effect of SLS program on performance attribution (Research Question 4c)

The SLS program aimed to encourage students' belief that science performance is partly determined by governable learning strategies. In doing this, perceived competence is maximised and students benefit in the affective domain of learning.

Interviews were conducted in February and December which yielded information relating to Research Question 4c. The teacher/researcher formed perceptions about the effects of the course on student attribution by considering their interview responses.

9.6.1 Student Interview February

Students were interviewed in groups of three or four as described earlier in this document. Responses to Question 7 provided information relating to Research Question 4c.

Question 7 Do you think that people can get better at understanding and remembering science ideas, or do you think you are born with a certain science ability?

This question examines student beliefs about the degree to which they can influence their science learning performance, given their innate ability. Responses were given by 15 students. Comments are reported in full.

> Some people are born smarter than others. You can get better at learning though. You can find out how to understand it more. For example, stuff you don't understand - you might learn to look it up in other books. A bit of each. Teachers teach you strategies although some work better than others. (Alex)

> A bit of each. Some strategies might be better than others and when you learn them you might do better. (Sophie)

> You can try harder, spend more time on it and listen in class. If they are doing all that and still not doing well, they could go to the tutoring centre. (Annabel)

> You can try harder, spend more time on it and listen in class. (Sarah)

> You can try harder, spend more time on it and listen in class. If they are doing all that and still not doing well, then they're stuck with it. (Amanda)

> You can try harder, spend more time on it and listen in class. If they are doing all that and still not doing well, they should concentrate on subjects they are good at. (Hannah)
>
> You can change. I'm learning more ways as I go from friends and relatives. (Chrissie)
>
> You can understand more if you try harder. (Bree)
>
> You could get 20% better. (Anna)
>
> Yes you could get 20% better. The teacher could show you better ways to learn. (Lilly)
>
> Yes, the teacher can help. (Lauren)
>
> Yes the teacher might help. She might tell you what to revise the day before and show other ways to study.(Louise)
>
> Yes, the teacher could show you different ways. (Steph)
>
> I think the teacher in my old school affected how I did (Natasha)
>
> I don't think I can get much better. Maybe if I highlighted more it would help. (Brittany)

These responses are pleasing in that students realised that it is possible to become better at understanding and learning science ideas. Interestingly, five students placed the responsibility for doing this on the teacher rather than on the student.

9.6.2 Student interviews in December

Weiner (1983) has contended that higher performance, perceived competence and motivation result from viewing academic success as personally caused and under student control. The character of performance attributions (causal explanations) also influences the students' emotional responses. The affective objectives of the SLS program were to shift to, or strengthen a belief in students that learning strategy competence is governable (personally caused and under their control) and that learning strategy facility can alter science performance. Secondly, the course was trying to improve perceived competence in science.

Nine students were interviewed in December. These students were selected on the basis of their availability at the hectic end of the year. The two students least supportive of the SLS program were interviewed. In these interviews, gains in perceived competence are indicated by a) gains in confidence in science and b) perceived improvement in science results (see Table 9.2). A shift in performance attributions to learning strategies which are personally caused and under their control (i.e., governable) is indicated in the interviews by students reporting increases in the sense of control they felt they have over their science performance.

Table 9.2   Interview questions used to determine achievement of affective objectives of the SLS course

Affective Objective	Measured by the questions :
To shift to, or strengthen a belief that learning strategy competence is governable (personally caused and under their control) and that learning strategy facility can alter science performance.	• Has the S.L.S program made you feel more in **control** of your performance in science?
To improve perceived competence.	• Are you more **confident** in science because of the SLS program? • What percentage have your marks improved because of the SLS program?

Full transcripts of the December Interviews are provided in Appendix 7.1. Extracts from the interviews follow

<u>Steph</u>

RE   Has the SLS work given you more confidence in science?

Steph   Yes it has, it's given me confidence that I can know and actually study more.

RE   Has it made you feel more in control of your performance in science?

Steph   I can control it better than I did but I still can't control it that well, not as well as I'd like.

RE   Now, just with improving your marks, can you give an impression of what percentage your mark has improved because of the SLS work?

Steph   Probably by 30 % or something

RE   You fairly sure about that?

Steph   Yes I think so, because last year I was pretty bad at science and this year I've done heaps better.

Steph indicated a moderate strengthening in the belief that she can personally control her use of learning strategies and consequently influence her performance in science. She expressed an increase in confidence and perceived a major improvement in her results (around 30%) implying that her perceived competence has been very positively influenced.

<u>Karen</u>

RE	Would you say that this work (the SLS program) has given you more of an idea about why you get the results you actually get?
Karen	A bit, probably a three.
RE	Why has it given you more of an idea?
Karen	If you've used your time wisely and you get a good result then you know it's that.
RE	Would this work have made you feel more confident in science this year?
Karen	Yeah, probably, because we worked really hard in class on how to use the summary and how to identify what are the key ideas. You feel confident that you're learning the right things.
RE	Would you say that the course has made you feel more in control of your performance in science?
Karen	Um, yeah probably, because you feel if you plan and spend the time summarising and actually learning the summary sheet, then you can get the mark you really want.
RE	You've said it's (SLS work) improved your marks by 10%. Do you feel that that's about right?
Karen	Yeah

Karen reported feeling more in control of her science performance and attributed this to improved learning strategies which allowed her to "get the mark you really want". She described an improved level of competence indicated by a perceived 10% improvement in science performance.

<u>Brittany</u>

RE	Has the SLS work given you more of an idea about why you get the results that you get?
Brittany	Yeah, sort of.

RE So if you get a good result do you know why you got it?

Brittany Yeah.

RE Would you say that the work has made you confident in science

Brittany Yeah , a lot more confident.

RE Is that because you feel you can plan better?

Brittany Yeah and also if I ask you before if the organisers are right and then I'm really confident that I'll go well.

RE Has the course made you feel more in control of how you are going in science.

Brittany Yes, same sorts of reasons, the planner and the mind maps particularly.

RE Overall, what difference has the SLS course made to your mark?

Brittany About 10%

RE You fairly sure about that?

Brittany Yeah.

Brittany reported feeling that the SLS course made her a “lot more confident” and explains that her increasing mastery of learning strategies has lead her to feel more in control of her science learning, and to have raised her perceived competence by about 10%.

<u>Natasha</u>

RE Has the course given you a better idea about why you get the results that you get?

Natasha Yes, it has because I know in my mind that I've learnt everything and so if I do badly, then I know because I wasn't paying attention too much in class when you were discussing more about something.

RE Can you give it a number out of 5?

Natasha 3 or 4

RE How much difference has the SLS course made to your confidence in science?

Natasha Four or five.

RE Can you explain why?

Natasha I've learnt summarising and I'm finding it just so much easier to learn and remember everything.

RE So you feel more confident? (nods) Why is that?

Natasha I know everything, and I learn easier.

RE Has the course made you feel more in control of your performance in science?

Natasha 4 - I know what I'm learning now and I'm more clear with all the things we've been taught and I'm understanding more because I'm using all these strategies and stuff. I can be in control of what I learn and what I put down in a test.

RE How much has the SLS affected your science results. Overall?

Natasha 10%

RE Can you tell me what made you say 10?

Natasha Well in the beginning I didn't really like summarising things but when I learnt how to take out information better, then I found it easier to study and so I knew more.

Natasha reported learning to attribute a disappointing test result to governable learning strategies. She reported increasing control of what she learns and how she performs in a test. Natasha believes she is understanding more because she's using "all these strategies and stuff."

<u>Lilly</u>

RE Has the course given you more of an idea about why you get the results that you get?

Lilly Yep, the Planners help because you know that if you've studied more you get better results.

RE Does it (indicate Planner) show up whether you are doing enough work or not, does it keep a more accurate tab of what you've actually done rather than what you think you've done?

Lilly Yeah, its good like that.

RE Has it made you more confident in science?

Lilly Yeah, a bit, about 3. Because of all the strategies and stuff, the mind maps. I'd rather do mind maps than concept mapping.

RE So if you hadn't done any of the work with me at all, do you think you'd feel as confident as you do now in preparing for tests? Do you think your own strategies would have done as well?

Lilly Probably not, my own strategies weren't very good.

RE What would you have been using?

Lilly Just notes, handwritten ones.

RE What would have been wrong with them?

Lilly It's hard to learn them.

RE Has the work made you feel more in control of your learning?

Lilly Yeah about 3 or 4 because it makes you do study.

RE What actually makes you study more?

Lilly The Planner things.

RE So you've been able to do those realistically?

Lilly Yep.

RE Overall affect on results?

Lilly Improved by 30%.

RE Think carefully about that.

Lilly About 25%

RE So you've found it really helpful?

Lilly Yeah.

Lilly has come to believe that improving her facility with the planners has led to improved results in science in the order of 25-30%. She commented that her original learning strategies (used before participating in the SLS program) “weren’t very good”.

<u>Amanda</u>

RE Has the SLS made you more confident in science?

Amanda I think it has. At the beginning of the year I wasn't very confident with science and I wasn't getting good marks compared to now when I've got the purple book (*SLS* booklet).

RE Has it made you feel you are in control of your science performance?

Amanda Yes, if I want to do better I know how to.

RE Overall improvement?

Amanda About 10%

RE Are you sure?

Amanda Yeah.

Amanda attributed her improved confidence and perceived competence in science directly to SLS tools used in the course. She described increasing feelings of control saying “ if I want to do better, I know how to.” Amanda attributed a 10% increase in science performance to her improved SLS skills.

Isabel

RE You put 5% for the change in your mark and I know from the chat we had the other day with Sonia that you didn't really enjoy the SLS course. Can you explain what you didn't like about it?

Isabel Well the mind maps and things meant a lot of extra study.

RE Do you think the course made you feel more in control of how you went?

Isabel I was in control anyway.

RE What about confidence. I suppose you were already confident?

Isabel Yes I was.

Isabel reported that the SLS program had had no effects on her feelings of control and confidence in science because she was already confident and in control of her performance.

Lauren

RE Has the course given idea about why you get particular results?

Lauren It sort of helps you pick out the right things.

RE But if you do badly in a particular test, does it give you information about why?

Lauren Yeah, going through it afterwards and doing the Reasons for Errors sheet makes you think why you actually got it wrong and find out the right answers.

RE With the Reasons for Errors sheets, if you got something wrong because you've not read questions carefully, has that helped you read the questions more carefully next time.

Lauren Yep.

RE Can you think of any other changes you've made in taking tests?

Lauren Like studying more, but sometimes I forget because I'm nervous.

RE Would you say the SLS work made you feel more confident?

Lauren Yes, 4 because I've tested all the different strategies and worked out which ones suit me.

RE What ones suit you?

Lauren Parrot fashion but also understanding.

RE Do you feel more in control of your learning?

Lauren Yeah, 3 or 4 because its good how we go through and make sure everybody understands before the test with the CLC.

RE Overall percentage improvement?

Lauren Improved me 40.

RE Wow that's a lot. Are you sure?

Lauren Yeah because other subjects haven't gone through why we've gone wrong and made sure we understand. I'd be 30-40%.

Lauren reported a very large gain in her feelings of competence and confidence as a result of completing the SLS program. She believed that the course resulted in an improvement of her marks in the order of 30-40%. Lauren reported trying out all of the strategies and determining which ones helped her the most. She believed that developing her use of the CLC technique meant she could be more in control her learning.

<u>Jemma</u>

RE So it may have helped you a bit in helping you to get on top of the material by mapping it?

Jemma Yeah.

RE I would say that you've improved over the year in your summarising. Do you think so?

Jemma Yeah.

RE And yet your saying it hasn't helped your results. Do you know why that would be?

Jemma No.

RE Do you think the SLS course made you more confident in science?

Jemma Not really.

RE Has the course made you feel a bit more in control of your science learning.

Jemma No. I don’t think so.

Jemma’s perceived competence and feelings of control over her learning did not improve as a result of her participation in the SLS course

9.7 Summary of section 9.6 Response to Research Question 4c: Teacher perception of the effects of the SLS course on performance attribution

It was an objective of the SLS program to encourage students to believe that their science performance was determined not only by their innate ability and but also by their selection of, and facility with, appropriate learning strategies (ie. the student has control over them), so that perceived competence is maximised.

Responses in the February group interviews revealed that students believe that they can alter their science outcomes by modifying their learning behaviour.

In December, two of the nine students interviewed (Jemma and Isabel), believed their ability to choose and apply learning strategies, and to perform in science, had been not been improved as a result of their participation in the SLS program.

A group of four students (Amanda, Natasha, Brittany and Karen) attribute a 10% increase in science performance to their improved learning strategy skills. They describe increased feelings of control of their learning and improvements in confidence and/or perceived competence stemming from their participation in the intervention.

Three students (Steph, Lauren and Lilly) attributed very large improvements in science performance, in the order of 25-40%, to participation in the SLS program. The students reported developing beliefs that their learning strategy competence is under their control and that this degree of command allows them to maximise their science performance.

The teacher/researcher formed the view that students had been helped, to varying extents, by the SLS course to develop realistic explanations for their science performance and to perceive that their use of learning strategies was governable and could influenced their performance.

9.8 Summary of Chapter 9 - Response to Research Question 4: Student, parent and teacher perceptions of the effects of the Science Learning Strategies program on performance attribution

Students in Class 5 generally found the SLS course helpful in explaining their science performance. The Student Questionnaire revealed a strong increase in satisfaction with science performance for Class 5 students which they felt was due to the intervention. Student perceptions of ability and learning strategy competence increased during 1999. The proportion of students in Class 5 attributing success to good learning strategies rose considerably. Effort attributions did not change over the year. Attributions of disappointing results to low ability fell considerably.

Some outcomes for students in Classes 1-4 were different. Their level of satisfaction with results remained virtually the same over the year and, by December, was well below that of Class 5 students. Level of dissatisfaction with results rose slightly for students in Classes 1-4 by December whereas it dropped for students in Class 5. The proportion of students in Classes 1-4 attributing poor performance to low ability rose by eight percent whereas it dropped by 11% for Class 5 students.

Similarly to their daughters, few parents attributed pleasing results to high ability in February. The major attribution was to high effort. In the phone survey conducted in December, a large proportion (43%) of parents of Class 5 students believed that their daughters would have blamed poor results in Year 7 on a lack of ability. By the end of Year 8 only four parents (22%) described their daughters attributing disappointing results to factors outside their control (e.g. low ability, hard paper).

Several parents made positive, general comments about affective benefits of the course. Six parents (33%) described their daughters as ascribing results to factors under their control at the end of Year 8.

It was evident to the teacher/researcher that by the end of the SLS program most students came to realise that their science performance was governed by factors other than just innate ability, such as studying behaviour, motivation and other aspects of affect. The teacher/researcher perceived that the students had been assisted by the SLS program to develop realistic attributions for their performance, to realise that they controlled their use of learning strategies and that their selection of, and competence with, strategies could influence their science results.

Chapter 10

Summary, review, recommendations and reflections

10.1 Introduction

In this chapter, Section 10.2 outlines the objectives of the SLS program. Section 10.3 reviews and summarises the data generated as answers to the four Research Questions and Section 10.4 presents recommendations for assessment. Section 10.5 suggests recommendations for research. In Section 10.6, recommendations for teaching and learning are examined, while Section 10.7 describes the limitations of the research. Section 10.8 discusses the level of achievement of the objectives of the intervention. Section 10.9 briefly summarises the research problems and their solutions.

10.2 The objectives of the SLS program

In recognition of the cognitive, metacognitive and affective aspects of learning, the following objectives served as the terms of reference in the development of the SLS course. The course objectives were to :

i) improve student ability to apply learning strategies to science studies

ii) improve performance in science

iii) encourage students to believe that their science performance is determined not only by their innate ability and but also by their selection of, and facility with, appropriate learning strategies (ie. the student has control over them), so that perceived competence is maximised.

10.3 The Research Problems, the Research Questions and their solutions

The research problems were, firstly, to investigate the extent to which learning strategy education is valued and fostered in Western Australia by science teachers, and secondly, to determine how much students would benefit from a year long, formal learning strategy course which was embedded within the science curriculum.

The preceding nine chapters of this thesis have described aspects of these problems, as generated by four Research Questions:

1) What role do Western Australian science teachers currently play in the delivery of learning strategy education to high school science students?

2) What perceptions of the effects of the embedded learning strategy course on student ability to apply learning strategies to science are held by:
   a) students, b) parents and c) the teacher?

3) What perceptions of the effects of the embedded learning strategies course on science achievement are held by:
   a) students, b) parents and c) the teacher?

4) What perceptions of the effects of the embedded learning strategies course on performance attribution are held by:
   a) students, b) parents and c) the teacher?

10.3.1 Response to Research Question 1: The role of Western Australian science teachers in the delivery of learning strategy education to high school students

In answer to Research Question 1, the survey revealed that, at the time of the survey, many Western Australian science teachers were delivering some learning strategy education to students, although to widely varying extents, and 53% valued such a strategy as being as important as teaching subject processes and content, while another 22.5% considered it more important. Sixty seven percent recognised that improving study strategies can improve confidence and/or motivation.

Some encouraging statistics were that 77% of respondents reported helping students to identify key concepts from science texts or notes and 59% indicated that they encourage students to develop summaries using mainly their own wording (See Table 5.3). However, there was a contrast between the 74% of respondents who believed that learning strategy education can improve performance in science and the fact that 37% of teachers responding to this questionnaire spent ten minutes per week or less on teaching it (per class). This was of concern because the respondents were experienced teachers who were members of their professional association. Encouragingly, however, another 30% spent between 11 and 20 minutes per class, per week on learning strategy education and 18% reported spending between 21 and 30 minutes (see Table 5.4).

Only 28% of respondents reported teaching students to develop high order visual aids such as mind maps to obtain an overview of the topic (see Table 5.3).

Responses to the survey, however, indicated that a wide variety of learning strategies were being taught.

No teachers reported implementing a formal learning strategies program within their science classes and only one teacher specifically reported incorporating learning strategy education in the teaching of process or content. Helping teachers incorporate learning strategy instruction into the delivery of science education without sacrificing content was a future goal of this research project.

10.3.2 Response to Research Question 2a: Student perception on the effects of the SLS intervention on learning strategy utility

Student perceptions of the effect of the SLS course on learning strategy ability in science were measured by a number of instruments including interviews, questionnaires and the *SLS* booklet.

Interviews at the start of the year revealed that students, as a rule, did not use cognitively demanding learning strategies to process and remember science ideas. At the end of the year, seven of the nine students interviewed reported that the SLS course had improved their learning strategy competence. This finding was reinforced in interviews with a small group of Year 9 students who reported very positive changes to their learning strategy competence as a result of participation in the SLS pilot program in 1998. Two students in the 1999 intervention found that the course had not helped their learning strategy ability.

The Tools for Learning Questionnaires revealed that, by November, an average of 34.5% of students gave high or very high ratings to describe the perceived effectiveness of the SLS program at improving their learning strategy competencies (see Table 6.8). (An average of only 15% of students described low ratings). Two strategies, ‘Splash down’ and concept mapping, were not helpful for most students because too few opportunities were provided for students to use concept maps and the ‘Splash down’ strategy was unhelpful as it did not suit the type of assessment at the school.

In relation to the *SLS* booklet, Class 5 students perceived improvements in competence in four of the five learning strategy categories - Organising, Learning, Test preparation and Taking tests – resulting from the SLS program. There was no improvement in the Managing Stress category as competence was already quite high in August. The selected students expressed variable ratings of their learning strategy competence in the *SLS* booklet, but these ratings generally improved between August and November.

The measurement tools used in probing student perceptions of the effect of the SLS course on learning strategy utility (the Tools for Learning Questionnaires, interviews and the *SLS* booklet) revealed similar results, indicating that students generally perceived that the SLS course did improve their learning strategy competence, and some students perceived major improvements.

10.3.3 Response to Research Questions 2b and 2c: Parent and teacher perceptions of the effects of the SLS course on student ability to apply learning strategies to science.

10.3.3.1 Parent perceptions

A third of the 21 parents interviewed by telephone in December were able to identify positive changes to their daughters' study and learning strategies that they attributed to the SLS intervention. The remainder of the parents were unaware of any changes or made inconclusive comments. No parents reported negative effects of the course on students.

10.3.3.2 Teacher perceptions

The teacher/researcher observed a greater improvement over the year in the ability of Class 5 students to use more cognitively demanding and fruitful learning strategies in response to learning strategy instruction than in students in Classes 1-4.

However, the teacher/researcher perceived that Class 5 students were outperformed by students in Classes 1-4 in the December LASSI-HS. In February, there were no significant differences between students in Class 5 and students in Classes 1-4 on any of the ten scales. By December, the mean scores for students in Classes 1-4 were significantly higher on four scales – Study aids, Information processing, Self testing and Time management (see Tables 7.2 and 7.3). These surprising results provide disconfirming evidence to the researcher about the value of the SLS course in promoting the development of student learning strategies. The poor results contradict the observation by the teacher/researcher of improvements in science learning strategy competence as described in Sections 7.4.1 and 7.4.3.

10.3.4 Response to Research Question 3: Student, parent and teacher perceptions of the effects of the SLS program on science achievement

10.3.4.1 Student perceptions

Most students reported positive changes in their science results as a result of participation in the SLS course. Twenty three percent of Class 5 students described major improvements in their science scores, of 25% or more, which they attributed to the program. Two students reported that the SLS intervention had no effect on their marks. No students considered that their marks had been adversely affected. The rest of the students reported improvements of 5% (4 students), 10% (5 students) and 20% (6 students). The mean perceived increase in scores for the class was 15.7%.

10.3.4.2 Parent perceptions

Thirty eight percent of the 21 parents interviewed in December reported perceived improvements in science achievement and attributed these to participation by their daughters in the SLS program. Five parents reported strong, or very strong improvements, while no-one felt student performance had suffered.

10.3.4.3 Teacher perceptions

The teacher/researcher's perception of the effect of the SLS course on student science achievement was based on the examination of student scores. The teacher/researcher found no statistically significant difference between the academic achievement in science of students in Class 5 compared to that of students in Classes 1-4. The teacher/researcher concluded that participation of Class 5 students in the SLS course had not improved their science performance.

10.3.5 Response to Research Question 4: Student, parent and teacher perceptions of the effects of the Science Learning Strategies program on performance attribution

10.3.5.1 Student perceptions

Class 5 students expressed a strong increase in levels of satisfaction with science performance at the end of the year. By contrast, the level of satisfaction with results for students in Classes 1-4 did not improve over the year and by December was well below that of students participating in the intervention. Levels of dissatisfaction with their science performance decreased for students in Class 5, but rose for students in Classes 1-4.

In December, the proportion of Class 5 students attributing good performance to sound learning strategies increased considerably from 25% to 36%. (However, similar percentage changes were reported for students in Classes 1-4.) At the completion of the intervention, the proportion of Class 5 students blaming disappointing results on a lack of ability fell from 18% to 7%, while the proportion of students in Classes 1-4 blaming low ability rose by 8% to 23%. The number of Class 5 students attributing good performance to effort did not change over the year, whereas it rose for the other students.

10.3.5.2 Parent perceptions

Forty five percent of parents of Class 5 students (9 individuals) surveyed by telephone considered that their daughters attributed disappointing Year 7 results to lack of ability at the start of the year. At the end of 1999, only 22% considered their daughters would blame disappointing results to factors they couldn't control (ability, hard test etc.). By the end of the year, 33% of parents believed their daughters attributed their science results to factors under their control.

10.3.5.3 Teacher perceptions

The teacher/researcher observed that the intervention was successful in helping students realise that their science performance was governed by factors in addition to their natural ability, such as studying behaviour and the affective dimension of learning. The teacher/researcher perceived that the SLS program assisted students to realise that they had control over their use of learning strategies and that this control could effect their science performance.

10.4 Recommendations for assessment

In Western Australia in recent years, there has been a change to outcomes-based assessment in schools. At the time the SLS program was implemented in 1999, the school in which the intervention occurred had not moved to outcomes based assessment, and 90% of marks were allocated to tests comprised of multiple choice items and short answer questions. Students received test scores expressed as percentages. At the end of the year students were allocated a grade based on their final percentage.

If it is accepted that assessment and instructional practice are inextricably linked (Resnick & Resnick, 1992), then it follows that if instructional change to a constructivist framework is to occur, the assessment must be changed in a way that will facilitate, rather than impede, the transition. The shift should be towards what is variously called performance assessment, authentic, alternative assessment, direct assessment, constructive assessment, incidental assessment, informal assessment, balanced assessment, curriculum-embedded assessment and curriculum-based assessment (Birenbaum, 1996). A strong emphasis should be placed on the integration of assessment and instruction. In this alternative assessment model, Birenbaum (1996) comments that

> the perceived position of the student with regard to the evaluation process changes from that of a passive, powerless, often oppressed subject, who is mystified by the process to an active participant who shares responsibility in the process, practices self-evaluation, reflection and collaboration, and conducts a continuous dialogue with the teacher (p.7).

Grace (1992) explains that the shift in assessment should include “ the practice of realistic student involvement in the evaluation of student achievement. Authentic assessments are performance-based and instructionally appropriate” (p.1). These new approaches to assessment rely on information from a variety of sources and the stress is placed on formative rather than summative assessment so that assessment can be the “servant of learning” (Black, 1995, p. 272) while still permitting formal certification and reporting. Black (1998) considers formative assessment, especially if not graded, to be a very powerful teaching and learning strategy.

Particular classroom strategies used in performance assessment include open – ended questions, exhibits, demonstrations, hands-on execution of experiments, computer simulations, journal and logbook writing, checklists, peer and self assessments and student portfolios. Many detailed descriptions of these strategies have been given (for example Birenbaum & Dochy, 1996; Secondary Education Authority-*Assessment support material*, 1996; Desforges, 1990; Tamir, 1996) and extensive, specific information about them is available from the National Center for Research on Evaluation, Standards and Student Testing (CRESST), the Northwest Regional Educational Laboratory (NWEL) and many of the other sources available through the Educational Research Information Center (ERIC) via the Internet.

These strategies are much more appropriate for classrooms embracing constructivism. Feedback on classroom tasks was regularly provided during the intervention, although because of the assessment policy of the school at the time, only 10% of marks could be assigned to formative assessment of learning tasks.

A worrying new trend to arise in science classrooms has been described by Herbert (2003). Herbert expressed concern that there is a move for science teachers in Western Australia to value the learning of science process over the learning of science content. While it is important that teachers focus on science processes, it is essential that students still be expected to learn and retain science content. Formative assessment and students' knowledge of science content should not be considered mutually exclusive entities. The strategies of mind mapping and idea organisers, were formative exercises used during the intervention which assisted students to both understand, and retain, science concepts.

10.5 Recommendations for further research

A number of issues and questions arose during the intervention which could be met or investigated by further research.

Issues:

- There is a need for more research into the effectiveness of subject embedded learning strategy courses, of lengthy duration, in the high school setting.

- Longitudinal studies might try to determine how learning strategies that students develop, as a result of participating in embedded, extended learning strategy programs, persist over time.

Several research questions that could guide future research include:

- How well do learning strategy skills gained in one learning area transfer to other learning areas?

- How effectively could schools be persuaded that the positive outcomes perceived and expressed by students, parents and the teacher/researcher resulting from the SLS course are credible, and valuable, if academic scores did not improve as a result of participation in the intervention?

- Will SLS be embraced by the science education community

- How could the effect of learning strategy programs on academic performance best be determined in an environment of outcomes-based assessment?

- Would programs, like the one described in this study, work as well with boys only, or in mixed gender settings? Would they work in the public school setting?

- Why did the LASSI-HS not confirm the positive outcomes of the SLS course which were indicated by other measures?

- How could other teaching staff be encouraged to try implementing some aspects of the SLS program? In regards to this question, would the refinement and publication of some of the learning materials produced for this intervention (such as the *SLS* booklet and CLC) be of use to other teaching staff?

Two strategies implemented in the intervention show great potential to benefit students and need further investigation and development. These are the ‘edit circle’ technique and mind mapping.

The power of the ‘edit circle’ strategy as a constructivist tool for modifying alternative conceptions could be investigated further by monitoring student exchanges in edit circles (small groups of peers who discuss each others work), to reveal the fine grain processes that are occurring. Many aspects of this process could be studied. For example, research could focus on whether students are only publicly modifying their understandings, but privately adhering to their original beliefs.

Much more research into mind mapping as a teaching and learning tool is suggested. Mind maps have wonderful benefits appreciated by the students and teacher/researcher involved in this study. The potential for teachers to use this tool to determine student conceptions rapidly is considerable. Further research into the cognitive and metacognitive processes involved in mind mapping is warranted.

10.6 Recommendations for teaching and learning

10.6.1 A constructivist approach to teaching and learning.

Constructivist teaching principles should be used where possible in the science classroom. The teacher/researcher implemented a number of constructivist strategies during the intervention with the aim of seeking out the nature of students’ alternative conceptions and to find the means to modify them. Small group discussions during the CLC process allowed students to clarify, reflect on, and if desired, modify their understandings. Peer 'edit circles' were formed to assist students through a process of constructive criticism of mind maps. As part of this process, students explained and justified their understandings, with other students evaluating their work, asking questions to challenge their ideas, or making suggestions which the student could choose to adopt or ignore when producing the final draft of their map. Social interaction was found to be a powerful medium for constructivist learning.

10.6.2 Reflections on embedding a learning strategy program within the science curriculum

The principle hurdle facing teachers wishing to embed a learning strategy program into the science curriculum, is the issue of time. It needs to be made very clear to parents, science staff and other teaching staff, and the school administration, that the strategies and science content are inter-woven so that there is no net loss of time spent on science tasks. To be effective, it is recommended that in Term 1, 40 minutes per week be allocated, reducing to 30 minutes per week for the other three terms in a four-term academic year. Some homework should also be set to reinforce the learning strategies. The potential benefits of the course to students, with reference to research findings described in Chapter 2, should also be stressed.

Strategies need to be introduced to assist students in cognitive, metacognitive and affective domains for reasons described in earlier chapters. (The strategies used in the intervention are listed in Figure 3.1.) Students should also have their learning strategy work rewarded in the assessment structure so that they view their participation as fruitful.

Year 8 was an appropriate level at which to introduce the learning strategy program, as the stakes were not as high in terms of academic pressure, and the students gained the most benefit by learning these skills on entering secondary schooling. It was explained to students at the outset that they would be taught a range of learning strategies in the first half of the year, so that they could find those which best suited their learning styles. Parental support for the implementation was gained at the very beginning of the year through parents granting written permission for their daughters to participate. This was helpful in building the level of student support for the intervention. All of the students were aware that their parents had agreed to their participation in the program.

Progress reports were given to the parents and staff via a newsletter at the end of Terms 1-3 (Appendix 10.1). Further, it was important to inform other science staff about the progress of the intervention and to reassure them that there would be no comparison of individual class results.

Experience at teaching learning strategies is best gained by trialing short modules to gauge student responses and to evaluate the effectiveness of the instruction. Before implementation, it is important to establish what learning strategy instruction is already offered in other subjects so that complementary programs can be developed.

10.6.3 Reflections on SLS teaching and learning materials and processes

10.6.3.1 Check your Learning Chart (CLC)

The CLC was a very successful tool that was accessed by most students at some stage. The CLC required students to reflect on their understanding of concepts and helped them to modify their understandings, where desirable, in a supportive small group setting. Some students found that using the CLC led to major improvements in their understanding of concepts.

10.6.3.2 SLS Planner

The SLS Planners (Appendix 3.4) had three components which were described in Section 3.5.1. The Planning section was helpful for some students because it required them to set an assessment goal and work out a study plan in order to achieve that goal. The Diary section gave some students new ideas for studying and taught them to prioritise their commitments. Other students liked the Test Feedback component because it helped them learn from their mistakes.

Overall, the SLS Planners were helpful for most students in some way, and were very helpful for particular individuals, assisting them to develop metacognitive skills.

10.6.3.3 The *SLS* booklet

The *SLS* booklet was a useful teaching and learning device. It was a good source of data about students' perceptions of their learning strategy competence. It was also a helpful device in explaining to students both simple and complex concepts about learning, in a succinct and accessible way. For example, the chapter entitled *Learning* introduced students to the concepts of deep processing and the importance of being able to select the main idea, summarise and check their understanding in a format they found easy to understand.

The *SLS* booklet also placed learning tools such as the CLC in context. In the section 'Asking for help', it was explained that the CLC would get students into the habit of identifying problems in their understanding, and also explained the benefits of getting help early. The graphics in the booklet allowed complex material to be presented simply for students. For example, the value of re-visiting memorised material to improve retention was illustrated by comparing a graph showing the percentage of information retained after a one hour study session, with no revision, to a graph showing the high retention of material that is regularly revised.

10.6.3.4 Reasons for Errors sheets

The Reasons for Errors sheets (Appendix 6.2) helped some students to understand why their actual performance did not match their stated goal, and prompted them to make changes which assisted them in later assessments.

10.6.3.5 Peer Evaluation sheets

Peer Evaluation sheets (Figure 3.6) allowed students to experience the process of making judgements about the quality of the SLS work of their peers. This experience, by extension, equipped them to view their own work critically and objectively.

10.6.3.6 Concept maps

Concept maps allow students to identify the connections between concepts. They are also very powerful as diagnostic tools helping teachers to rapidly identify student alternative conceptions. However, concept maps were not endorsed by students in this study, probably because the students were not given enough time to learn to use them effectively. Nevertheless, the teacher/researcher had previously used them successfully in other classes and at different year levels and there was an expectation that the concept maps would be seen as useful with this group of Year 8 students. Upon reflection, time should have been made during the intervention to more fully acquaint students with concept maps.

10.6.3.7 Mind maps

Mind maps (Appendix 3.5) were simple to teach and were a very effective tool - from the perspectives of both students and the teacher/researcher. Constructing a mind map required the student to view a topic as a whole, understand how the knowledge components fitted together, and to discern the links between them. Students learnt to discriminate primary information from non-essential material. The use of symbols or images to represent ideas required students to think carefully about the meaning of concepts. For example, one student drew a taxi to represent the biological process of *taxis* (where the whole organism moves in response to a stimulus). The maps were very efficient in reducing the topic into one or two A4 sheets to help students understand the concepts, and remember them during consolidation tasks or assessments. By July (i.e. six months into the academic year), 90% of students rated mind maps as being moderately to very easy to recall in tests. This compares well with the 74% of students who found idea organisers moderately to very easy to remember. Because of these benefits, mind maps were introduced to the students; a large majority of whom had previously only used text-based summaries.

Student drawings (such as mind maps) have the advantage, described by van den Berg (2003), of allowing the teacher to very rapidly assess the crucial features. As students prepared their mind maps and other graphic organisers, their thinking was evident to the teacher. The teacher/researcher found the mind maps very helpful in detecting alternative conceptions whilst moving around the classroom.

Both content knowledge and the understanding of processes could be tested by asking students to redraw and explain their maps from memory, or be tested on their knowledge of them by a more traditional instrument. Sixty percent of students said they liked mind maps moderately or better (see Table 6.1).

10.6.3.8 Idea organisers

A similar percentage of students, 61.5% (see Table 6.2), expressed a moderate or better liking for idea organisers. The text based idea organisers (Appendix 3.7) suited some students better than mind maps, although most students were comfortable using either. The idea organisers helped students to identify and include key concepts but, from the viewpoint of the teacher/researcher, did not require of students the same level of deep processing and synthesising of ideas necessary to complete a mind map.

The teacher/researcher found that idea organisers did not provide the same opportunities for detection of alternative conceptions as did mind maps. This is a key difference. Constructivist pedagogy requires the teacher to monitor the understandings that students have. Mind maps were an effective way of rapidly clarifying student conceptions so that opportunities could be provided for any necessary review of an individual's concepts by the individual, in concert with the teacher and a small group of students in the 'edit circle' process previously described in Section 3.2.8.

Both mind maps and idea organisers were successful at assisting students to retain science concepts, thus developing the foundations upon which students could build further science learning

10.6.3.9 Summary

As expected, different learning 'tools' and processes were suited to students with different learning styles. It was important to introduce students to a broad range of strategies so that they could make informed decisions about which of them to adopt and develop as part of their learning strategy repertoire.

10.7 Limitations of the study

10.7.1 Teacher survey

The Teacher Questionnaire was focused on cognitive learning strategies such as studying and understanding, and did not sufficiently probe the teaching of affective learning strategies. The questionnaire was deliberately limited to one page to increase the degree of completion and the rate of return of the surveys.
Even so, the page could have been reformatted to include brief questions about affective aspects of strategy instruction. Judicious phrasing of these questions would have been needed to avoid 'putting off' teachers who consider that it is not their responsibility to teach in the affective domain. This thinking by the teacher/researcher reflects her possibly incorrect assumption that science teachers would think this way. This assumption may have been based on the teacher/researcher's personal experience having failed to build into the SLS program sufficient affective strategy instruction, despite being aware its importance..

As mentioned in Section 1.6, the majority of science teachers returning completed surveys were experienced teachers belonging to their professional teaching body. Consequently, the survey did not provide data about learning strategy instruction implemented by inexperienced teachers.

10.7.2 Dependability

The dependability of the research findings (discussed in Section 4.5.1.2) was adequate but could have been strengthened by interviewing the students one or two years after the intervention. Circumstances precluded this, although several students involved in the pilot study in 1998 were interviewed in 1999 (Section 6.2.3.2).

10.7.3 Natural maturation

Some learning strategy competencies change naturally over time. The effect of natural maturation on cross curricular learning and study strategy competence across all classes was investigated by the LASSI-HS. In terms of science specific strategies, it was not possible to compare natural changes of performance of students in Classes 1-4 on science learning strategies that they had not been taught, with the end of year SLS competence of Class 5 students. Consequently, it was difficult to attribute changes solely to the SLS course. This problem was partly overcome by asking Class 5 students to recount only the changes in learning strategy competence they perceived to be due to the SLS course.

10.7.4 Constructivist strategies

The collection of data on the constructivist aspects of the program would have given the reader a clearer picture of the learning experience of the students. In particular, ‘edit circles’, in which students presented the reasoning behind their mind maps to small groups of peers to receive constructive feedback, could have been audio-taped. The inclusion of such data would have given a richer description of the processes involved in the activity. Such data would have provided evidence of group dynamics and elucidated evidence of ‘group think’, where students go along with the comments being made by others, rather than voicing dissenting opinions.

10.7.5 Involvement of other science staff

At the end of 1998, other science staff were briefed about the program and invited to participate in the 1999 intervention as a matter of courtesy. Several staff indicated interest in adopting some parts of the program although, at the busy start of 1999, found it to difficult to participate. While the involvement of other staff was not a formal part of the intervention, their participation would have provided useful additional data. More importantly, a larger group of students could have benefited from the program.

10.8 Achieving the objectives of the intervention

In terms of the objectives of the intervention to improve learning strategy competence, attribution and performance, the SLS program was successful in many ways. The wide range of data in this research indicates that students gained considerable benefit from the program in terms of perceived competence, perceived performance and perceived ability to apply learning strategies to science.

The SLS program, however, did not result in improved academic performance. This may have been because in Year 8 students were learning the strategies as well as the science content. In later years, time spent on mastery of the learning strategies in Year 8 can be spent on more efficient and thorough learning and understanding following which content acquisition should improve. The program should perhaps be extended over two years.

It was an achievement that the intervention produced so many positive outcomes in the cognitive, metacognitive and affective learning domains without detracting from test scores. Cognitive improvement should occur over time as the benefits from these improvements accumulate when students are faced with growing amounts of content as they progress through their secondary and tertiary studies.

Improving performance was only one of the purposes of the intervention. Students were viewed as holistic learners where metacognitive and affective gains were considered as important as cognitive gains.

The results achieved in this study need to be interpreted with care. It is possible that positive changes were due to a greater or lesser extent to natural maturation even though the participants attributed them to the SLS course.

10. 9 The Research Problems and their solutions

In examining the extent to which learning strategy education was valued and fostered in Western Australia by science teachers prior to 1999, the survey revealed that teachers were embracing learning strategy education to varying extents within the science classroom. Most teachers recognised the need for teaching students these skills, although 37% of them spent ten minutes or less per week doing so. Encouragingly, a further 30% were spending between 11 and 20 minutes per week on teaching learning strategies.

In terms of discovering how much students would benefit from a year long, formal learning strategy course, which was embedded within the science curriculum, the program was regarded as a success by all but two students, one third of parents (the remainder were unsure or did not know), and the teacher/researcher. No parents or students considered that participation in the program had any deleterious effects.

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Appendix 3.1

PERMISSION LETTER
YEAR 8 SCIENCE 5

February, 1999

Dear Parent or Guardian,

I am writing to you as your daughter's science teacher to seek permission to interview her about the Science Learning Strategy (S.L.S.) Program which she will be participating in as part of her Year 8 science studies in 1999.

This program is designed to help your daughter **more actively manage her science learning** so that she can improve her understanding and leaning of science**.** The students are taught a series of strategies (such as concept mapping, mind mapping, checking their learning and test preparation skills) as an integral part of the science course. The program does not require science content to be sacrificed as the content is delivered **via** the learning strategy instruction.

As part of my research for a Doctorate in Science Education at Curtin University, I will be evaluating student perceptions of the effectiveness of the S.L.S. Program. Consequently I am writing to request permission to interview your daughter briefly (during Common Time or Form period) several times over 1999, about her perceptions of the value of the S.L.S. Program.

If you are willing to allow your daughter to be interviewed, could you please complete and return the permission slip below. If you would like more information, please feel free to contact me on (08) **9335 9649**.

Thank-you
Mrs Penny McGlynn

Science Department.

S.L.S. Program

YEAR 8Sc5 INTERVIEW PERMISSION SLIP 1999

As Parent / Guardian I give permission for __________________________ to be interviewed about her perceptions of the effectiveness of the Science Learning Strategies Program during 1999.

PARENT/GUARDIAN SIGNATURE ____________________

S.L.S. Program

Appendix 3.2

YEAR 8 SCIENCE LEARNING STRATEGIES PARENT QUESTIONNAIRE
TERM 1 1999

Please complete the questionnaire, without the assistance of your daughter, seal it in the envelope provided and ask your daughter to fill in the details on the front of the envelope and hand it to her Science teacher.

YOUR CHILD'S CODE NAME __________________ **SCIENCE CLASS**_________________

Please circle the chosen response.

1. How would you rate your daughter's **interest** in Science at this time?

   Not interested at all 1 2 3 4 5 Extremely interested

2. How would you rate your daughter's Science **ability** at this time?

   Very low 1 2 3 4 5 Extremely high

3. How strongly do you think your daughter **wants** to get the best results in Science that she can?

   Not strongly at all 1 2 3 4 5 Very strongly

4. How **aware** are you of the strategies your daughter uses to prepare for tests in science?

   Unaware 1 2 3 4 5 Fully aware

5. Your daughter prepared for the **most recent Year 7 Science test** in the following ways (circle the **closest** estimated time)

   i) Total study time (hours) 0 0.5 1 1.5 2 2.5 3 3.5 4 Other_____

   ii) Study spread over (days) 1 2 3 4 Other________

   iii)**Tick any of the following strategies used by your daughter to study for science tests.**

   a☐Read text
   b☐Underlined or highlighted the text
   c☐Copied notes from the text
   d☐Made dot point notes from the text
   e☐Made notes in her own words from the text
   f☐Made up a mneumomic (eg.**N**ever **E**at **S**oggy **W**heatbix) to help her remember things
   g☐Learnt a small section at a time
   h☐Tested herself until she knew a section before learning the next section
   i☐Had regular breaks during a study session
   j☐Rewarded herself after studying each section
   k☐Went over the work from the day before to make sure she still remembered it, before learning a new section.
   l☐Made up questions and answered them
   m☐Got someone else to test her
   n☐Asked for help if she didn't understand something
   o☐Drew a mind map
   p☐Learnt to re-draw the mind map from memory
   q☐ Drew a concept map
   r☐ Did a revision sheet

   Other ways?____

6. Looking back over Year 7, which mark range did she **most often achieve** in Science tests?

   a ☐<40% b☐41-50 c ☐51-60 d ☐61-70 e ☐71-80 f ☐81-90 g ☐91-100 .

7. Looking back over Year 7, which of the following statements **best** describes your daughter's current **belief** about her Science performance?

   A. I usually get the science results that I want
   B. I don't usually get the Science results that I want
   C. Other____

   This is because **(you may circle more than one reason)**

   D. I put as much effort as I can into my science studies
   E. I have natural science ability
   F. I have good strategies and habits for studying
   G. I don't put in enough effort
   H. I don't have much science ability
   I. I don't have good study strategies and habits
   J. Other
   ____

Thank you for your participation.

Appendix 3.3

Dot Point Summary

SELECTING THE MAIN IDEAS FOR DOT POINT NOTES

Here is a piece of text where the main ideas have been turned into dot point notes.

1.In the clue box write which clues helped to show that this was a main idea.

<u>All living things need a FOOD SOURCE</u>

All living things must be able to obtain food in order to have energy to <u>grow</u> and <u>repair</u> their tissues.

Plants make their own food by a process known as **photosynthesis** using **energy** from the sunlight**, carbon dioxide** from the air and **water** from the soil.

Photosynthesis occurs only in green plants. The green colour of the leaves is due to chlorophyll, a substance that absorbs the energy of sunlight. The plant uses this energy to make food in the form of a type of sugar called glucose. Other types of food such as protein and fats and oils are made by plants using this sugar and from minerals it takes from the soil.

DOT POINT SUMMARY:

<u>Living things need food</u>

All Living Things need FOOD

- for - - growth
  - repair
  -
- Plants
  Make **own** food by **photosynthesis:**

  1.ENERGY caught by leaf chlorophyll CAUSES:

  2.Carbon Dioxide (from air) + 3.Water (from soil) TO MAKE:

  4.Glucose (sugar) AND 5. Oxygen

CLUES:

2. Now select the main ideas from the following text and turn them into dot point notes in the space at the bottom of the page.

<u>Plant responses</u>

When you plant a seed, do you worry about which way is up when you plant it in the soil? It appears that without our help the roots grow down and the shoot or stem grows up. Roots and stems of plants respond to many **stimuli.** They respond to gravity, light, water and touch.

Gravity is a force that acts towards the centre of the earth. It is because of gravity that we don't float off into space. Roots grow downwards (towards the centre of the earth) so we say they respond positively to gravity. **Geotropism** is the term we use for a response to gravity. If the response is toward gravity (down) then it is a positive geotropism. If the response is away from gravity (up) then it is a negative geotropism

S.L.S. PLANNER

TEST TOPIC:________________ Mini ☐ or Major ☐ (tick)
Tick the test mark range you would be SATISFIED WITH **a) <40%** ◯ **b) 41-50** ◯ **c) 51-60** ◯ **d) 61-70** ◯ **e) 71-80** ◯ **f) 81-90** ◯ **g) 91-100** ◯

In the top section: Fill in the test date in the right hand column **first**, and then work backwards along the columns until today.
In the second section:
- Fill in all your assignments and tests for the week on the appropriate day. **Write next to each one how much it is worth**.
- Also fill in after school and weekend activities, parties etc.
- **Number all of these (assessments and activities) with the most important receiving a 1, the next most important receiving a 2 etc.**

In the third section: Write in the time you have left for homework, and the time you will spend on Science revision. **(N.B. only do this after you have looked at the suggestions on your last Test Feedback Sheet.)**
In the fourth section: Write in the time you **actually spent** studying for the Science test.

Day Date	Day Date	Day Date	Day Date	Day Date	Day Date	**Test day** **Test date**
Assessments - % Activities	Assessments - % Activities	Assessments - % Activities	Assessments - % Activities	Assessments - % Activities	Assessments - % Activities	Assessments - % Activities
Time left for all homework Time for revising for Science Test	Time left for all homework Time for revising for Science Test	Time left for all homework Time for revising for Science Test	Time left for all homework Time for revising for Science Test	Time left for all homework Time for revising for Science Test	Time left for all homework Time for revising for Science Test	Time left for all homework Time for revising for Science Test
Actual time spent revising Science	**Actual** time spent revising Science	**Actual** time spent revising Science	**Actual** time spent revising Science	**Actual** time spent revising Science	**Actual** time spent revising Science	**Actual** time spent revising Science

Appendix 3.4

P.T.O.

STUDY DIARY- CONTINUED

Tick any of the following strategies you used to study for this test.

☐Read booklet
☐Made dot point notes from the booklet
☐Made up a mneumonic to help me remember things
☐Learnt a small section at a time
☐Got someone else to test me
☐Drew a mind map
☐Learnt to re-draw the mind map from memory
☐Drew some other kind of diagram
☐Asked for help if I didn't understand something
☐Copied notes from the booklet
☐Made notes in my own words from the booklet
☐Made up questions and answered them
☐Tested myself until I knew a section before learning the next section
☐Rewarded myself at the end of each study session
☐Had regular breaks during a study session
☐Did a revision sheet
☐Drew a concept map
☐Went over the work from the day before to make sure I still remembered it before starting a new section.

Other ways?____

TEST -FEEDBACK

1.Did you stick to the **Actual time** you had planned to study for the Science test? 1. Yes/No **(circle your choice)**

2.If you **didn't** stick to it, do you wish you had? 2. Yes/No **(circle your choice)**

3.If you wished you had stuck to it, how can you make sure you stick to it next time?

____

4. Did you get the mark you said you would be satisfied with (check which circle you ticked on the Test Planner)? 4. Yes/No **(circle your choice)**

5. Was your mark better than, worse than, or the same as the one you said you would be satisfied with? 5. Same/Better/Worse **(circle your choice)**

6. If your mark was better or worse, why do you think this happened?

____

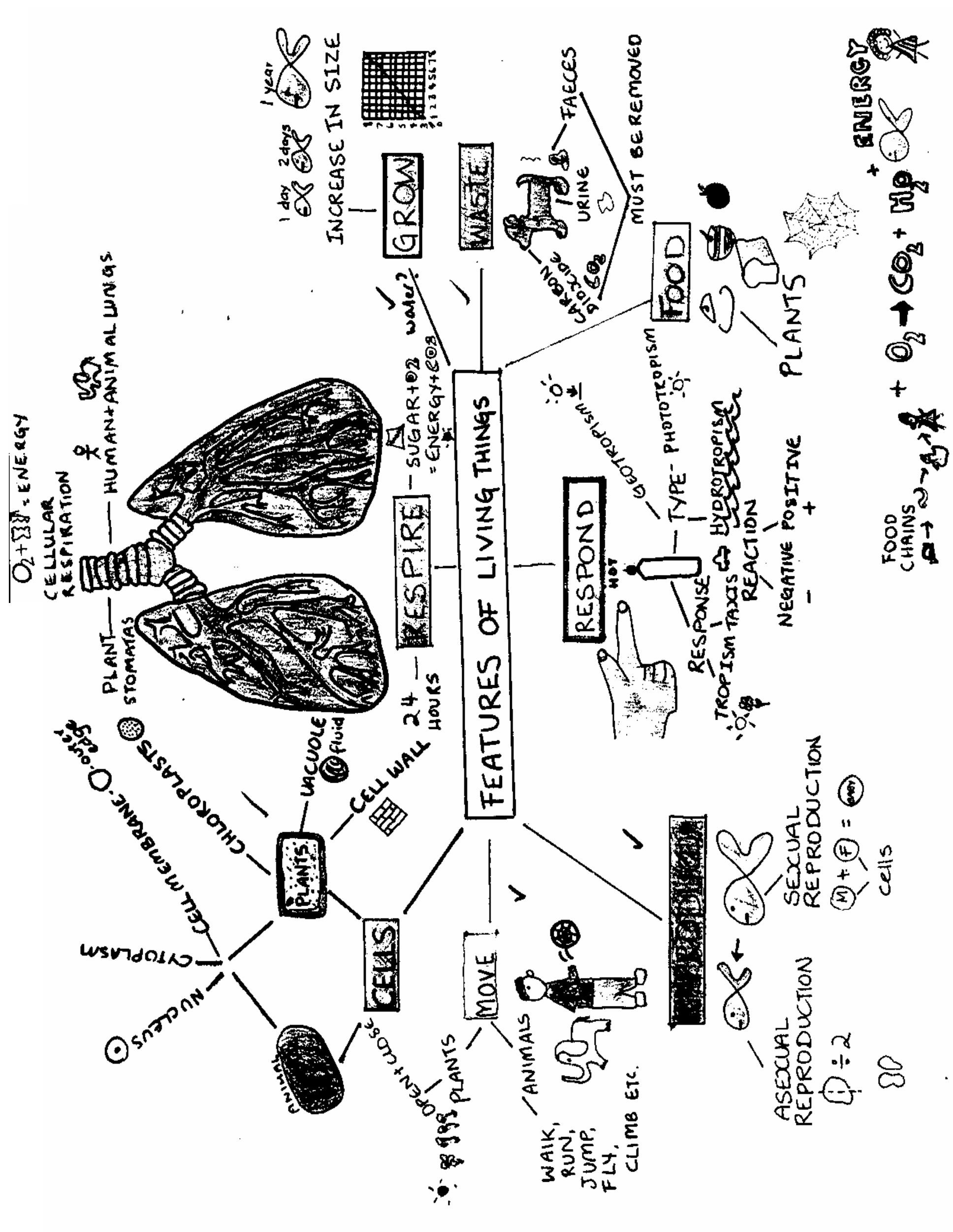
7. Do you want to improve your mark in the next test? 7.Yes/No **(circle your choice)**

8. If you said Yes in question 7, what things can you do to help your mark improve?

____

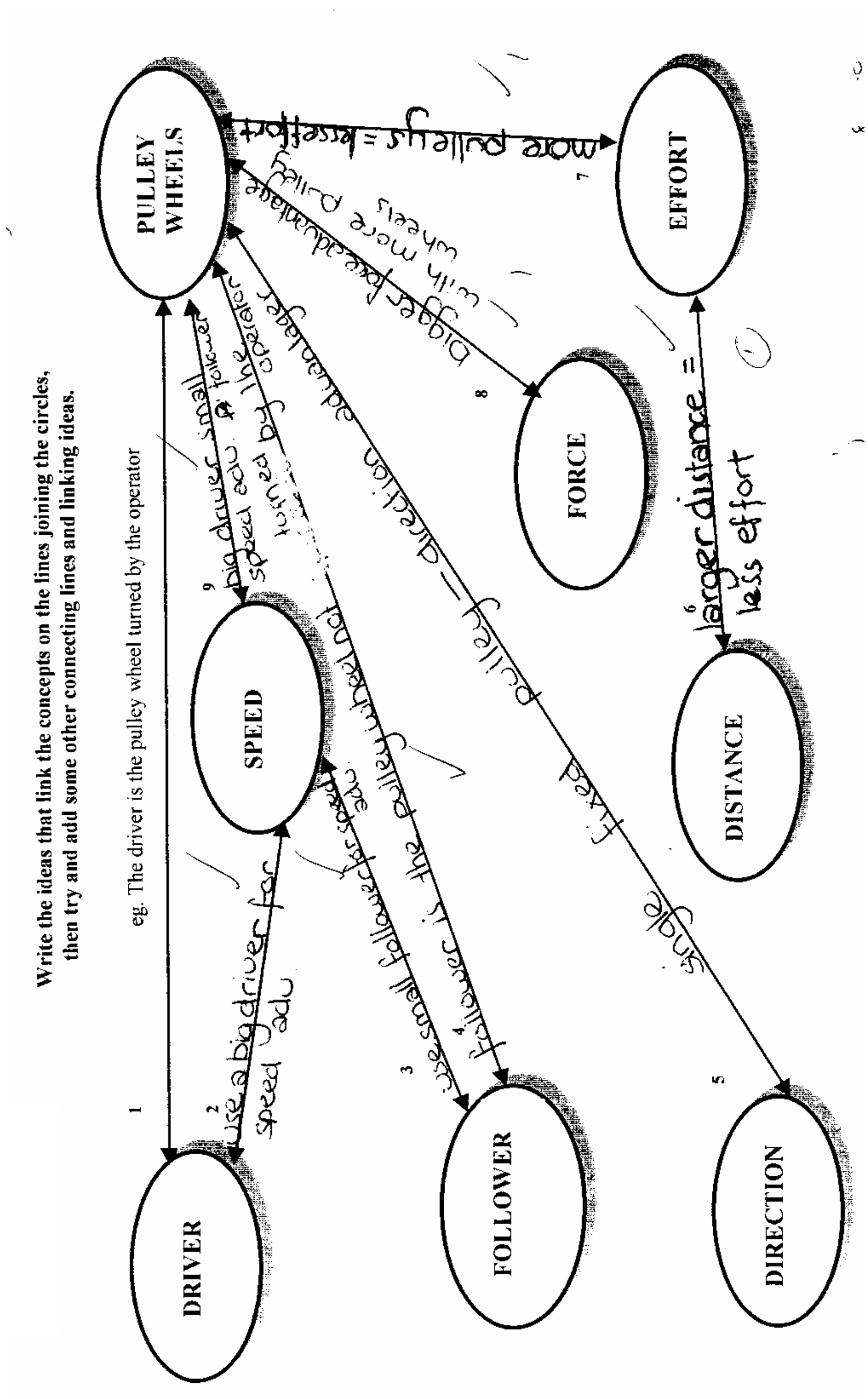
Appendix 3.5.

Mind map



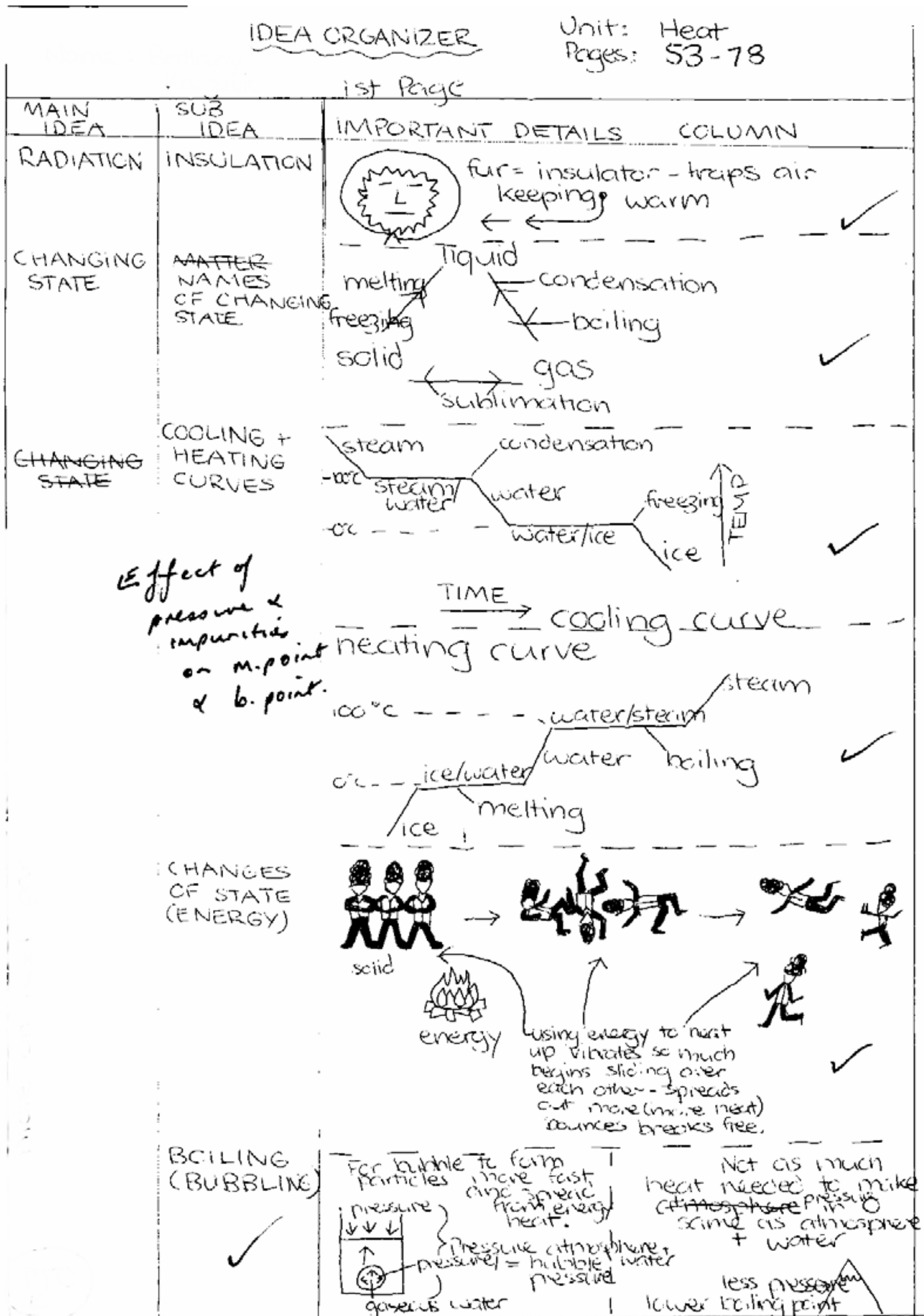
Appendix 3.6

Concept map



Appendix 3.7

Idea organiser



Appendix 4.1

SCIENCE TEACHER STUDY STRATEGIES QUESTIONNAIRE

Please send completed form by return mail to Penny McGlynn C/O St Hilda's ASG. Bay view Tce Mosman Park 6012. Fax 9384 2916. or email me at pmcglynnpj@alpha2.curtin.edu.au

Please circle your responses

1. I have been teaching secondary science for

   1. less than two years 2. two to five years 3. more than five years

2. How pressured do you usually feel at work?

   Not pressured at all 1 2 3 4 5 Extremely pressured

3. To what extent do you believe it is important for you to teach study strategies (eg. how to summarize, how to draw concept maps, how to revise) to **lower** school students, during science classes?

1	2	3	4	5	6
Not important at all			As important as teaching subject processes and content		The most important aspect

Other opinion?____

4. Please circle the statement which explains the response you have given in Question 3. (You may circle more than one statement.)

A. Students naturally have these strategies
B. The curriculum is too hectic to allow me to teach these strategies, even though I would like to
C. I am not interested in teaching these strategies
D. It is not my responsibility to teach these strategies.
E. Students are taught these strategies in special courses (other than in science) at this school.
F. Students have these skills to varying degrees in lower school and can be taught to improve them
G. Improving study strategies can improve confidence and/or motivation
H. Improving study strategies may improve science performance

Other____

5. If you incorporate the teaching of study strategies into your **lower** school science classes, please circle the strategies you teach.

A. Identify key concepts from science text/notes
B. Previewing text, skimming or scanning
C. Create summaries from the text (using mainly text wording)
D. Create summaries using mainly their own wording
E. Developing their own concept maps
F. Developing their own mind maps and/or other visual aids
G. Generating their own revision questions
H. Test revision strategies such as ratio of study time/break time/percent recall and importance of revisiting learnt material regularly

Other ____

6. If you incorporate the teaching of these strategies into **lower** school science classes, on average, how many minutes per week, per class would you spend doing this? ______ minutes

General comments:

Thank-you for your participation. It is much appreciated.

Want to do your best at school?

Improving your learning strategies can make a big difference.

Rate your learning strategies every few months to see if you are improving.
Put a tick in the box if you are good at a strategy.
Put a cross for the ones you need to work on.

		DATE	
1	**Getting Organized**	☐ ☐ ☐	
1.1	Filing materials	☐ ☐ ☐	• Keep your booklet in a file to protect it. Other people are less likely to take it by mistake if you have it in a colourful file. • Use file dividers to keep your loose notes, test papers and summaries organized. • "Weed out'" your files every now and then.
1.2	Coming to class with everything you need	☐ ☐ ☐	• A simple thing, but lots of people forget that they often need a calculator, ruler, pencil and eraser for science. • You always need your science file!
1.3	Organising your study time	☐ ☐ ☐	• Use your diary and make a list of things to do so that you can tick them off as you get them finished. • Take your family and social commitments into account when planning your study time. • Be realistic about how much you can do in one evening or weekend. • Your S.L.S. Planner will help you here.

1.4	Setting goals	☐ ☐ ☐	• It's easier to motivate yourself to study and do homework if you have a goal to work towards. • Your S.L.S. Planner will help you to think about your goals in science.
1.5	Setting priorities	☐ ☐ ☐	• When you are a busy person, sometimes its hard to know which things to put your energy into first. Think about which activity is the most important to you and allow the most energy and time for it. • Your S.L.S Planner can help you practice setting priorities.
1.6	Completing homework and class work	☐ ☐ ☐	• Keep your booklet up to date. • If you are away, borrow someone's notes the next day and copy them. • Ask for help if you don't understand the work you missed. • Homework can be a pain, but it's important to do it as it helps you learn the work done in class. It's also a good way to identify things you didn't really understand in class. Make a note of them in your booklet and ask a friend, or your teacher, the next day.
2.	**Managing Stress**		
2.1	Self confidence	☐ ☐ ☐	• Knowing you have planned your study time carefully around your family and social life will help you feel more confident.
2.2	Having fun	☐ ☐ ☐	• Its really important to do something fun every day. "All work and no play" will pretty soon leave you feeling flat and unable to do your best at anything!. •

2.3	Asking for help	☐ ☐ ☐	• Lots of people hate asking for help because they think they should know something, but it's actually the **smart thing** to do. • Successful students ask **lots** of questions and they ask as **soon** as they need help. • If you don't understand something, and you can't ask a friend or the teacher during class, make a note in your booklet or diary to get it sorted out. You could ask the teacher to help at the end of class, ask a friend at lunch time or get your parents to help. • The main thing is not to forget about it, because ideas in science often build on each other. If you misunderstand something, the whole topic might start to look very confusing. • The Check Your Learning Chart will help you to get into the habit of identifying problems and getting help.
2.4	Taking responsibility for your learning	☐ ☐ ☐	• How well you do at school depends on **you**. • Once you have finished school, no-one is going to be interested in listening to you explain why you didn't do as well as you could. You may have a teacher who doesn't explain things, or who you feel doesn't like you . You may have a lot of music commitments. Do something about it! Find ways of learning in spite of the obstacles.
2.3	Knowing your strengths and weaknesses	☐ ☐ ☐	• Make the most of your strengths and work on your weaknesses. • Use the Reasons for Errors sheet after the Mini-Feedback test to help you improve in the Topic Test by writing reminder notes in your diary near the date of the test.
2.4	Eating well	☐ ☐ ☐	• Your blood sugar level directly effects how well your brain functions. • Eat complex carbohydrates like bread and pasta rather than simple sugar, to keep your blood sugar levels steady through the day. • Eat breakfast!

2.5	Getting plenty of rest and exercise	☐ ☐ ☐	• Keeps you fresh and alert. When you are tired, exercise can actually make you feel refreshed and improve your concentration. • Research has shown that students who exercise regularly, do better at school.
2.6	Avoiding harmful substances	☐ ☐ ☐	• Nicotine and caffeine affect your health. • Anything that reduces your health affects your performance at school
3	**Learning**		
3.1	Deep processing	☐ ☐ ☐	• Research shows that just reading the textisn't the best way to learn. • Getting your brain to process the information more deeply and reproduce it in your own version gives better results. • Making your own mind maps, idea organizers, spider diagrams, concept maps, compare/contrast charts, events chains, and using the SQ3R system, are great ways to improve your understanding and learning of science.
3.2	Selecting the main idea	☐ ☐ ☐	• Being able to make good quality mind maps, idea organizers etc. depends on you being able to select the main ideas from your booklet. • This is a skill which improves with practice. • Always read your booklet with a highlighter in your hand. • Look for clues in the text such as bold type, headings, and the first and last sentence of each paragraph. • Edit circles will help you learn how other people select the main ideas.
3.3	Summarizing	☐ ☐ ☐	• This is a very important skill which helps you learn and gives you a big advantage at test time. If you learn to do this well, you will have a small set of summary notes, instead of three or four whole files to study for the exams next year.

3.4	Checking your understanding	☐ ☐ ☐	• Do this while reading over the booklet at home and while listening during the lesson. • Use the Check Your Learning Chart in class. • Make your own Check Your Learning Chart and get help to solve the things you're not sure of. Then you can tick them off when you have sorted them out. • Make up your own questions or get parents and friends to test you, to find weak areas. • Follow up the things you wrote on the Reasons for Errors chart after the mini-feedback test. Do this by writing yourself a note in your diary before the date of the next test.
4	**Test preparation**		
4.1	Planning your study time	☐ ☐ ☐	• Use your diary or the S.L.S. Record sheet to help you plan.. (See also section 1.3)
4.2	Deciding how important the test is	☐ ☐ ☐	• Use your S.L.S. Record sheet to help you sort out what activities need to be done first
4.3	Revising summaries	☐ ☐ ☐	• Go over your summaries, maps and diagrams regularly. • Practice doing them from memory until you know them completely (see section 4.7 on memorising).
4.4	Working out what the test will cover	☐ ☐ ☐	• Use the objectives at the front of the booklet . They tell you everything you are expected to know.
4.5	Breaking revision into small sections	☐ ☐ ☐	• It's hard to start working when the task seems huge. Lots of people can never get started at all! • Break it up so that you only have to face doing a small section of work.

4.6	Rewarding yourself after studying	☐ ☐ ☐	• Reward yourself when you finish the small task. Having this reward to look forward to is a big help. Play with the dog, or watch a bit of TV before starting the next section.
4.7	Memorising	☐ ☐ ☐	• Using mneumonics means using key words or images to remind you of the sound or meaning of an idea you are trying to remember eg drawing a taxi to remind you that Taxis means that the **whole** of an organism responds to a stimulus. • Use mneumonics whenever you can. They are a great aid to memory. • Use pictures or mneumonic words to represent ideas in mind maps and diagrams. • **Visit revisit effect on memory**
4.8	Testing yourself	☐ ☐ ☐	• Check that you have covered all of the objectives in the booklet. • Make up questions for yourself. • Use the Check Your Learning chart.
4.9	Forming a study group	☐ ☐ ☐	• Form a group to share study ideas, swap mneumonics, test each other and get help with things you're not sure of. • Choose a group of people with different strengths and weaknesses. Someone who knows a section better than somewhere else can learn a lot **more** by explaining it
4.10	Avoiding cramming	☐ ☐ ☐	• Cramming (studying everything the night before) may work in Year 8, but it is a bad habit to get into. You wont be able to fit it all in at the last minute next year. • Do yourself a favour, practice spreading your study now. Use your school diary and/or the SLS record sheet to help you plan your study.

5	**Taking Tests**		
5.1	Staying calm	☐ ☐ ☐	• Its good to be a bit nervous but being too worried stops you from doing your best. • If you are feeling really anxious, take some slow, deep breaths. While you are doing this, remind yourself that you have revised thoroughly, that you have Checked Your Learning and have been working on your weak areas. • 'Splash down' (see below)will help to give you confidence that you can remember everything.
5.2	Reading test directions carefully	☐ ☐ ☐	• Your eyes sometimes see what they want to see rather than what is really on the page, so read the directions slowly and carefully. • Also check that you have completed all the pages.
5.2	'Splash Down'	☐ ☐ ☐	• Use the Splash Down technique. As soon as you start your test, spend 1 or 2 minutes drawing diagrams, writing a "skeleton" of your summary and noting down things you are worried you might forget. This is often a big help during a test.
5.3	Highlighting key ideas in questions	☐ ☐ ☐	• This will help you focus on exactly what the marker expects you to write.
5.4	Multiple choice - 'Guess before you choose'	☐ ☐ ☐	• If you tend to do poorly in multiple choice tests you can try this strategy. Cover up the choices and read the question carefully. Try and think of the answer to the question and then see which choice fits your answer best. • This technique can help you focus on the main idea needed to answer the question, and stop you getting sidetracked by some of the choices.

5.5	Answering easy questions first	☐ ☐ ☐	• This gives you confidence and helps you stay relaxed. If you are relaxed, you will remember more and be able to think more clearly. • Once you have read a question that you think will be hard, part of your brain keeps working on it while you are doing the easy questions. • Sometimes the answer even pops into your head when you go back to the question.
5.6	Check your answers	☐ ☐ ☐	• A simple but important strategy that can really improve your results.
5.7	Getting your test back	☐ ☐ ☐	• If you did better or worse than you expected, think carefully about why this happened. You may be able to learn something which will help you next time. • For questions that you got wrong, use the Reasons for Errors sheet. Note down any suggestions in your diary for next test and follow them!

Appendix 4.3

TOOLS FOR LEARNING June 1999

Name:___________________

1. How well do you think you are doing Mind Maps now? (circle your choice)

1	2	3	4	5
Not well at all				Very well

2. What problems do you have in using them?

____

____

3. How much do you like them?

1	2	3	4	5
Not at all				Very much

Why did you choose this answer?

____

4. How well do you think you are doing the Idea Organizers now?

1	2	3	4	5
Not well at all				Very well

5. What problems do you have in using them?

____

____

6. How much do you like them?

1	2	3	4	5
Not at all				Very much

Why did you choose this answer?

____

7. Why do you think I've been getting you to learn to use Mind Maps and Idea Organizers? How do you think they're supposed to help you?

____

____

8. Thinking just about Mind Maps, how easily do you manage to choose the most important material to put onto them?

1	2	3	4	5
Very difficult				Very easily

9. How easy do you find it to remember your Mind Maps for tests?

1	2	3	4	5
Very difficult				Very easily

Why did you choose this answer?

____

10. How much have the Mind Maps helped your test results?

1	2	3	4	5	6	7	8	9	10
Made marks worse				Made no difference					Improved them a lot

Why did you choose this answer?

____

11. How much have Mind Maps helped you in *understanding* the ideas in the booklets?

1	2	3	4	5
Not at all				A very big help

Why did you choose this answer?

____

12. How much have the Mind Maps helped you in understanding how the ideas in the booklets fit together so that the whole unit makes sense?

1	2	3	4	5
Not at all				A very big help

13. Do you think that learning to use these maps has made you more confident in your ability to learn science?

1	2	3	4	5
Not at all				A very big help

Why did you choose this answer?

____

14. Thinking just about the Idea Organizers, how easily do you manage to choose the most important material to put onto them?

1	2	3	4	5
Very difficult				Very easily

15. How easy do you find it to remember the Idea Organizers for tests?

1	2	3	4	5
Very difficult				Very easily

Why did you choose this answer?

____

16. How much have the Idea Organizers helped your test results?

1	2	3	4	5	6	7	8	9	10
Made marks worse				Made no difference					Improved them a lot

Why did you choose this answer?

____

17. How much have Idea Organizers helped you in *understanding* the ideas in the booklets?

1	2	3	4	5
Not at all				A very big help

Why did you choose this answer?

____

18. How much have they helped you in understanding how the ideas in the booklets fit together so that the whole unit makes sense?

1	2	3	4	5
Not at all				A very big help

19. Do you think that learning to use these Idea Organizers has made you more confident in your ability to learn science?

1	2	3	4	5
Not at all				A very big help

Why did you choose this answer?

____

20. How well do you think you are doing the Test Planning and Feedback sheets now?

1	2	3	4	5
Not well at all				Very well

21. What problems do you have in using them?

____

22. How much do you like them?

1	2	3	4	5
Not at all				Very much

Why did you choose this answer?

____

23. How much have these Test Planning and Feedback sheets helped your test results?

1	2	3	4	5	6	7	8	9	10
Made marks worse				Made no difference					Improved them a lot

Why did you choose this answer?

____

24. Do you think that using these Planning sheets have made you more confident in your ability to learn science?

1	2	3	4	5
Not at all				A lot more confident

Why did you choose this answer?

____

25. What can you remember about the discussion we had in class about how to *prepare* for tests?

____

26. What can you remember about the discussion we had in class about ways to *do* tests more effectively?

____

____

27. We did an activity in class where we tried to think of all the *factors that affect test performance.* People mentioned things like finding a quiet place to study, getting plenty of rest the night before and spreading out their revision over a few days. What changes have you made in these kinds of things because of our discussion?

____

____

____

28. If you made any changes, how much effect have they had on your test results?

1	2	3	4	5	6	7	8	9	10
Made marks worse				Made no difference					Improved them a lot

29. We have used the Check Your Learning Chart (the purple chart where you put stickers up under headings where you have questions or problems) a few times so far this year. How helpful have you found the Check Your Learning Chart so far?

1	2	3	4	5
Not helpful at all				Very helpful

Why did you choose this answer?

____

30. How much has the Check Your Learning Chart helped you in *understanding* the ideas in the booklets?

1	2	3	4	5
Not at all				A very big help

Why did you choose this answer?

____

31. Do you think that using the Check Your Learning Chart made you more confident in your ability to learn science?

1	2	3	4	5
Not at all				A lot more confident

Why did you choose this answer?

____

32. How much effect has using the Chart had on your test results?

1	2	3	4	5	6	7	8	9	10
Made marks worse				Made no difference					Improved them a lot

Why did you choose this answer?____

33. When you get your tests back, I have asked you to fill in the chart about why you made errors eg. made a silly mistake, couldn't understand the question. How helpful have you found filling in these charts.

1	2	3	4	5
Not helpful at all				Very helpful

Why did you choose this answer?

____

34. Do you think that using the Error Chart has made you more confident in your ability to learn science?

1	2	3	4	5
Not at all				A lot more confident

Why did you choose this answer?

____

35. How much effect has using the Check Your Learning Chart had on your test results?

1	2	3	4	5	6	7	8	9	10
Made marks worse				Made no difference					Improved them a lot

Why did you choose this answer?

____

36. All of the questions you have answered so far have been about the learning strategies you have learnt in science this year. What have you learnt about these kinds of strategies in other subjects this year?

____

____

37. How important do you think it is to be taught these kinds of learning strategies at high school?

1	2	3	4	5
Not at all				Very important

Thank-you for your time.

Appendix 4.4

TOOLS FOR LEARNING QUESTIONNAIRE

November 1999 NAME________________________

1. The Learning Strategy work I have done with you this year has aimed to help you manage your learning better. What things do you do better now because of the Learning Strategies work we have done?
____
____

2. We have used various "Tools" to help you develop different learning skills. How much have you improved at each of these skills **because of the S.L.S. work.**

Skill	Tool	Usefulness					
		Already knew it	I am no better at this because of the S.L.S. work				I am very much better at this because of the S.L.S work
1. General learning strategies	Science Learning Strategies book	0	1	2	3	4	5
2. Learning to pick the main ideas from text	Mind maps, spider maps, idea organizers	0	1	2	3	4	5
3. Summarising	Idea organizers	0	1	2	3	4	5
4. Summarising	Mind maps	0	1	2	3	4	5
5. Learning to link ideas together	Concept maps	0	1	2	3	4	5
6. Setting goals	Test Planner	0	1	2	3	4	5
7. Setting priorities	Test Planner	0	1	2	3	4	5
8. Deciding how important a test is	Test Planner	0	1	2	3	4	5
9. Planning your study time	Test Planner	0	1	2	3	4	5
10. Asking for help	Check Your Learning Chart	0	1	2	3	4	5
11. Checking your understanding	Check Your Learning Chart	0	1	2	3	4	5
12. Breaking revision into small sections	Class discussion	0	1	2	3	4	5
13. Rewarding yourself after studying	Class discussion	0	1	2	3	4	5
14. Spreading study out to avoid cramming and improve memory	Class discussion and Science Learning Strategies book	0	1	2	3	4	5
15. Staying calm	Class discussion	0	1	2	3	4	5
16. "Splash down"	Science Learning Strategies book	0	1	2	3	4	5
17. Answering easy questions first	Class discussion and Science Learning Strategies book	0	1	2	3	4	5
18. "Guess before you choose"	Class discussion and Science Learning Strategies book	0	1	2	3	4	5
19.Learn from test errors	Reason for errors sheet	0	1	2	3	4	5
20.Work out what the test will cover	Using the objectives	0	1	2	3	4	5

3. How much have these S.L.S skills and tools **contributed to the results you gained this year in Science?** (Use a minus score if they have made your results worse.)

Skill	Tool	Usefulness					
		Already knew it	Hasn't helped my results				Has helped my results a lot
1. Overview of learning strategies	Science Learning Strategies book	0	1	2	3	4	5
2. Summarising	Mind maps or spider maps	0	1	2	3	4	5
3. Learning to pick the main ideas from text	Mind maps or spider maps, idea organisers	0	1	2	3	4	5
4. Summarising	Idea organisers	0	1	2	3	4	5
5. Learning to link ideas together	Concept maps	0	1	2	3	4	5
6. Setting goals	Test Planner	0	1	2	3	4	5
7. Setting priorities	Test Planner	0	1	2	3	4	5
8. Deciding how important a test is	Test Planner	0	1	2	3	4	5
9. Planning your study time	Test Planner	0	1	2	3	4	5
10. Asking for help	Check Your Learning Chart	0	1	2	3	4	5
11. Checking your understanding	Check Your Learning Chart	0	1	2	3	4	5
12. Breaking revision into small sections	Class discussion	0	1	2	3	4	5
13. Rewarding yourself after studying	Class discussion	0	1	2	3	4	5
14. Spreading study out to avoid cramming and improve memory	Class discussion and Science Learning Strategies book	0	1	2	3	4	5
15. Staying calm	Class discussion	0	1	2	3	4	5
16. "Splash down"	Science Learning Strategies book	0	1	2	3	4	5
17. Answering easy questions first	Class discussion and Science Learning Strategies book	0	1	2	3	4	5
18. "Guess before you choose"	Class discussion and Science Learning Strategies book	0	1	2	3	4	5
19. Learning from test errors	Reason for errors sheet	0	1	2	3	4	5
20. Working out what the test will cover	Using the objectives	0	1	2	3	4	5

4. Overall, how much would you say the S.L.S. work we have done has affected your science results on average during the year.

- ☐ No effect on my marks
- ☐ Improved them by ____ % on average
- ☐ Made them worse by ____ % on average

5. Can you think of any instances where the S.L.S. work helped for a particular test. How much percentage difference would you say it made?

____

____

6. How important do you believe it is to be taught these kinds of strategies in science?

Not important at all 1 2 3 4 5 Very important

Please explain why ____

____

7. Have you spent much time learning these kinds of things in other core subjects this year?
Please give details ____

____

8. Has the S.L.S. course given you more of an idea about why you get the results that you get?
Please explain your answer.

____

____

9. Has the S.L.S. course made you feel more confident in science? Please explain your answer.

____

____

10. Has the S.L.S. course made you feel more in control of your performance in science?
Please explain your answer.

____

____

____

Thank-you for your participation.

Appendix 4.5

Test Taking Strategies Questionnaire
November 1999

NAME:__________________

Please circle your response

Staying calm

Often in tests we get anxious and worried and this can stop us from concentrating.

1. Did you have any negative or worrying thoughts in the test yesterday? Yes No

2. If you circled Yes, describe what strategies you used to help you stop these negative thoughts.

3. Where or when did you learn the strategies?

4. How much has using strategies to stop negative thoughts helped with your test result/s

0	1	2	3	4	5
I don't get anxious	Hasn't helped				A very big help

The Splash Down Technique

5. Did you use the Splash Down technique in the test yesterday? Yes No

6. Why?

7. Had you heard of this technique before we read about it in the purple booklets? Yes No

8. How much has using this strategy to helped with your test result/s

0	1	2	3	4	5
I don't use it	Hasn't helped				A very big help

Highlighting key ideas in questions

9. Did you use this technique in the test yesterday? Yes No

10. Why?

11. Had you heard of this technique before we read about it in the purple booklets? Yes No

12. How much has using this strategy to helped with your test result/s

0	1	2	3	4	5
I don't use it	Hasn't helped				A very big help

Multiple Choice 'Guess Before You Choose'

13. Did you use this technique in the test yesterday? Yes No

14. Why?

15. Had you heard of this technique before we read about it in the purple booklets? Yes No

16. How much has using this strategy to helped with your test result/s

0	1	2	3	4	5
I don't use it	Hasn't helped				A very big help

Answering easy questions first

17. Did you use this technique in the test yesterday? Yes No

18. Why?

19. Had you heard of this technique before we read about it in the purple booklets? Yes No

20. How much has using this strategy to helped with your test result/s

0	1	2	3	4	5
I don't use it	Hasn't helped				A very big help

Appendix 4.5 continued

Checking Your Answers

21. Did you use this technique in the test yesterday? Yes No

22. Why?

23. Had you heard of this technique before we read about it in the purple booklets? Yes No

24. How much has using this strategy to helped with your test result/s

0	1	2	3	4	5
I don't use it	Hasn't helped				A very big help

Reading test directions carefully

25. Did you use this technique in the test yesterday? Yes No

26. Why?

27. Had you heard of this technique before we read about it in the purple booklets? Yes No

28. How much has using this strategy to helped with your test result/s

0	1	2	3	4	5
I don't use it	Hasn't helped				A very big help

Thankyou for completing this questionnaire

YEAR 8 SCIENCE LEARNING STRATEGIES STUDENT QUESTIONNAIRE
TERM 1 1999

Thank-you completing this questionnaire. Please complete it, then fold it and hand it to your Science teacher.

NAME ___________________________ **SCIENCE CLASS**_________________

Please circle the chosen response.

1. How would you rate your **interest** in Science at this time?

Not interested at all 1 2 3 4 5 Extremely interested

2. How would you rate your Science **ability** at this time?

Very low 1 2 3 4 5 Extremely high

3. How strongly do you **want** to get the best results in Science that you can?

Not strongly at all 1 2 3 4 5 Very strongly

4. I prepared for the **most recent Year 7 Science test** in the following ways (circle the **closest** estimated time)

i) Total study time (hours) 0 0.5 1 1.5 2 2.5 3 3.5 4

Other_____

ii) Study spread over (days) 1 2 3 4 Other____

iii)**Tick any of the following strategies you used to study for this test.**

a□Read text
b□Underlined or highlighted the text
c□Copied notes from the text
d□Made dot point notes from the text
e□Made notes in my own words from the text
f□Made up a mneumomic (eg.**N**ever **E**at **S**oggy **W**heatbix) to help me remember things
g□Learnt a small section at a time
h□Tested myself until I knew a section before learning the next section
i□Had regular breaks during a study session
j□Rewarded myself after studying each section
k□Went over the work from the day before to make sure I still remembered it, before starting to learn a new section
l□Made up questions and answered them
m□Got someone else to test me
n□Asked for help if I didn't understand something
o□Drew a mind map
p□Learnt to re-draw the mind map from memory
q □ Drew a concept map
r□ Did a revision sheet

Otherways?____

5. Looking back over Year 7, which mark range did you **most often achieve** in Science tests?
a □<40% b□41-50 c □51-60 d □61-70 e □71-80 f □81-90 g □91-100 .

6. Looking back over Year 7, which of the following statements **best** describes your science performance?

A. I usually get the science results that I want

B. I don't usually get the Science results that I want

C. Other____

This is because **(you may circle more than one reason)**

F. I put as much effort as I can into my science studies
G. I have natural science ability
F. I have good strategies and habits for studying
G. I don't put in enough effort
H. I don't have much science ability
I. I don't have good study strategies and habits

K. Other____

Thank-you for your participation.

Appendix 4.7

YEAR 8 SCIENCE LEARNING STRATEGIES STUDENT QUESTIONNAIRE
TERM 4 1999

Thank-you for completing this questionnaire. Please complete it, then fold it and hand it to your Science teacher.

NAME ________________________ **SCIENCE CLASS**________________

Please circle the chosen response.

1. How would you rate your **interest** in Science at this time?

Not interested at all 1 2 3 4 5 Extremely interested

2. How would you rate your Science **ability** at this time?

Very low 1 2 3 4 5 Extremely high

3. How strongly do you **want** to get the best results in Science that you can?

Not strongly at all 1 2 3 4 5 Very strongly

4. I prepared for the **most recent Science test** in the following ways (circle the **closest** estimated time)

i) Total study time (hours) 0 0.5 1 1.5 2 2.5 3 3.5 4

Other_____

ii) Study spread over (days) 1 2 3 4 Other____

iii)**Tick any of the following strategies you used to study for this test.**

a□Read text
b□Underlined or highlighted the text
c□Copied notes from the text
d□Made dot point notes from the text
e□Made notes in my own words from the text
f□Made up a mneumomic (eg.**N**ever **E**at **S**oggy **W**heatbix) to help me remember things
g□Learnt a small section at a time
h□Tested myself until I knew a section before learning the next section
i□Had regular breaks during a study session
j□Rewarded myself after studying each section
k□Went over the work from the day before to make sure I still remembered it, before starting to learn a new section
l□Made up questions and answered them
m□Got someone else to test me
n□Asked for help if I didn't understand something
o□Drew a mind map
p□Learnt to re-draw the mind map from memory
q □ Drew a concept map
r□ Did a revision sheet

Otherways?____

5. Looking back over Year 8, which mark range did you **most often achieve** in Science tests?
a □<40% b□41-50 c □51-60 d □61-70 e □71-80 f □81-90 g □91-100 .

6. Looking back over Year 8, which of the following statements **best** describes your science performance?

A. I usually get the science results that I want

B. I don't usually get the Science results that I want

C. Other____

This is because **(you may circle more than one reason)**

H. I put as much effort as I can into my science studies
I. I have natural science ability
F. I have good strategies and habits for studying

G. I don't put in enough effort
H. I don't have much science ability
I. I don't have good study strategies and habits

J. Other____

Thank-you for your participation.

Appendix 4.8

LASSI-HS

Student CODE name___________________

Science class ___________

CAUTION - There should be nothing between this pressure-sensitive form and your desktop.

a. Not at all like me
b. Not very much like me
c. Somewhat like me
d. Fairly much like me
e. Very much like me

1. I worry that I will fail my classes. a b c d e
2. I can tell the difference between more important and less important information my teacher tells me. a b c d e
3. I find it hard to stick to a study schedule. a b c d e
4. After a class, I look over my notes to help me understand the information. a b c d e
5. I don't care if I finish high school as long as I can get a job. a b c d e
6. I find that when my teacher is teaching I think of other things and don't really listen to what is being said. a b c d e
7. I use special study helps, such as italics and headings, that are in my textbook. a b c d e
8. I try to identify the main ideas when I listen to my teacher teaching. a b c d e
9. I get discouraged because of low grades. a b c d e
10. I am up-to-date in my class assignments. a b c d e
11. Problems outside of school - dating, conflict with parents, etc. - cause me to not do my school work. a b c d e
12. I try to think through a topic and decide what I am supposed to learn from it rather than just read it over when doing schoolwork. a b c d e
13. Even when study materials are dull and not interesting, I manage to keep working until I finish. a b c d e
14. I feel confused and undecided as to what my educational goals should be. a b c d e
15. I learn new words or ideas by imagining a situation in which they occur. a b c d e
16. I come to class unprepared. a b c d e
17. When studying for an exam, I think of questions that might be on the test. a b c d e
18. I would rather not be in school. a b c d e
19. The notes I take as I read my textbooks are helpful when I review the textbook material. a b c d e

a. Not at all like me
b. Not very much like me
c. Somewhat like me
d. Fairly much like me
e. Very much like me

20. I do poorly on tests because I find it hard to plan my work within a short period of time. a b c d e
21. I try to think of possible test questions when studying my class material. a b c d e
22. I only study when there is the pressure of a test. a b c d e
23. I change the material I am studying into my own words. a b c d e
24. I compare class notes with other students to make sure my notes are correct. a b c d e
25. I am very tense when I study. a b c d e
26. I look over my notes before the next class. a b c d e
27. I have trouble summarizing what I have just heard in class or read in a textbook. a b c d e
28. I work hard to get a good grade, even when I don't like a class. a b c d e
29. I often feel like I have little control over what happens to me in school. a b c d e
30. I stop often while reading and think over or review what has been said. a b c d e
31. Even when I am well prepared for a test, I feel very upset when taking it. a b c d e
32. When I study a topic I try to make the ideas fit together and make sense. a b c d e
33. I talk myself into believing some excuse for not doing a homework assignment. a b c d e
34. When I study, I have trouble figuring out just what to do to learn the material. a b c d e
35. When I begin a test, I feel pretty sure that I will do well. a b c d e
36. I check to see if I understand what my teacher is saying during a class period. a b c d e
37. I do not want to learn a lot of different things in school. I just want to learn what I need to get a good job. a b c d e
38. I am sometimes unable to keep my mind on my schoolwork because I am restless or moody. a b c d e

Student CODE name________________

Science class __________

CAUTION - There should be nothing between this pressure-sensitive form and your desktop.

e. Very much like me
d. Fairly much like me
c. Somewhat like me
b. Not very much like me
a. Not at all like me

39. I try to find connections between what I am learning and what I already know.	a b c d e
40. I set high standards or goals for myself in school.	a b c d e
41. I end up "cramming" for almost every test.	a b c d e
42. I find it hard to pay attention during class.	a b c d e
43. I key in on the first or last sentences of most paragraphs when reading my textbooks.	a b c d e
44. I only study the subjects I like.	a b c d e
45. I am distracted from my studies very easily.	a b c d e
46. I try to find connections between what I am studying and my own experiences.	a b c d e
47. I make good use of study hours after school.	a b c d e
48. When work is difficult I either give up or study only the easy parts.	a b c d e
49. I make drawings or sketches to help me understand what I am studying.	a b c d e
50. I dislike most of the work in my classes.	a b c d e
51. I have trouble understanding just what a test question is asking.	a b c d e
52. I make simple charts, diagrams, or tables to pull together material in my classes.	a b c d e
53. While I am taking a test, worrying about doing poorly gets in the way of keeping my mind on the test.	a b c d e
54. I don't understand some class material because I do not listen carefully.	a b c d e
55. I read textbooks assigned for my classes.	a b c d e
56. I feel very panicky when I take an important test.	a b c d e
57. When I decide to do schoolwork, I set aside a certain amount of time and stick with it.	a b c d e
58. When I take a test I realize I have studied the wrong material.	a b c d e

e. Very much like me
d. Fairly much like me
c. Somewhat like me
b. Not very much like me
a. Not at all like me

59. It is hard for me to know what is important to remember in a textbook.	a b c d e
60. I pay attention fully when studying.	a b c d e
61. I use the chapter headings as a guide to find important ideas in my reading.	a b c d e
62. I get so nervous and confused when taking a test that I don't answer questions to the best of my ability.	a b c d e
63. I memorize grammatical rules, technical terms, formulas, etc., without understanding them.	a b c d e
64. I test myself to be sure I know the material I have been studying.	a b c d e
65. I put off schoolwork more than I should.	a b c d e
66. I try to see how what I am studying would apply to my everyday living.	a b c d e
67. My mind wanders a lot when I do schoolwork.	a b c d e
68. In my opinion, what is taught in my classes is not worth learning.	a b c d e
69. I go over homework assignments when reviewing class materials.	a b c d e
70. I have a hard time knowing how to study for different types of subjects.	a b c d e
71. Often when doing schoolwork I seem to get lost in details and can't remember the main ideas.	a b c d e
72. When they are available, I go to study or review sessions.	a b c d e
73. I spend so much time with my friends that my schoolwork suffers.	a b c d e
74. In taking tests, writing themes, and other schoolwork, I find I have not understood what the teacher wants and lose points because of it.	a b c d e
75. I try to make connections between various ideas in what I am studying.	a b c d e
76. I have a hard time finding the important ideas in my reading.	a b c d e

Appendix 5.1

Log of time spent in 1998 trialing strategies for 1999

Term 3-Chemistry 2 20 lessons

Total time trialing strategies in 1998 = 175 minutes

Effective time required for S.L.S. work: **175-50*=125 minutes**

(*Traditionally, at least one fifty minute period per topic would be devoted to pre-test revision. This time has been subtracted from the 1998 totals to estimate time required to cover S.L.S. program in 1999.)

Details of S.L.S. activities:

a. Post test study diary, test feedback sheets. Action statements (content specific and metacognitive for mid topic tests while only metacognitive for end topic tests), attributions (x2) 30 minutes

b. Check Learning Chart (x 3) Students not requiring clarification use time for mind maps/notes, testing in pairs etc**.** 30minutes

c. View pink file action statements from last test and then complete test planner (x2) 50 minutes

d. Mind mapping and other forms of synthesising content for improving understanding and revision purposes. (This can generally be done as homework, once the strategies had been mastered) 50 minutes

e. Revision strategies discussion 15 minutes

Term 3- Tinkering with machines 26 lessons

Total l time trialing strategies in 1998 =200 minutes

Effective time required for S.L.S. work **= 200 - 50* = 150 minutes**

a. Post test study diary, test feedback sheets. Action statements are metacognitive if it is an end topic test while only metacognitive for end topic tests), attributions (x2) 30 minutes

b. Check Learning Chart (x 3) (includes 20 min assisting C.L.C students.) Others use time for mind maps/notes etc**.** 30 minutes

c. View pink file action statements from last test and then complete test planner (x2) 50 minutes

d. Factors affecting test performance lesson (to be done in Term 1 in 1999) 20 minutes

e. Concept mapping (x2) 40 minutes

f. Mind map edit circle with peer assessment form 30 minutes**.**

Term 4- Animals 1O lessons

Total trial time in 1998 **=** 80 minutes

Effective time required for S.L.S. work **= 80 - 50* = 30 minutes**

a. Post test study diary, test feedback sheets. Action statements are metacognitive if it is an end topic test while only metacognitive for end topic tests), attributions 15 minutes

b. Check Learning Chart (x 3) (includes 20 min assisting C.L.C students.) Others use time for mind maps/notes/revision sheets etc**.** 30 minutes

c. View pink file action statements from last test and then complete test planner 25 minutes

d. Mind map edit circles with verbal feedback 10 minutes

Appendix 5.2

YEAR 8 LEARNING STRATEGIES STUDENT QUESTIONNAIRE
May 1998

Thank-you for agreeing to complete this questionnaire. Please complete it, then fold it and hand it to your Science teacher.

YOUR CODE NAME ________________________ SCIENCE CLASS________________

Please circle the chosen response.

1. How would you rate your **interest** in Science at this time?

Not interested at all 1 2 3 4 5 Extremely interested

2. How would you rate your Science **ability** at this time?

Very low 1 2 3 4 5 Extremely high

3. Complete the following table by circling the responses.

I prepare for Science **tests** in the following ways

i) Total study time (hours) ii) Study spread over (days)	1 2 3 4 or more
iii) Strategies used (circle as many as you need to)	A. just read book B. underline/highlight book C. make a summary of book (using book wording) D. make my own version of notes (using mainly my own wording) E. practise out loud F. make my own tables or diagrams J. complete the revision sheets in book H. get someone else to test me I. Other ____

4. Which of the following bests describes your science performance?

A. I usually get the science results that I want

This is because (you may circle more than one reason)

B. I put as much effort as I can into my science studies
C. I have natural science ability
D. I have good strategies and habits for studying
E. Other__________________________________
____

F. I don't usually get the Science results that I want

This is because (you may circle more than one reason)

G. I don't put in enough effort
H. I don't have much science ability
I. I don't have good study strategies and habits
J. Other ______________________________
____

Thank-you for your participation.

Appendix 5.3

YEAR 8 LEARNING STRATEGIES PARENT QUESTIONNAIRE
April 1998

Thank-you for agreeing to complete this questionnaire. Please complete it without the assistance of your daughter, seal it in the envelope provided and ask your child to return it to her Science teacher.

Please circle the chosen response.

1. How would you rate your daughter's **interest** in Science at this time?

Completely disinterested	1	2	3	4	5	Extremely interested

2. How would you rate your daughter's Science **ability** at this time?

Very low	1	2	3	4	5	Extremely high

3. How **aware** are you of the strategies your daughter uses to prepare for tests in science?

Unaware	1	2	3	4	5	Fully aware

4. If you feel able to complete the following table reasonably accurately, without asking your daughter, please do so by circling the best responses.

My daughter prepares for Science **tests** in the following ways

Total time (hours) ___________

Study spread over (days) 1 2 3 4 or more

Strategies used (circle as many as you need to)

A. just reads book
B. underlines/highlights book
C. makes a summary of book (using book wording)
D. makes own version of notes (using mainly her own wording)
E. rehearses out loud
F. makes own tables or diagrams
J. completes the revision sheets in book
H. gets someone else to test her
I. Other ____

5. Which of the following bests describes the current **belief** your daughter holds about her science performance?

A. I usually get the science results that I want

This is because (you may circle more than one reason)

B. I put as much effort as I can into my science studies
C. I have natural science ability
D. I have good strategies and habits for studying
E. Other__________________________________

F. I don't usually get the Science results that I want

This is because (you may circle more than one reason)

G. I don't put in enough effort
H. I don't have much science ability
I. I don't have good study strategies and habits
J. Other _____________________________

Thank-you for your participation.

Appendix 5.4

TOOLS FOR LEARNING QUESTIONNAIRE
YEAR 8 SCIENCE 3 December1998

CODE NAME:____________________
Please circle your response

1. How useful have you found the **Test Planner** in helping you **prepare for tests?**

1 2 3 4 5

Not useful at all ... Extremely useful

Reason____

2. How useful have you found the **Test Diary** in helping you **prepare for tests?**

1 2 3 4 5

Not useful at all ... Extremely useful

Reason____

3. How useful have you found the **Test Feedback Sheet** in helping you **prepare for the next test?**

1 2 3 4 5

Not useful at all ... Extremely useful

Reason:____

4. How useful have you found the **Check Your Learning Chart** in helping you **understand the work?**

1 2 3 4 5

Not useful at all ... Extremely useful

Reason:____

5. How useful have you found the **Check Your Learning Chart** in helping you **prepare for tests?**

1 2 3 4 5

Not useful at all ... Extremely useful

Reason:____

6. How useful have you found the **Mind Maps** in helping you **understand the work?**

1 2 3 4 5

Not useful at all ... Extremely useful

Reason:____

7. How useful have you found the **Mind Maps** in helping you **prepare for tests?**

1 2 3 4 5

Not useful at all ... Extremely useful

Reason:____

8. Do you think that using any of these "tools" **improved your results** in Science in any of the six units (eg. Chem Semester 1, Biol Semester 2) you have studied this year?

Not in any units | In 1 Unit | In 2 Units | In 3 Units | In 4 Units | In 5 Units | In all 6 Units

Please explain why:____

____

Thankyou for completing this Questionnaire.

Appendix 5.5

Reason for Ratings in Tools for Learning Questionnaire

Question 1	Rating	
Test Planner	5	It helps me know when I have to revise
	4	It helps me get organized; It made me prepare for my test It made me study for the amount of time I had planned It helped me plan my time wisely (x2) I usually stuck to it a lot It helped me spread out my study time It helped me sort things out
	3	I don't always stick to it (x2) I only study when I want to It does help but I don't look at it enough after I have completed it
	2.	I don't stick to it (x2) I just rely on my head for study planning (x2) I couldn't be bothered to look at it I don't really know how to study hardly use it at all
	1	I don't need it
Question 2 Test diary	5	Helped me to improve study habits by learning from my mistakes It was good to look back to see how I went in previous tests
	4	Because it helps me
	3	It doesn't help me much (x2) I don't pay much attention to it (x3)
	2	Not sure why Can't be bothered (x2) I didn't follow it It didn't really help me I didn't use it that much (x2)
	1	I don't need it
Question 3 Test Feedback 4	5	Helps me know how hard I have to study It shows you where you need to study more. It made me see what I should do next test Because I could see if I have to study more It helped me realise what I did wrong (x2) It showed me what I could improve (x2) Helps to focus on things I could fix It helped me learn from my mistakes
	3	It shows how I can do better Did the same anyway I know what I don't know I would have liked to take it home to remember my mistakes
	2	I don't really use it I never use it
	1	It doesn't help me at all because I'm always satisfied with my test mark
Question 4 Check Learning Chart	5	It helps you before the test by explaining the work It was easier to understand the work It helped me understand things a lot more (x3) Because I could get help on things I didn't understand Because you go over the stuff you think you know but sometimes you might have left things out Allowed me to understand all the booklet and refresh my memory It helped me answer all the test questions I can have things explained again so I know the topic better I could understand things I didn't understand before Gives you a better picture of things
	4	Could get help when I missed lessons It is a good way to make sure you understand the topic
	3	Haven't used it myself It has helped me sometimes just to clarify the topic I didn't use it very much
	2	No responses
	1	I didn't understand it

Question 5 Check Learning Chart helps prepare for tests	5	It just helps me I can go and check that I know everything before the test Good revision (x2) Test preparation - I have done much better in tests It helps you study. Quick revision I wrote notes on things I didn't understand It was very useful and helped me understand things better (2) It helped to refresh my memory & know what to spend more time on
	4	It lets you understanding things **before** the night before the test Helped me know everything
	3	I didn't use it very much I haven't used it yet
	2	Useful when I used it but sometimes I didn't really prepare for the test anyway I tend to prepare for tests at home
	1	I didn't understand
Question 6 Mind Maps improve understanding	5	Helps you understand a lot better I think these are the best It was very good for me to learn The pictures remained in my mind They covered all the work without pages of notes Much easier to study (x2)
	4	I can see the ideas fit together They are REALLY useful and help you visualize your information Because they are fun They help you understand the work better (x2)
	2	It was sort of helpful (x2) Because I need lots of detail and when I do them they're too messy They're all right but not more effective than other means of study A good way of showing the information differently
	2	I normally understand everything very clearly
	1	I cannot remember anything about them
Question 7 Mind maps help prepare for tests	5	They help you understand a lot better I have understood these more They help me learn points I need to know Good revision You don't have to go through pages of notes to study (x2) I look at it and it sticks in my mind If they were clear they took me less time to study Studying is easier and you can remember it more
	4	A place to start my study because everything was summed up A good way of studying Its easier to study from a Mind Map Because they are fun
	3	I didn't really look over them much (2) Sort of helpful They're all right but not more effective than other means of study The pictures help me remember
	2	I normally understood everything very clearly I don't have faith in them
	1	No responses

Question 8 Perception of the number of units, from a total of six, in which the learning 'tools' had helped improve Science marks.

No. units	No.students	Comments
6/6	11	They help you get more organised & motivated to study and do well Because it made my study more spread out and I didn't study at the last minute Even though my results may not have been great, I'm sure everything contributed to better work I understood things better It helped in all units because I knew what I needed to know

		New ways to see info Without the Learning Chart I would have failed every test. It helped me understand Because it is an easier way to help me understand what is going on in science Because each time I understood it better Because of all the reasons I have mentioned
5	5	I understood and enjoyed the units, it was easier to study Mind maps especially - I studied a lot I wasn't here for the first unit. It helped in all the others because things stick in my mind
4	2	For two units I don't think we did it For some I didn't have time or I wasn't sure how to use them
3	0	
2	1	The two units we did mind maps in
1	0	
0	1	I've always understood everything in every topic

Appendix 5.6

Comparison between student and parent Questionnaire responses

Science interest: parent & daughter comparison

Matching parent and daughter responses:

Of the 70 pairs where responses were received from both parent and daughter, 51.5% chose matching interest ratings. Of these, 11 pairs selected a rating of 5 (extremely interested), 16 chose a rating of 4, and 9 pairs chose a rating of 3 (intermediate interest).

Differing parent and daughter responses:

Twenty eight point five percent of parents chose an interest rating which was, on average, 1.2 scale units higher than their daughters. Twenty percent of parents chose a lower rating than did their children. These students rated their interest level an average 1.5 scale units higher than their parents.

Science ability: parent and daughter comparison

Matching parent and daughter responses:

Of the sixty nine pairs where responses were received from both parent and daughter, 50.5% chose matching ability ratings. Of these, 15 pairs selected a rating of 5 (extremely high), 13 chose a rating of 4, and 7 chose a rating of 3 (intermediate ability).

Differing parent and daughter responses:

Thirty two parents chose a higher ability rating than did their daughters. The rating was an average of 0.9 scale units higher. Seventeen point five percent of parents chose a lower rating than did their offspring. The students rated their ability an average of 1.5 scale units higher than their parent.

Study time (hours): parent and daughter comparison

Matching parent and daughter responses

Of the forty four pairs where responses were received from both parent and daughter for this question, only 13.5 % nominated the same amount of study time (1.1 hours on average). The low number of matches was possibly because the item was not presented in scale form (it was open ended) and was also not well located.

Differing parent and daughter responses:

Fifty seven percent believed their daughters studied an average of 1.7 hours more studying for science tests than their daughters reported. Twenty nine point five percent of parents believed that their daughters studied an average of 0.9 hours less than their daughters reported.

Study spread (days): parent and daughter comparison

Matching parent and daughter responses

Of the fifty pairs where responses were received from both parent and daughter for this question, 48 % of pairs indicated the same number of days studying for science tests. Most of these pairs (13) nominated 2 days, 6 pairs nominated 3 days, 3 pairs nominated 2 days and 2 pairs nominated 1 day.

Differing parent and daughter responses:

Thirty two percent of these pairs believed their daughters studied an average of 1.4 days more studying for science tests than their daughters reported. Twenty percent of parents believed that their daughters studied an average of 1 day less than their daughters reported.

Parent awareness of student test preparation strategies

On a scale of 1 to 5, only 5 parents (7%) of the 69 who responded to this question said that they were 'fully aware'(5 on the scale) of their daughter's learning strategies. Twenty four point five percent of parents chose a rating of 4. Thirty three percent chose an intermediate rating of 3. Twenty six percent chose a low rating of 2 and 8.5 % said they were 'unaware' of the learning strategies used by their daughters. These parent opinions about their level of awareness are supported by the high percentage of agreement about the number of strategies used at the higher reported awareness levels (see Table). As reported parental awareness levels drop from 5 down to 3, so do the number of strategies commonly agreed to by the majority ($\geq$ 40%) of parents. At the awareness level of 2, 42% of pairs agreed on either 1 or 0 strategies.

Percentage of parents (of varying stated levels of awareness) in agreement with offspring on different numbers of test preparation strategies

Level of awareness	No. of strategies agreed upon					
	0	1	2	3	4	5
5 fully aware(n=5)	0	0	20	20	**40**	20
4 (n=14)	0	0	21	**43**	21	14
3 (n=17)	18	**41**	29	18	0	6
2 (n=14)	21	21	29	14	7	7
1 unaware (n=3)	7	0	33*	0	0	0

* N is unacceptably low and no conclusions can be made at this awareness level

Satisfaction with results: parent & daughter comparison

Matching parent and daughter responses:

Of the sixty pairs where responses were received from both parent and daughter for this question, fifty one pairs (85 %) had matching responses. This high percentage of matching responses indicates that parents of this cohort have a high degree of awareness of the level of satisfaction felt by their daughters about their science results. Of the 50 matching pairs, 43 pairs responded that they usually get the results that they want, while 8 pairs agreed that they do *not* usually get the results they want.

Differing parent and daughter responses:

In three percent of the 60 pairs, parents believed that their children get the results that they want, whereas the students indicated that they do *not* usually get the results that they want. In twelve percent of the 60 pairs the students indicated that they usually do get the results they want while their parents indicated that they do not.

Attribution for results

Students satisfied with their results:

For 61 individuals, attributions were made by either parent, student or both
(parent or daughter may have nominated more than one attribution).

n=61	High effort (%)	High ability (%)	Good study strategies & habits (%)
Both parent & daughter	28	18	15
Student only	31	10	20
Parent only	8	10	23
	Low effort (%)	Low ability (%)	Poor study strategies & habits (%)
Both parent & daughter	0	2	0
Student only	0	2	0
Parent only	3	2	7

It is evident that satisfying results were most often attributed to high effort, rather than high ability by students. …

Students dissatisfied with their results:

For twenty nine individuals, attributions were made by either parent, student or both (parent or daughter may have nominated more than one attribution).

n=29	Low effort (%)	Low ability (%)	Poor study strategies & habits (%)
Both parent & daughter	0	17	7
Student only	7	**45**	20
Parent only	7	7	7
	High effort (%)	High ability (%)	Good study strategies & habits (%)
Both parent & daughter	0	0	0
Student only	24	0	0
Parent only	10	7	3

There is a very high attribution by students to low ability that varies from parent. 62% of students said low ability while only 24% of parents said low ability. Student attribution to low ability may be exaggerated as parents and student views about ability match closely. It is likely for parent and student attributions to differ more than views on student interest, ability and study time because attribution is not as overtly obvious to parents. Attribution is probably less likely to be revealed in general parent child discussions.

Appendix 5.7

Teacher Survey Question Three Opinions

It's important to teach in context
I've always been meaning to do this.
Important but not for me to do.
How to obtain information, where to look and tools and skills to do this.
I give lip service to its importance rather than practice.
I'm doubtful as to whether they have any positive effects.
I believe it is important but it tends to be neglected. Students lose interest quickly when teaching study skills.
Content needs winding back to achieve more. Consistency across all subjects is an issue. Perhaps it needs to be addressed as a separate whole school issue
How to reflect and metacognition are just as important.
Without these skills, content is useless.
Important to reinforce, not necessarily teach. These tools for learning should have been introduced well before kids come to high school.
I see it as essential across the curriculum.
Importance increases in Year 10.
Independence in learning is important.
Teaching how to learn is as important as the content.
If students learn how to learn, my job is easier.
What I believe and what I achieve in class are two different matters (mentioned three times ie. x3).
Our syllabuses don't allow enough time to do this properly (x4).
Not much time when you have to teach lots of content as prescribed by curriculum or HOD (x4).
I prefer to advise on an individual basis. Many students already have good study skills (x3).
Time constraints prevent this being taken further (x3).
Believing study strategies are important doesn't mean that they are taught, or that much time is spent teaching them. (x4).
More important to coordinate teaching of strategies across each year so that students have a consistent and cohesive set of strategies to work with (x5).
Find year 8-10s not so interested and don't need study skills as much as Year 11 or 12 (x4).
It <u>needs</u> to be taught. Students are coming to high school without these skills (x5).
Integrate them with the teaching process.
Study strategies imply the test is dominant and I don't believe the test should be the main assessment tool, nor should the test dominate the learning process.

Appendix 5.8

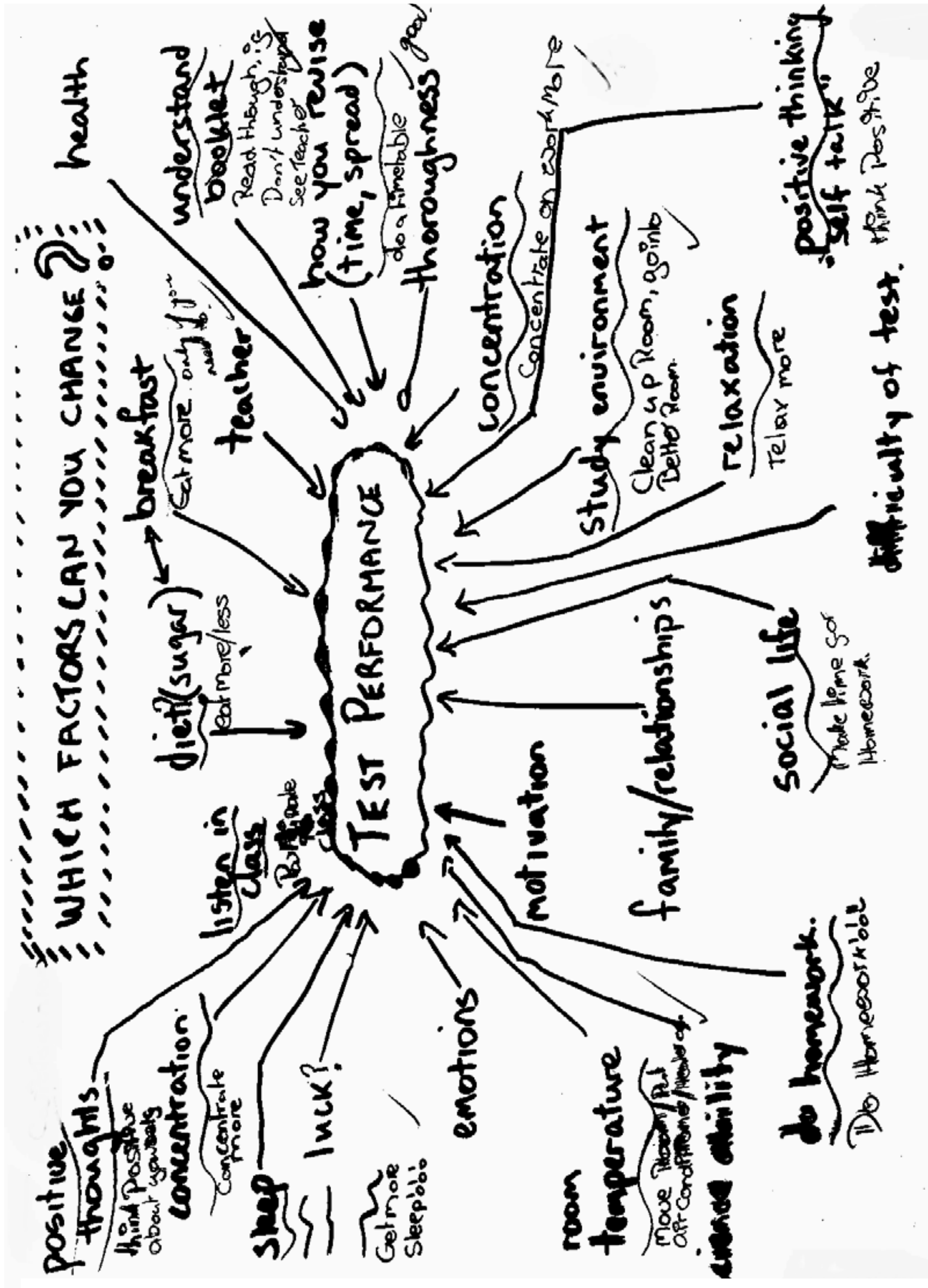
Teacher Survey Question Four Opinions

Other comments explaining the teachers judgment about the importance of teaching study strategies:

It helps them to be independent learners.
Study strategies are important but content is too hectic to allow them to be the main focus.
It is a vital skill which is carried to other years.
The academic coordinator can teach study skills to students.
The strategies can be transferred to upper school.
Students naturally form their own strategies but they are not inborn.
It is more important that students can use skills to find information than memorise heaps of content.
I should do more of it.
Students often don't get these skills anywhere else.
I do the best I can – which is far from perfect. I don't know all that much about study skills. Different people learn differently.
It has to be a part of the curriculum. It doesn't work if it's done as "study skills". As part of science it is O.K. or as part of other subjects.
It also practically integrates different subject areas in that there is exposure in other disciplines as well.
Students need to be taught how to become independent and efficient learners, rather than filled with content.
Improving strategies in Lower School makes my job easier.
It is a skill that can be carried through to other subjects and further education.
We have a person at our school who has the responsibility to teach study skills.
We should have special courses at our school.
Also we have the responsibility to reinforce such skills even if they are taught in other learning areas.
Students should refine these skills while doing homework and exam revision.
Strategies are incorporated in the teaching of process and content.
Many teachers teach study strategies.
I don't feel sufficiently qualified to teach some of them-needs specialist teaching in a study skills course.
It allows for a variety of teaching activities to be used if students have these skills.
Study strategies make better use of available study time – improves efficiency.

Appendix 6.1

Factors affecting test performance



REASONS FOR ERRORS

Topic:___________________________________

For each question you got wrong, write your name in the column that explains why you made the error.
You can choose more than one reason.

Question number	Misread question	The wording confused me	Didn't learn it	I was away when we did it	I didn't understand the idea	It was too hard for me	I knew it but I made a silly mistake	I didn't understand the question	I couldn't remember it	Other
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										

Appendix 6.2

Appendix 6.3

Parent phone survey – December 1999

Hello, I'm Penny McGlynn, __________'s science teacher at school. Can I ask you a few questions for my PhD research about the Year 8 Science course.

This year_________________'s class has been taught a series of science learning and study strategies as part of the Year 8 Science course.

1. Were you aware of this Yes No
2. How much did ____________ tell you about the S L S Program
   Nothing 1 2 3 4 5 everything
3. Were you aware of ____________'s study and learning strategies changing over the course of the year as a result of the Program? Can you explain how they changed?

4. How much effect would you say the Learning Strategy Program had on _________'s results.
   No effect 1 2 3 4 5 a very large effect.

5. How much effect would you say the Learning Strategy Program had on _________'s results.
   No effect 1 2 3 4 5 a very large effect.

6 What would your daughter have blamed disappointing science results on at the end of Year seven?

7 Has there been any change over the year in what your daughter believes causes her results, as a result of the S.L.S. course?

Appendix 6.4

February student interviews

<u>Question 1:</u> How would you make sure you understood all of the ideas?

I read the book, read the questions, try and think of the answer then go and ask a smart person (Alex)
Read over the booklet. If I don't know the meaning of a word I look it up (Hannah)
Read the book and ask you if I don't know something (Karen)
Test myself on one bit before I go onto the next thing. I also make up questions and answer them (Chrissie)
Write a list of points and ask a friend or ring her up (Anna)
Check through several times (Lilly)
Write points down (Robin)
Just keep reading (Tilly)
Write a list of problems and page numbers and ask the teacher next day (Lauren)
Ask the teacher although I usually understand (Louise)
Ask my parents, then the teacher (Sally)

<u>Question 2</u>: If you didn't understand an idea, what would you do about it?

Ask the teacher or parents (Alex, Sophie, Annabel, Amanda, Sarah)
Read through book and get Mum to help me with bits I don't understand. If I don't understand in class I ask questions (Brittany)

<u>Question 3</u>: How would you go about remembering the ideas and how would you know when you had remembered them?

On the first study day I make notes on the main topics. Then I read these every night and test myself. I keep reading through the book to make sure I understand. Then I put it away and say it in my head. I do this a few times. Then I read a bit more of the book. I do the same thing on the next night but also go over the stuff from the first night. I also get friends to test me because Mum and Dad are busy. (Natasha)
I read and cover, say it in my head over and over and then test and check if I got it right. If I got it wrong, I'd read the section again, write it down over and over until I get it right. (Sophie)
Things or words I can't remember, I write in order and use the first letters of each thing to make up a word. Then I practise saying it in my head until I get it right. (Alex)
I say it over in my mind. I just know when I know it. (Annabel)
Sometimes I highlight. I write notes and get Mum to test me. (Brittany)
I work through the section, then go back, then forward, then back to the beginning (Sarah)
I read through, highlight things I don't know. The next night I go through the things I didn't know again and try and understand them. Next day, I make up some questions. I make up a sheet of questions for each day and put those in the next day's session as well (Laura)
Repeat stuff in my head 4 or 5 times (Anna)
I read and repeat. Mainly just repeating (Robin)
I try a different strategy each time. I write out a branching list, cover and recall, dot point notes, make up questions, draw pictures (Lauren)
I write questions on slips of paper, put them in a bag and draw them out (Louise)
I repeat about 10 times but I have trouble remembering. I talk through it with my parents (Sally)
I test myself until I know it and try and answer it without looking. I also get a friend to test me. I also read revision questions and write the answer without looking. I also make up questions (Ginia)
I test myself every night and make up questions I think will be in the test (Alex)
Read cover, say it in my head over and over and then test and check if I got it right (Sophie)
Cover, test, retest. Get my parents to ask me questions (Sarah)
Test myself (Hannah)

Question 4: How many days would you spread your test revision over and how long would you study each night?

Three or four nights for 30 mins each night (Brittany)
Five weekdays but leave the weekend free. Half an hour each night plus Science homework (Alex)
If something is hard to remember, I might look at it every night. Otherwise I'd look at it three times (Sophie)
About four days, half an hour on the first night then building up (Annabel)
Two nights, if I do more than that I forget it (Sarah)
I start a week away for a 60% test and do 30 minutes each night (Laura)
Thirty minutes each day for a few days (Bree)
Forty five minutes each day for a few days (Ginia)
I spread it over a few days (Chrissie)
Thirty minutes four days and one hour the night before test (Karen)
One hour the first night for five nights (Anna)
Four or five days (Lilly)
Two days before. Most on night before test (Robin)
About half an hour for 4 days and one hour the night before the test (Lauren, Louise, Steph)

It was pleasing to see that many of the students who responded to this question reported spreading their learning over several days rather than 'cramming' on the evening before the test.

Question 5: What tricks for understanding and remembering ideas you have tried?

Make up a song (Laura)
We used Never Eat Soggy Wheat-bix (mnuemonics) (Chrissie)
Get Mum to test me (Karen)
Mneumonics don't work for me. I just memorise key sentences and then look back, cover and test. (Ginia).
Laura, Bree, Karen and Chrissie also commented that they cover and test)

Question 6: Did you do any work in primary school about how to understand, learn and remember science?

Last year we could put anonymous questions on paper into a box so we wouldn't look stupid. Then the teacher would write the answers on the board. I also use mneumonics. We also did flow charts. (Sarah)
We learnt flow charts (Annabel)
The day before a test the teacher used to revise in class with us (Karen)
We used an A3 sheet divided into 8 squares with the main subtopics and points. We also watched Behind the News (BTN) and practiced taking down the main points and then writing a report from them. We also learned poems. (Brittany)
The teacher plays a tape or video of BTN. You take down the main points and write an essay from them.
We did some mind mapping but nothing about how memory works (Lilly)
Some mind mapping, nothing about how memory works (Anna)
BTN and mind mapping (Tilly)
Mind mapping (Amanda, Ginia, Chrissie, Robin)
We learnt mind mapping but I didn't get it. It didn't work for me. (Lauren)
We didn't do any except "look, cover, check" for spelling (Sophie)
Tests in primary school were really easy so you didn't really have to remember much (Alex)
Nothing (Laura, Bree, Steph, Louise)
We got no help learning how to learn. We just had to learn things off by heart in Jakarta (Natasha)

Appendix 7.1

Tapes December 1999

Researcher = RE
<u>Steph</u>
RE What things do you do better now?
S. I can memorize things easier and I understand them and having the mind map, that really helps me because I like to look back at that and go over it and I understand it just by looking at it.
RE So why do you think you can remember things better now?
S I need to memorize more in high school and the spider map helps me and I've also had more interest in science.
RE Big difference ?
S Just the spider maps again
RE Important to be taught?
S Very important because science is an important subject
RE Have you been taught these things in other subjects?
S No
RE Has it given you more of an idea about why you get the results that you get?
S Yes it has
RE Can you say what has helped you have more of an idea?
S Well, because I'm not always satisfied with the marks I get and so that helps me I know that I have to try to get more marks, I have to study quite hard.
RE Has the SLS work made you feel more confident in Science?
S Yes it has, its given me confidence that I know more and actually study more.
RE Made you feel more in control of your performance in science?
S I can control it better than I could before but I still can't control it that well, not as well as I'd like.
RE Purple book. How useful did you find it? We didn't have a lot of time with it.
S Um, it was good because I went through and I saw what I needed to do more of. But I needed to be able to take it home and study it and have goals and I didn't have time to compare last terms scores to this terms.
RE Would you like to keep the booklet?
S. That would be good for next year.
RE Did it make you see what a big range of things actually contribute to haw well you go?
S.Yes, quite a big help.
RE Now just with improving your marks, can you give an impession of what percentage your mark has improved because of the SLS work?
S Probably by 30 % or something
RE You fairly sure about that?
S Yes I think so, because last year I was pretty bad at science and this year I've done heaps better.

<u>Karen</u>
RE Thinking of all the S.L.S. work does anything stand out that you've improved on?
K The main thing is the idea organiser chart. To be able to know what's important to study. And to be able to summarise ideas and make studying a lot easier.
RE Can you think of any instances where the SLS work has helped you for a particular test, has anything stood out?
K. The idea organiser.
RE How imprtant do you believe it is to be taught these kinds of strategies? 1 not important, 5 very important?
K Probably about a three
RE Have you spent much time learning these sorts of things in other core subjects this year?
K. NO none at all
RE Would you say that this work has given you more of an idea about why you get the results that you actually get?
K A bit probably a three.
RE Why has it given you more of an idea
K If you've used your time wisely and you get a good result then you know it's that.
RE So you would attribute it to the way youre actually setting out your study time?
K Yeah
RE Would this work have made you feel more confident in science this year?
K Yeah probably, because we worked really hard in class on how to use the summary and how to identify what are the key ideas. You feel confident that you're learning the right things.
RE Would you say that the course has made you feel more in control of your performance in science
K. Um, yeah probably, because you feel if you plan and spend the time summarising and actually learning the summary sheet, then you can get the mark you really want.
RE Purple book. Some of the things you've jumped up a mark like knowing your stengths and weaknesses and deep processing and selecting the main idea, checking your understanding, what do you think has made you feel that you're improving on those?
K Just because like we had more practise at each strategy with each section we did.
RE So it was like a practise effect.
K Yeah
RE You've really improved on the "cramming" one. Why was that?
K Well with the summaries, they take a while and you need to start them ahead so they are ready in time. It's good because it forces you to spread the revision time out.
RE These two graphs , was this interesting for you, did you know about the way you lose information if you don't spread your revision out?
K NO I didn't know before
RE Do the graphs match your experience when you changed from doing everything the night before to spreading it out?
K Yeah it does

RE Why did orgainsing your study time go down?
K At the beginning, I didn't realise I shouldn't be cramming so I gave myself a score that was too high. But now I know that some people start studying a week before, I realise that Im only going OK on that now.
RE You've put improved your marks by 10%. Do you feel that that's about right
K Yeah
RE Have you been able to use any of these strategies like planning for tests, spreading your study time for other subjects?
K Well for the test week we did a test planner and because we were used to doing them for science you felt like you knew what you should be doing. So it was useful for test week.
RE And are you checking your own learning a bit more in other subjects now?
K Yes I just naturally do it now because of the practise we've had.
RE So you've found it quite valuable?
K Yes, can we keep the purple booklet? Then I can keep going back to it?
RE Yes you can. Were you not really aware of that range of things contributing.
K No I wouldn't have thought that there was that many things you can change
RE I've just picked some
K Yes you've picked the relevant ones
RE Is most of it useful?
K I think it is, not all of it is relevant to each person but if you're doing it for everyone then everyone feels that different things are relevant to them.
RE Would you rather have not done the SLS work?
K Probably if we had started in year 10 I wouldn't have liked to do it but in Year 8 you've got the time to spend on it to get it right then it's worth it. It's been better at the end once we knew all the strategies when we could chose the ones that suited us best, but we still had to do it and you checked it.
RE Yes I think you need to make people do enough of each thing so that they are good at it and then let them choose.

Brittany.
RE Just thinking about all the S.L.S. work we've done this year, what things do you do better now than before we did the program?
B Probably summarising and probably organising my study time
RE Can you think of any times when the work we did made a big difference for a particular test?
B. No
RE How important do you think it is to be taught these kinds of strategies in science 1 is not important, 5 is very important?
B 4
RE Why do you think its important?
B I find the summarising really good because usually I don't know what to study. And I get confused by what's the most important. So it's helped a lot.
RE Have you spent much time learning these things in other subjects this year?
B No
RE Has the SLS work given you more of an idea about why you get the results that you get?
B Yeah, sort of.
RE So if you get a good result do you know why you got it?
B. Yeah,
RE Would you say that the work has made you confident in science
B Yeah , a lot more confident.
RE Is that because you feel you can plan better?
B Yeah and also if I ask you before if the organisers are right and then I'm really confident that I'll go well.
RE Has the course made you feel more in control of how you are going in science.
B. Yes, same sorts of reasons, the planner and the mind maps particularly.
RE This purple book, how useful have you found this? Has it been a surprise to you the number of things that you can change and did that effect how you go?
B Yeah
RE So you're going really well at all of them arent you? You've put a 3 for knowing your strengths and weaknesses is that because…. When you use the reasons for errors sheet does that help you to work out what sort of mistakes you are making so that you can then change them?
B. Yeah, usually I make silly mistakes.
RE Overall, what difference has the SLS course made to your mark?
B About 10%
RE You fairly sure about that.
B. Yeah

Isabel
RE How well do you think you're going doing Record sheets 1 is not well and 5 is very well
I About 3
RE What problems do you have with them
I Well I usually forget to fill them in sometimes I put a certain amount of study time but I don't do any because I just don't have time or something because of the way things turn out.
RE And what about this section her (test feedback) do you find this helpful to do or not really?
I Not really, it doesn't affect me much.
RE. Is that because you always do well?
I I suppose so , Yeah

RE OK So how would you rank them for helpfulness
I About 2
RE Do you understand what the record sheets are trying to teach you?
I Is it helping you study stuff?
RE Yes, planning time and things like that and I think that you already know how to do all those things. Would you agree with that?
I (noise interrupts tape)
RE You put 5% for the change in your mark and I know from the chat we had the other day with Sonia that you didn't really enjoy the S.L.S. courese. Can you explain what you didn't like about it?
I Well the mind maps and things meant a lot of extra study.
RE Do you think the course made you feel more in control of how you went?
I I was in control aanyway.
RE What about confidence. I suppose you were already confident?
I Yes I was.
RE Can you think of a way that I could have done the course that would have been more helpful to someone with your capabilities. Obviously, you know most of the strategies. What about say at the end of term 1 I had said, OK those people who are not finding the course useful can do project work once you have passed a S.L.S. test?
I Yeah, that would have been good.

<u>Natasha</u>
RE How much has the S.L.S. effected your science results. Overall?
N 10%
RE Can you tell me what made you say 10?
N Well in the beginning I didn't really like summar Appendix 7.1 continued take out information better, then I found it easier to study and so I knew more.
RE So you felt that you were better prepared?
N Yes
RE How important do you think it is to be taught the S.L.S. strategies
N 5 because its always good to know the strategies you can use even if it doesn't help you its always good to just know for yourself.
RE Have you learnt any of these things in other core subjects this year?
N. In English we've learned essay planning and summarising things from books.
RE Does it feel like all of the strategies have been a constant part of the science course this year?
N Yeah, different things have been shown to us at dufferent times but there's always something.
RE So it has felt like a special program?
N. Yeah, it comes along with the package.
RE Has the course given you a better idea about why you get the results that you get?
N Yes, it has because I know in my mind that I've learnt everything and so if I do badly, then I know because I wasn't paying attention too much in class when you were discussing more about something.
RE Can you give it a number?
N 3 or 4
RE Confidence. How much difference has the S.L.S course made to your confidence in Science?
N 4 or 5
RE Can you explain why?
N I've learnt summarising and I'm finding it just so much easier to learn and remember everything.
RE And what about understanding? Is it helping you there?
RE So you feel more confident. Why is that?
N I know everything, and I learn easier.
RE I was asking about understanding. Has the SLS stuff helped.
N Yes its broken it down to the very basic things and then from the basic things you can go of and rebuild it for yourself.
RE Has the course made you feel more in control of your performance in science?
N 4 I know what I'm learning now and I'm more clear with all the things we've been taught and I'm understanding more because I'm using all these strategies and stuff. I can be in control of what I learn and what I put down in a test.
RE How did you find the purple book? Did you find it very useful at all?
N Not really. Some of the information that it gave on the pages was quite useful.
RE Thanks

<u>Jemma</u>
RE So you've only found the S.L.S.a little bit helpful. Can you say why?
Jemma Because sometimes I didn't really want to have to do it. So I didn't really want to do it my best.
RE How could we have changed it to have made it more useful for you or would you rather not have done it all if you had the choice?
Jemma Probably I would have wanted to do the mind maps.
RE You found them good?
Jemma Yeah
RE And then try and have more choice with the strategies? Maybe just learnt the strategies in first term and then had free choice, would that have suited you better.?
Jemma Mm
RE And did you feel that it took time to do it that you could have used better in other ways?
Jemma No not really

RE So if you hadn't been doing the mind maps and stuff would you have been doing study for the science tests in some other way or would you tend to have done less study?
Jemma Less study
RE So it may have helped you a bit in helping you to get on top of the material by mapping it?
Jemma Yeah.
RE I would say that you've improved over the year in your summarising. Do You think so?
Jemma Yeah
RE And yet your saying it hasn't helped your results. Do you know why that would be?
Jemma No
RE Do you think there are some things about test technique that might be a problem?
Jemma (no answer)
RE With your tutor, are you finding that's been helpful.
Jemma I don't have a tutor any more
RE Just trying to think of ways we could have helped you a bit more. Did the Check Your Learning chart help?
Jemma. Yeah that was alright
RE. Is it mainly test technique for you more than anything. We should have spent some extra time going through tests after you get them back.
Jemma I think its more that I forget stuff
RE So what are you doing when you study for a test.
Jemma I just revise through the work and do little tests for myself. Cover it up.
RE Do you do the thing where you test some of it one day and then the next day you go right back to the beginning and then retest all of it again?
Jemma No
RE That might be making a difference (explained technique). Do you think the S.L.S. course made you more confident in science?
J Not really.
RE Has the course made you feel a bit more in control of your science learning.
J No. I don't think so.

<u>Lilly</u>
RE Can you think of any things that you do better now because of the SLS work we've done this year?
L Summarising
RE Anything about preparing for tests or any other things
L Probably mind maps
RE Can you think of any particular instances where the work helped for a test
L No, not really
RE How important would you say it is to be taught these kind of strategies in science? 1-5
L 3 Because you need some other ways of studying as well, and preparing, like your own ways are good as well.
RE Have you spent much time learning these kinds of things in other subjects this year.
L Not really, no
RE Has the course given you more of an idea about why you get the results that you get?
L Yep, the planners help because you know that if you've studied more you get better results.
RE Does it show up whether you are doing enough work or not, does it keep a more accurate tab of what you've actually done rather than what you think you've done?
L Yeah, its good like that
RE made more confident in science?
L Yeah, a bit about 3. Because of all the strategies and stuff, the mind maps. I'd rather do mind maps than concept mapping.
RE So if you hadn't done any of the work with me at all, do you think you'd feel as confident as you do now in preparing for tests? Do you think your own strategies would have done as well
L Probably not, my own strategies weren't very good.
RE What would you have been using?
L Just notes, handwritten ones.
RE What would have been wrong with them?
L It's hard to learn them
RE Has the work - control
L Yeah about 3 or 4 because it makes you do study.
RE What actually makes you study more?
L The planner things.
RE So you've been able to do those realistically?
L Yep
RE Overall affect on results
L Improved by 30%.
RE Think carefully about that.
L About 25%
RE So you've found it really helpful?
L Yeah

Lauren
RE What Do better now because of SLS?
L Doing the summaries and the right information out of the book. I've learnt not to do all of the whole book in my notes.
RE So that's something you've learned because of the SLS work?

L Aa Huh
RE Any instances?
L No
RE With all of these strategies, how important do you believe it is to be taught these in science?
L 4 because science is basically like a different language and its very hard to understand and learn.
RE Other subjects
L I think they expect us to know these things from junior school.
RE And do you think that's accurate?
L No, not really, the teachers in junior school weren't very good at teaching …
RE Not very conscientious about teaching learning strategies?
L No they weren't. Although we did do some mind maps.
RE Has the course given idea about why results
L Members It sort of helps you pick out the right things
RE But if you do badly in a particular test, does it give you information about why?
L Yeah, going through it afterwards and doing the reasons for errors sheet makes you think why you actually got it wrong and find out the right answers
RE With the reasons sheets, if you got something wrong because you've not read questiopns carefully, has that helped you read the questions more carefully next time.
L Yep
RE Can you think of any other changes you've made in taking tests
L Like studying more, but sometimes I forget because I'm nervous.
RE Would SLS fooel confident
L Yes, 4 because I've tested all the different strategies and work out which ones suit me.
RE What ones suit you?
L Parrot fashion but also understanding
RE In control
L Yeah, 3 or 4 because its good how we go through and make sure everybody understands before the test with the CLC.
RE Overall %
L Improved me 40.
RE Wow that's a lot. Are you sure?
L Yeah because other subjects haven't gone through why we've gone wrong and made sure we understand. I'd be 30-40%.

<u>Amanda</u>
RE Did you find the Purple booklet any help?
A I only used some sections.
RE Was it worth bothering with, how was it useful.
A Just to get you to think about all the different things that can help
RE SLS work has tried to help you manage your learning. General
A Goal setting sheet where you put your mark and where you put the priorities. And the CLC
RE Particular test
A Pass
RE Important to be taught?
A 3 because if you don't know the strategies then you won't get anywhere. It's better to know strategies because then they can help you learn
RE SO do you think that generally people come to year 8 without a good range of strategies?
A I think so, I didn't know anything, I don't know about other people.
RE. Have you learnt in other core subjects
A I think I did something for English about goals for an assignment.
RE Would you say that science has been much more definitely focused at learning strategies
A Yeah
RE Has the course given you more idea about results
A I don't know
RE I was thinking of the Reasons for errors sheet
A Yes I think they helped
RE Have any trends emerged for you about why you get things wrong
A Yeah, not reading the question carefully
RE What's the benefit of knowing why you got questions wrong?
A Cause then we can do it differently. I sometimes didn't study properly.
RE So have you learned to change your study patterns
A Yeah
RE How have you done that?
A I started studying the day I get the planning sheet and spread it out more
RE Confident?
A I think it has. At the beginning of the year I wasn't very confident with science and I wasn't getting good marks compared to now when I've got the purple book.
RE Control
A Yes, if I want to do better I know how to.
RE Overall
A About 10%
RE Are you sure
A Yeah

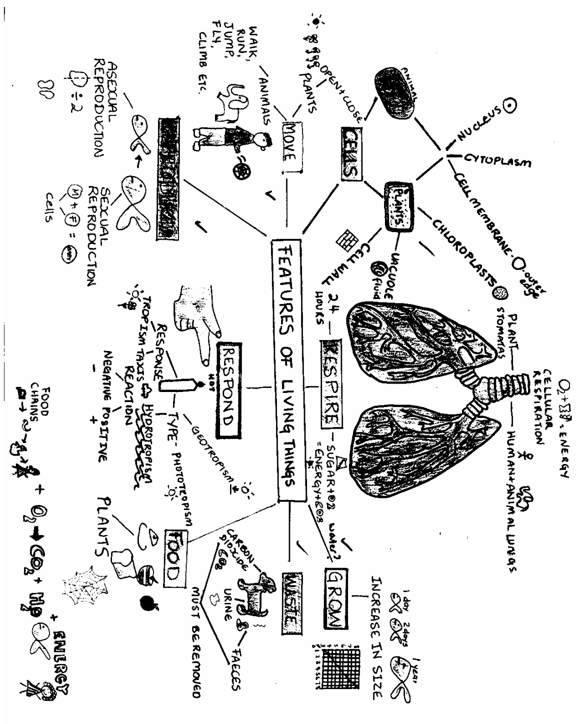
Appendix 10.1

SCIENCE LEARNING STRATEGIES PROGRAM
PARENT NEWSLETTER
June 1999

Dear Parent/s

Your daughter has been participating in the Science Learning Strategies Program (S.L.S.) this year, which is designed to help her **more actively manage her science learning.** Girls have been learning strategies such as those described below, as an integral part of the science course. It is important to note that science content is not sacrificed, as it is delivered through the learning strategy instruction.

Some strategies that the girls have learnt in first semester include Mind Mapping and the use of Idea Organisers. These "tools for learning" require students to identify key concepts from text, and encourage them to make concise summaries. The major advantage of these strategies is that students need to understand and become very familiar with the ideas in the course so that they can process them and then "translate" them into their own concise words or symbols. For the teacher, these Mind Maps are helpful in identifying student misunderstandings of important ideas. Here is an example of a Mind Map of the topic Features of Living Things.



A student's thoughts about Mind Maps:

"Mind maps help us study so we don't miss out stuff. Sometimes I wasn't sure what's going to be in the test but this way you get the main stuff. With the mind maps you have to sort everything out first so you can draw them."

We have also been using A Check Your Learning Chart. Periodically during the course of a unit, students are asked to look back through the unit to identify problems. They then put their names on Post It notes and place the notes under the heading where they experienced problems, on a laminated wall chart. During the following few days, small groups of students with similar problems are given extra help while the rest of the class proceeds with a set task. Students find this system very helpful and it encourages them to indicate that they need some help as soon as they encounter a problem. A student commented recently that the Check Your Learning Chart "*makes you aware that other people don't know stuff too."*

Additional strategies which we have addressed during first semester include planning for test revision and identifying reasons for test errors. To date, most students have viewed the program positively. In a recent interview, a student responded to a question about the overall benefits of the S.L.S. Program:
"Sometimes it's hard having to do it but in the end it's better because you learn the stuff better."

If you wish to discuss the program, please contact Dr Pam Garnett at school on 9384 1822.

Yours sincerely,

Penny McGlynn — Teacher/researcher

Dr Pam Garnett — Head of Science