Science and Mathematics Education Centre

The Responsiveness of an Australian Science Teacher Professional Development Program to the Needs of Local and Developing Country Science Educators

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Abstract

Many developing countries do not have in place high quality science education postgraduate programs; consequently, teachers from these countries are enrolling in programs in developed countries such as Australia, the United Kingdom and the United States. A number of authors have raised concerns that these programs are not responsive to the professional development needs of developing country teachers, suggesting that participants remain unaffected by their overseas experiences. There are similar concerns about teachers from developed countries also being unable to implement new ideas for teaching in their classrooms. This may be due to a number of reasons including feelings of powerlessness in overly prescriptive programs, high demands on teachers' time, a lack of resources, and a general lack of encouragement. These issues raise a number of questions about the nature of teacher professional development and in particular about appropriate ways to implement these programs.

In response to these concerns, this thesis examines the responsiveness of a science education postgraduate program conducted in Australia to the needs of local and developing country participants and the influences of differences between Australian and developing country science teachers in terms of their professional, personal and social development. The assumption being that programs in developed countries are largely orientated towards the needs of home-country students. The conceptual framework for the thesis is a recent approach to science teacher professional development that provides a holistic perspective on science teacher professional development, focusing not only on individual teachers but also on the educational environment in which they operate. This perspective acknowledges the complexities of school environments and considers teachers' beliefs and feelings.

The research focuses on participants from Australian and Indonesian who have completed a science education postgraduate program in Western Australia at the Science and Mathematics Education Centre (SMEC) located at Curtin University of Technology in Western Australia. These two groups were chosen because between 1988 and 1995 they were the predominant nationalities participating in SMEC programs. The research methodology and use of quantitative and qualitative research instruments was in keeping with the holistic conceptual framework adopted for the

study and follows recent trends in teacher professional development research which have seen a broadening of research methodologies. The instruments used included a postal questionnaire, classroom observation schedule and structured interviews.

The research findings indicated that the Indonesians have different needs to their Australian counterparts in terms of their professional, personal and social development. These differences included the Indonesians' strong beliefs in and use of didactic and formal teaching methodologies, limitations in Indonesian classrooms on the introduction of new teaching activities, a more centralised and formal education system in Indonesia in contrast to the increasing autonomy seen in Australia, and a more flexible teacher professional development approach in Australia focussing on personal development, as opposed to the curriculum and assessment focus seen in Indonesia. In addition, there are vast differences between the Indonesian and Australian education systems and these differences were seen to reinforce many of the different beliefs and practices between the Indonesian and Australian participants.

The study suggests that the Australian participants are able to implement teaching approaches and theoretical frameworks included in their postgraduate studies at SMEC; however, the conclusions highlight the limitations of expecting that this can occur for developing country participants. In examining approaches in overcoming these limitations, it was concluded that a range of minor interventions or modifications to program design and content would be insufficient and a number of key indicators were identified that point to the responsiveness of programs for developing country participants. These indicators included the need for host institutions to be fully conversant with the classrooms and social contexts of developing country participants, constructivist pedagogical approaches to program design, planning and implementation, and the necessary flexibility to maintain academic rigour in postgraduate science education programs while incorporating unfamiliar education notions and frameworks from developing countries.

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Chapter 1

Background and Rationale

1.1 Introduction

Public education, particularly in the sciences, is an important priority in most nations and expectations are that education provides the engine for economic growth and the opportunity for individuals to fully participate in social and economic development (Morris, 1996). Indeed, it is generally assumed that the quality of education is linked directly to the professional development of teachers in the areas of subject knowledge, curricula, and teaching methodologies (Klinzing & Tisher, 1993). This development is viewed as a process along a continuum encompassing pre-service education, induction and on-going teacher development (Northfield, Gunstone, & Erickson, 1996; Tobin, 1996; Turney & Wright, 1990).

Worldwide, the trend is for universities to offer award and non-award programs in education at undergraduate and postgraduate levels (Leavitt, 1992). For example, in Australia the most common pre-service undergraduate programs for secondary teachers are four-year Bachelor of Education programs, and four-year combined Bachelor of Arts or Bachelor of Science and Diploma in Education programs (Chadbourne, 1997; Department of Employment Education and Training, 1989). Following initial appointment as a teacher, common postgraduate programs for science teachers in Australia include Postgraduate Diplomas, Bachelor of Education, and Master of Education coursework degrees (Chadbourne, 1997; Department of Employment Education and Training, 1989). A number of other alternatives include research degrees in science and/or education. These postgraduate programs are designed to cater to participants who have previously developed skills in science and science teaching. Programs generally provide further teacher professional development across six broad areas that include scientific knowledge, science teaching, curriculum design, research skills, the nature of science within human and

technology contexts, and policy issues associated with science education and teacher professional development (Lunetta & van den Berg, 1995).

Another component of teacher professional development is in-service education and training. Here, Farah and Tarvin (1989) distinguish between two types of programs. The first are *ad hoc* activities designed to facilitate a specific initiative such as the introduction of a new curriculum. The second type is generally longest term. It is aimed at producing on-going teacher professional development and may be in the form of university postgraduate studies or long term projects across a number of schools. An example here is the Primary Science Program (PSP) in South Africa described by Webb and Wessels (1997). When originally introduced in 1984, the PSP targeted 32 schools for the training of teachers in the implementation of student practical activities. By 1997 the program had expanded to 800 schools and, with broadened objectives, was promoting teaching methodologies with a focus on process skills.

In a number of developing countries there has been a general decline in the implementation of teacher professional development approaches used by the former colonial powers (Leavitt, 1992). Instead, attempts are being made to develop and implement programs that are in harmony with local conditions and culture (Lee, 1992; Morris, 1996; Tan, 1991). However, because many developing countries do not have in place high quality science education postgraduate programs, teachers from these countries are enrolling in programs in developed countries such as Australia, the United Kingdom and the United States. Within this context, a number of authors have raised concerns regarding these programs attracting enrolments from teachers in developing countries (Kerrison, 1992; Lunetta & van den Berg, 1995; Morris, 1996). Essentially, the concerns expressed are that overseas teaching practices are inappropriate for local conditions and that the programs provided to these teachers are not responsive to the professional development needs of developing countries.

By way of clarification, the terms "developing country" and "developed country" are used throughout the thesis in preference to terminology such as "developed" and

"less developed", or "high income" and "low income" countries. While it is acknowledged that the use of these terms may be contentious, the commonly used terminology of "Northern/Southern hemisphere" is also unsatisfactory as it groups Australia with countries such as Indonesia and Thailand. Similarly, the use of the term "international students" in place of developing country students may imply that all students outside of Australia (international students) have similar backgrounds to developing country students which, of course, is not true. The focus of the thesis is on the needs of students and important differences and similarities in their teacher professional development experiences. The terms developing country and developed country, while arguably inadequate, are therefore used within this context as a convenient way of distinguishing between countries. On the one hand, those countries characterised by low levels of per capita income and limited industrialisation and infrastructure are labelled "developing countries", and countries such as Australia and the United Kingdom for example that are highly industrialised and urbanised, with high per capita incomes, are labelled "developed countries."

1.2 Background to Study

There has been slow recognition by the international science education community that pedagogical approaches developed in the United States or Europe may be inappropriate to the learning styles of developing countries (Morris, 1996). These views are supported by Kerrison (1992) who suggests that many teachers from developing countries remain unaffected by professional development experiences overseas. Similarly, Lunetta and van den Berg (1995) present the argument that teachers from developing countries enrolling in overseas science education postgraduate programs have profiles of knowledge, competencies, expectations, and experience that differ markedly from developed country participants for whom the programs were originally devised. Subsequently, these authors make a number of recommendations suggesting how these programs can become more responsive to the teacher professional development needs of developing country participants. Another suggestion provided by Ogawa (1996) is that consideration should be given to offering specially tailored optional courses, or the development of additional, more appropriate, teaching methodologies.

Within a broader perspective, questions concerning the effectiveness of teacher professional development arise in both developed and developing countries when teachers attending these programs are unable to implement new ideas for teaching in their classrooms. Consequently, these teachers invariably find themselves teaching in the same way that they have done prior to engaging in professional development activities (Briscoe, 1991). This may be due to a number of reasons including feelings of powerlessness when programs are overly prescriptive and ignore the professional input from teachers, the high demands on teachers' time, a lack of resources, and a general lack of encouragement (Bell & Gilbert, 1996). These findings raise a number of questions about the nature of teacher professional development programs and in particular about their implementation. Further, Tisher and Wideen (1990) raise the issue of dissatisfaction surrounding the manner in which research has been conceptualised and the limited contribution that this has made to the fuller understanding of the processes involved in teacher professional development. In the case of science teacher professional development, the research literature predominantly focuses on particular initiatives or one-of studies, and therefore does not provide the required comprehensiveness on which to build broad theoretical foundations (Anderson & Mitchener, 1994).

Supporting the view that a number of earlier approaches provided limited understanding of the processes involved in teacher professional development is a review of teacher professional development by Sprinthall, Reiman, and Thies-Sprinthall (1996). Another area of concern is that these approaches did not account for teacher resistance and the general complexity of educational environments (Anderson & Mitchener, 1994). A number of newer approaches have emerged since the mid-1980s which have attempted to address some of these concerns. For example, Griffin (1987) suggests that effective teacher professional development should be broadened to respond to the interrelated complexities of community, school, and classroom, and the way teachers extract meaning from their experiences. Within this context, Richardson (1990) provides an overview of the concept of reflection in teacher professional development, which is an alternative to the competency-based and performance-based teacher education approaches of the 1970s. Another approach recognises the importance of teachers' beliefs and Nespor

(1987) suggests that while a number of teachers may have similar scientific knowledge, they will teach in different ways because these beliefs are more powerful than their knowledge in influencing the way in which they teach. While not an area that has been widely researched, collegiality also has been recognised by a number of authors as an important element in ongoing teacher professional development (Little, 1982; Zahorik, 1987). More recent research has viewed social interaction between teachers as an element of broader sociocultural influences that are important in teacher professional development (Howe & Stubbs, 1996).

Within this environment of concerns about the effectiveness of teacher professional development programs in developed and developing countries and the emergence of new approaches are a number of concerns regarding postgraduate programs for developing country science teachers.

1.3 Concerns About the Effectiveness of Postgraduate Programs for Developing Country Science Teachers

Based on the author's experience as a consultant and teacher on education projects in Indonesia, Papua New Guinea and Vietnam, it is common for teacher professional development initiatives undertaken in developing countries to be supported by monies from organisations such as the Asian Development Bank, The World Bank, and the Australian Agency for International Development (AusAID) (Asian Development Bank, 1998; AusAID, 1998; Thair, 1995; 1996b; 1997; The World Bank, 1996). These teacher professional development activities generally involve groups of teachers in postgraduate studies or in-service education and training in their home country or overseas.

Externally funded in-service programs conducted in-country usually employ overseas "experts" and often focus on the implementation of student-centred teaching methodologies (Kerrison, 1992; Thair, 1995). However, these programs may be far removed from the day-to-day realities of teaching in a developing country and are usually conducted in well-equipped facilities that are unlikely to be found in schools. For example, a program for Filipino secondary school chemistry teachers reported by

Kerrison (1992) used Australian advisers who had little prior knowledge or experience of the prevailing teaching conditions and constraints operating in Philippine schools. During a 10-month program in Australia, the Filipino teachers received an upgrading in chemistry content knowledge along with a program enhancing teaching methodologies. On their return to the Philippines, these teachers were paired with two additional chemistry teachers who were then required to train other teachers in their region. Here, Kerrison (1992) describes the problem of local trainers and teachers reverting to didactic teaching styles, both in the presentation of alternative teaching approaches to teachers being inducted and in school classrooms. The Filipinos involved were convinced that the teaching practices seen in Australia were inappropriate and would not be successful under local conditions.

Similarly, Thair (1995) reports on a series of in-service activities involving the use of overseas experts in technical and vocational schools in Eastern Indonesia. Here, following the departure of these overseas personnel, participants commented that the program was a long way from the realities of their hot and overcrowded classrooms. In some cases teachers suggested that perhaps the experts had never taught in a "normal" classroom and would have problems successfully implementing the methodologies demonstrated. Therefore, while these teachers may have been exposed to student-centred approaches, they had never actually seen these implemented and used successfully in a classroom situation similar to their own. As a result, teaching methodologies often remained unchanged and the elaborately developed project materials, handouts, lesson plans, and other resources such as overhead projectors provided by these programs remain neatly locked away in school cupboards and unused by teachers (Thair, 1995). Similar problems are highlighted by Lewin (1990a) and Vulliamy (1990a) within the context of curriculum innovations in developing countries that fail to take into account the realities of classroom conditions and in particular the motivation of teachers. For example, in Malaysia Lewin (1990a) acknowledges the strong influence of foreign experts during the early stages of science curriculum reform. This outside advice was difficult to balance with local expertise and input from professional science educators at the school level until the institutional capacity of Malaysian curriculum centres had matured. Within this environment Lewin (1990a) reports:

> Implementation strategies tended to assume compliance and commitment from teachers to new curricula and the effort involved in changing working practices and educational goals. Later it became clear to many involved that insufficient attention had been given to understanding the motivation, capabilities and beliefs of teachers all of which had to change for implementation to be more than a facade. (p. 193)

Externally funded postgraduate studies or in-service education and training for developing country teachers often take place in developed countries such as Australia, the United Kingdom or the United States. The author has made a number of observations and has worked alongside teachers who have returned to their local school after attending such programs. In most cases, it is almost impossible to distinguish these teachers from other teachers in a school as they have essentially returned to exactly the same teaching patterns. These observations are similar to those reported by Kerrison (1992) where Filipino science teachers were convinced that their teaching practices adopted in Australia were inappropriate for science teaching in the Philippines. Within this context, Gray (1999) raises a number of important considerations including the acknowledgment of local expertise and knowledge, ownership issues of what is developed, the use of strategies that are holistic and have contextual relevance, and the development of support structures that can sustain program inputs. Further, the types of outcomes reported by Kerrison (1992) are not surprising considering the well-equipped environments in which overseas programs are usually conducted, compared to the school environment to which teachers return. While overseas, teachers from developing countries can fulfil program requirements and be assessed as skilled and effective science teachers. On their return home, these same teachers are confronted with the prevailing conditions of a developing country. This will generally include a critical shortage of resources, excessive bureaucratic burdens, poorly equipped classrooms and laboratories, and chronic overcrowding with perhaps 50 students or more per class being the norm (Bizzo, 1996; Cook & Taylor, 1994; Fairbrother, 1993; Irianto & Treagust, 1989).

Further problems may arise when the changes in classroom practice promoted by teacher professional development activities are not in harmony with the examination

system. While the objectives of professional development activities may focus on classroom methodologies enhancing student process skills, examination questions may continue to test recall and routine calculations (Cook & Taylor, 1994; Fairbrother, 1993; Lewin, 1990c; Monk, Fairbrother, & Dillon, 1993; Thair, 1996a). This issue highlights a particular problem, identified in Indonesia, associated with externally funded teacher professional development initiatives managed outside of the centralised education system. A number of authors (Dillon, 1993; Mahady, Wardani, Irianto, Somerset, & Nielson, 1996; Osborne, 1992) have reported on the lack of synchronisation between teacher professional development activities funded by a United Nations Development Program (UNDP)/United Nations Educational Scientific and Cultural Organisation (UNESCO) initiative in Indonesia (Pietersz, 1982) and the government departments responsible for national examinations and student assessment. Osborne (1992) reports that "Whilst the (teacher professional development)...project has little control over the content of the curriculum, it is a matter of concern that the dialogue between the in-service dimension...the curriculum development team and the assessment team is weak" (p. 8). These types of problems are expanded on by Lewin (1990a) when describing a similar situation in Malaysia and Sri Lanka:

> In both countries the close relationship that should have existed between the curriculum developers and the setters of national examinations were problematic. Curricula goals were not always reinforced by the selection of examination items. Some evidence suggested that classroom practices were not changing as much as anticipated as a result of conflicting messages emanating from the curriculum materials and the form of the public examinations. (p. 194)

Here, it can be argued that teachers may become "deskilled" by their experiences in overseas professional development programs. Naidoo (1996) provides the example of students from developing countries being deskilled by their participation in doctoral programs in developed countries. Having refined their research skills in a well-resourced university, Naidoo (1996) suggests that these students would have difficulty in continuing their research efforts under the poorly resourced conditions found in the majority of developing countries. Similarly, deskilling also may occur

among science teachers if a new pedagogy or theoretical framework introduced during overseas professional development is not compatible with the large class sizes, sociocultural environment and lack of resources found in developing countries. If these new skills are generally inappropriate to the local context, teachers will find them extremely difficult to incorporate into their day-to-day teaching practices and therefore they are unlikely to be implemented (Kerrison, 1992; Lunetta & van den Berg, 1995; Thair, 1995).

1.4 Rationale for the Study

The term "teacher professional development" can be viewed as encompassing pre-service and on-going professional development activities. Within this latter category, teacher professional development may take the form of postgraduate studies at university, or in-service education and training. For the purposes of this thesis, the focus will be on teacher professional development involving postgraduate studies conducted in a developed country, and will encompass two essential components identified by Bell and Gilbert (1996). The first is educational theory and new pedagogical approaches, which are usually covered in formal seminars and lectures. The second component involves teachers trying out and evaluating new ideas in their own classrooms over an extended period of time. Bell and Gilbert (1996) suggest that this second group of activities occurs informally, for example during staffroom discussions or when teachers visit each other's classroom.

The above discussion has identified a range of issues relating to teachers from developing countries enrolling in overseas science education postgraduate programs. These issues include a general lack of recognition that pedagogical styles developed in the United States or European countries may be inappropriate in many developing countries, and indications that teachers from developing countries remain unaffected by professional development experiences overseas. This thesis examines the responsiveness of a science education postgraduate program conducted in Australia to the specific needs of participants from developing countries, and in particular the influences of differences between Australian and developing country science teachers in terms of their professional, personal and social development. It is

assumed that science education postgraduate programs provided in developed countries are largely geared to the needs of teachers from the host country, in this case Australia. The conceptual framework for the thesis is a recent approach to science teacher professional development proposed by Bell and Gilbert (1996). These authors provide a holistic approach to science teacher professional development that focuses not only on individual teachers but also on the educational and societal environment in which they operate. This approach encapsulates many of the essential elements of effective teacher development identified by Sprinthall et al. (1996) and Coble and Koballa (1996). These elements include an acknowledgment of the complexities of the school environment; sensitivity towards teachers' beliefs and feelings; and the need for professional development programs to consider the entire school, not just individual teachers.

Personal development as identified by Bell and Gilbert (1996) includes feelings about being a teacher and about science education, while professional development is seen as encompassing changing concepts and beliefs about science education and classroom activities. In terms of social development, Bell and Gilbert (1996) identify areas such as working with and relating to other teachers and students in new ways. Development in all three areas – professional, personal and social development - is viewed as being interactive and interdependent; development in one aspect cannot proceed unless the other aspects are developed also. These authors argue that rather than focussing on one area alone, which will not provide for the desired teacher development, addressing all three aspects promotes teacher development. Bell and Gilbert (1996) suggest that the nature of learning achieved for individual teachers is influenced by perceptions of individual circumstances and that perhaps the most significant influence on the development of teachers is what they describe as the "cultural landscape of teaching and learning" (pp.151-160). Within this context, key aspects of schooling seen as influencing teacher development include the structure of the education system, school management, student expectations, nature of the curriculum, the nature of teaching, the nature and management of student assessment, staff appraisal techniques, and teacher development programs.

In summary, Bell and Gilbert (1996) conceptualise science teacher development from a social constructivist perspective where learning is seen as taking place within the social contexts of classrooms and the wider context of society. Within this context, these authors incorporate current thinking from a number of other recent approaches to teacher development. A more detailed rationale for use of the Bell and Gilbert approach as the conceptual framework for the thesis and its relationship with other approaches to teacher professional development is provided in Chapter 2.

1.5 Program Setting

The participants in this study are graduates from the Science and Mathematics Education Centre (SMEC) at Curtin University of Technology located in Western Australia which offers a range of postgraduate studies in science, mathematics and technology education. The programs offered include Doctor of Philosophy (PhD) by thesis, Doctor of Science Education (SciEdD) by coursework and thesis, Doctor of Mathematics Education (MathEdD) by coursework and thesis, Master of Science in Science Education or Mathematics Education by thesis or by coursework and project, and the Postgraduate Diploma in Science, Mathematics, or Technology Education. Currently with approximately 400 students, including nearly 250 studying at the doctoral level, SMEC has arguably the largest enrolment specifically in science, mathematics and technology education in the world. These students include local and Australian distance education students, as well as fee-paying students from overseas. At the time of the study overseas graduates from SMEC included those from Brunei, Canada, Fiji, Indonesia, Malaysia, Nigeria, Papua New Guinea, Philippines, Singapore, Solomon Islands, Tonga, the United States and Zimbabwe. For the purpose of this research, the Postgraduate Diploma and Master by coursework and project are being considered as these are the programs taken by the study participants (see Section 1.6).

Across all programs offered at SMEC, local, distance education and overseas students essentially follow similar programs of study. Typically, the Postgraduate Diploma is completed in a minimum of one-year full-time study or two years part-time study, and five core units of science/mathematics education are required. These

include units on foundations and issues, research and evaluation, and trends and developments in science education/mathematics education. In addition, program participants complete a science or mathematics education project that involves students developing a proposal based on a literature review, then a pilot study or development of curriculum materials. Students also are required to complete between four and six elective units depending on their areas of interest. These may include for example content units in biology, chemistry, computer, mathematics, or physics and biology, chemistry, mathematics and physics education units, gender issues, contemporary issues in science, classroom climate, or evaluation issues.

The Master of Science (Science Education) by coursework-and-project in science or mathematics education consists of coursework comprising core and elective units, and the completion of a project. The minimum time requirements are one year full-time or two years part-time. Areas covered in the core and elective units, which comprise up to one-third of the program, include gender issues, teaching and learning, constructivism, school leadership, classroom environments, evaluation and assessment, and curriculum issues in science, mathematics and technology education. The project is generally in an area of applied research related to the interest and work of participants and the research interests of SMEC academic staff.

The programs provide for an increase in knowledge and skills across a range of subject areas in science and mathematics education, science, mathematics, educational administration and computing, and the planning and implementation of independent research or evaluation. Essentially, the aims of these programs are the development of participant's critical self-awareness of their roles in science or mathematics education (Science and Mathematics Education Centre, 1997).

1.6 The Study Participants

The participants in this study were selected from the SMEC alumni database that has a voluntary membership and is used to provide regular updates of current SMEC activities. As shown in Table 1, during January 1998 there were 233 Australian and 78 overseas graduates registered on the database. The majority of overseas students

attending SMEC postgraduate programs between 1988 and 1995 were Indonesians selected by their government to participate in the PKG project described in Chapter 2. During this period, 51 Indonesian science and mathematics in-service instructors completed Postgraduate Diploma in Science or Mathematics programs which led participants onto completing the Master of Science program by coursework-and-project (Thair, 1996a).

Table 1
SMEC Alumni Database Membership on January 1998 and Participant Numbers Selected for the Study

SMEC Alumni Database	Alumni Registered	Selected Participants
Australia		
Canberra	1	0
New South Wales	19	19
Northern Territory	9	8
Queensland	23	18
South Australia	10	6
Tasmania	3	3
Victoria	9	7
Western Australia	159	107
Brunei	2	
Canada	2	
Fiji	1	
Indonesia	52	41
Malaysia	1	
Netherlands	1	
New Zealand	1	
Nigeria	2	
Pakistan	2	
Papua New Guinea	3	
Philippines	1	
Singapore	4	
Solomon Islands	1	
Tonga	1	
United States of America	3	
Zimbabwe	1	
TOTALS		
Australia	233	168
Overseas	78	41

Considering the relatively large number of Indonesian participants compared to those from other developing countries, and the differences in cultures between these graduates and others from developing countries such as Tonga, Zimbabwe and Nigeria, the decision was made to limit the study to Indonesian graduates. As shown in Table 1 the largest group of Australian participants are from Western Australia, followed by participants from the states of New South Wales and Queensland. All other states and territories are represented except for the Australian Capital Territory (Canberra).

While these participants represent a wide cross-section of participants in Indonesia and Australia, the sampling of participants for interviews and classroom observation was not random, being dictated by geographical location and convenience. The Indonesian teachers came from government schools, which are generally of a higher standard than private schools. Therefore, the study data which are restricted to government schools, provide little information on teachers in other sections of the secondary education system in Indonesia. In Australia, the interviews and classroom observation was conducted in schools in Perth, Western Australia, and included both private and government schools as this represented the cross-section of teachers attending SMEC. Therefore, the study data are restricted to city schools in one state and provide little information about rural schools and schools in other states.

1.7 Research Questions

Literature that has questioned the responsiveness of science education postgraduate programs conducted in developed countries to the needs of participants from the host country and developing countries has generated the formulation of this thesis. Consequently, the research focuses on Australian and Indonesian science teachers who have completed a science education postgraduate program in Western Australia at the Science and Mathematics Education Centre (SMEC) located at Curtin University of Technology in Western Australia. These two groups were chosen because between 1988 and 1995 teachers from Indonesia and Australia were the predominant nationalities participating in SMEC programs. In particular, the study

examines the following research questions in terms of the personal, professional and social development conceptualised by Bell and Gilbert (1996):

(1) What differences and similarities exist between Australian and Indonesian graduates in terms of personal development with respect to their feelings about being a science teacher and beliefs about science education?

(2) What differences and similarities in professional development exist between Australian and Indonesian graduates in terms of classroom practices generally and the introduction of new teaching activities?

(3) What differences and similarities in social development exist between Australian and Indonesian graduates in terms of their ways of relating to other teachers and notions of teacher development?

(4) What are the influences on Indonesian and Australian graduates of the structure of the educational system, school management, and availability of teacher development programs?

In keeping with the social constructivist perspective of the approach to science teacher professional development outlined by Bell and Gilbert (1996), the research methodology adopted for the study includes the use of a number of quantitative and qualitative approaches to data collection. Instruments used included a postal questionnaire, a classroom observation schedule and structured interviews with the study participants and SMEC staff. Details of the methodologies selected and their relationship to the research questions are provided in Chapter 3.

1.8 Significance of Study

The proposed study was designed to provide an insight into an Australian postgraduate program offered to science teachers in the host nation and from a developing country. A review of the literature indicates that this type of research is not widely reported. For example, Ayers and Berney (1990) produced a bibliography

focusing on teacher education program evaluation in the United States and this does not include any reference to evaluating programs in respect to the needs of overseas students. Lunetta and van den Berg (1995) discuss the inadequacies of postgraduate science education programs in developed countries which are offered to developing country teachers, however the position presented by these authors is not supported by data or the opinions of participating teachers.

Any developing country faces two major hurdles - the need for development and at the same time retention of a unique cultural identity that can be supported by the education system. Education systems play a vital role in facing these hurdles. An inherent danger in any international cooperation or offering of educational programs to overseas students, especially from developing countries, is the reinforcement of cultural imperialism stemming from any perceived superiority of programs originating from developed country institutions (Seepe, 1996). This approach ultimately can lead to relationships of dependence which may hinder development (Krasilchik, 1989). Hence, educational institutions in developed countries engaging with developing countries must have a clear understanding of their own capabilities, while at the same time remaining mindful of the needs of developing countries in order to perpetuate a process and relationship of empowerment as opposed to dependence (Seepe, 1996). This empowerment of postgraduate science educators from developing countries should involve them in an analysis and understanding of the context of science education within their own country (George, 1996). On returning home, these science educators should have the ability to work effectively and to make decisions on what is seen as worthwhile and useful within their own national science education contexts.

In response to this need to promote empowerment and remain open to the needs of science educators from developing countries, the study takes a holistic approach to science teacher professional development. This approach involves not just individual teachers but the social contexts of classrooms, and examines both the differences and similarities between the Australian and Indonesian participants of a science education postgraduate program. It is anticipated that from the results of the study factors will be identified that can enhance the responsiveness of science teacher

professional development programs conducted in developed countries to the needs of teachers from developing countries.

1.9 Conclusion and Overview of Other Chapters

This thesis utilises a social constructivist approach to science teacher professional development to evaluate the responsiveness of a science education graduate program conducted in a developed country to the needs of science teachers in the host nation and those from a developing country. The issues examined are in response to a number of concerns surrounding the effectiveness of these programs where teachers returning to their home country remain unaffected by their experience overseas.

Chapter 2 provides a broad overview of a number of contextual issues related to teacher development generally, and more specifically in developing countries. Here, a review is provided of teacher professional development in Indonesia and Australia, an overview of various approaches to teacher professional development, the national imperatives and constraints impinging on science teacher development, and the impact of culture on science education and the implications for teacher professional development. The thesis research methodology is outlined in Chapter 3 and includes a description of the program setting, participants and research instrumentation. Chapter 4 presents the results from the data collection, with a number of supplementary tables being provided in the appropriate appendices. Responses to the research questions and conclusions are made in Chapter 5.

Chapter 2

Review of Literature

2.1 Introduction and Overview

Publications such as the *Handbook of research on teaching* (Wittrock, 1986) and the *Handbook of research on science teaching and learning* (Gabel, 1994) provide a context for the research questions identified in Chapter 1; however, these handbooks are limited in their coverage of science teacher professional development. Further, reviews and bibliographies such as that produced by Ayers and Berney (1990) do not generally include evaluations of teacher professional development programs catering to the needs of students from developing countries. In keeping with the conceptual framework adopted for this study outlined in Chapter 1, the literature review therefore intends to provide a broad holistic examination of the key issues associated with science teacher professional development pertinent to the research questions, a focus that is lacking in much of the past research literature.

Central to the research questions is that developing country participants in science education postgraduate programs return to their own countries to work in education systems where conditions are vastly different from those in developed countries. Therefore, this review has a strong focus on contextual issues, beginning with an overview of science teacher professional development activities in Indonesia and Australia, contrasting the particular imperatives operating in each country. This is followed by an examination of various approaches to teacher professional development and identifiable elements of effective professional development including teacher reflection, teacher beliefs, self-efficacy and collegiality. Further contextual background is provided by a review of the constraints on teacher professional development in developing countries. Cultural practices and traditional beliefs in the developing world are known to impact on pedagogy and conceptual understanding and these issues are examined in relation to the implications for science teacher professional development. The review of cultural issues is broadened to include students in developed countries. Finally, the chapter concludes with a

summary of the main themes emerging from the literature reviewed and these are related to the research questions.

2.2 Teacher Professional Development in Indonesia and Australia

2.2.1 *Introduction*

In addition to issues concerning the nature and effectiveness of teacher professional development, there are a number of broader social and economic contexts in which teacher professional development must be considered. As the participants in this study are from Indonesia and Australia, the following sections provide a broad contextual perspective of teacher professional development initiatives in these two countries.

2.2.2 *Indonesia*

Introduction. Professional development programs for teachers have had a strong tradition in Indonesia since the 1970s. As was characteristic during the 1960s of the majority of education systems in developing countries, Indonesia experienced a rapid quantitative growth in the demands for education (Lewin, 1993). The response of governments during this period was to implement strategies to accommodate larger numbers of students and a number of achievements were made in achieving universal enrolment at primary levels; however, with the limited resources available there were subsequent declines in educational quality (Lewin, 1990b).

Within this environment, the expectations placed on education systems in developing countries are amplified due to the associated costs of maintaining and expanding the system in order to meet developmental goals (Shaeffer, 1993). The magnitude of this task is outlined by Miller (1968) with estimates in South East Asia (including Afghanistan, Burma, Cambodia, Ceylon, India, Indonesia, Iran, Korea, Laos, Malaysia, Nepal, Pakistan, Philippines, Thailand, Vietnam) in 1960 that only 8.5 per cent of the population was attending primary school, whereas projections at that time for five of these countries (Cambodia, India, Indonesia, Philippines and Thailand) anticipated that by 1980, 24 per cent of the population would be between 5 and 14 years of age and therefore eligible for schooling. Consequently, during the 1960's these factors produced a concentration of efforts in primary education; as this was at

the expense of secondary and tertiary education, inevitably this impacted on the quality of primary education because the pool of potential student teachers for primary schools was quite small (Miller, 1968).

Issues of quality also have been evident at the secondary level. For example, during the 1980s the number of new science teachers required to be recruited at the junior secondary level in Indonesia was between 2000 and 3000 each year and another 2000 each year for the senior secondary level; also there was the need to retrain many of the unqualified science teachers (van den Berg & Lunetta, 1984) and the teacher education institutions at that time could only provide approximately half of this requirement.

In addition to teacher shortages, expansion in student numbers invariably produces a number of other critical imperatives. These include the demand for more relevant curriculum materials to meet increasing diversified local needs, which in turn produces new demands for textbooks, learning materials, equipment, and innovative teaching approaches (Lewin, 1990a; Lewin, 1990b; Shaeffer, 1993; van den Berg & Lunetta, 1984). Teachers must deal directly with these challenges, as well as to pressures that are external to the classroom such as teachers seeking supplementary employment because the expansion of the education systems' budgets for salaries is under pressure (Shaeffer, 1993; Thair, 1996a). Further, this expansion and increased budgetary requirement for education produces a need for greater accountability. Teachers are required to maintain increased records in order to respond to local and national demands from expanded educational bureaucracies and parents, which further adds to the demands on teacher's time and abilities (Shaeffer, 1993). Within this environment, Shaeffer (1993) suggests that teacher professional development initiatives in many developing countries are unable to respond to this broad and complex set of challenges.

The Indonesian government's response to increasing enrolments was the establishment of emergency teacher education courses to address critical teacher shortages (van den Berg & Lunetta, 1984). When these demands were met, the emergency programs ceased and teacher training became concentrated in Secondary School Teachers' Colleges (*Institut Keguruan dan Ilmu Pendidikan* - IKIP) and

education faculties within universities (*Fakultus Keguruan dan Ilmu Pendidikan* - FKIP).

In-service Teacher Professional Development. During the 1970's a massive campaign was launched in order to provide three-week workshops for Indonesia's 600,000 teachers in government-run primary schools. These workshops covered the use of new textbooks being implemented into the primary system, and the training staff consisted of 1,200 specialists formed into 120 mobile provincial teams, who by 1976 had managed to reach 90,000 teachers (Soedijarto, Suryadi, Machmud, Pangemanan, Tangyong, Nasoetion & Thomas, 1980).

In 1979, two new in-service teacher professional development centres (*Pusat Pengembangan Pendidikan Guru* - PPPG) were established in order to supplement the professional development activities of existing establishments. At that time, five additional centres were in the progress of construction, with a further eight centres planned (Soedijarto et al., 1980). These centres were located near existing teachers colleges which were utilised for staffing purposes, and the live-in professional development programs were designed around specific subject-areas (science, mathematics, social studies, language, technology, and vocational subjects) and conducted over a six-week period. The PPPGs were also responsible for establishing regional professional development programs (*Balai Pendidikan Guru* - BPG), and data from the Improving the Efficiency of Educational Systems (IEES) (1986) reports indicated that by 1986 fourteen BPGs were in operation, and that by 1989, thirteen more were scheduled to be built. This approach to in-service professional development required taking teachers out of their classrooms; thus administrators of schools were caught between the need to have teachers upgraded and the problem of having classes left without teachers. Additionally, the subject areas experiencing the most severe teacher shortages were the same areas in most need of teacher professional development.

The Development of Science In-service Professional Development for Secondary School Teachers. The first two decades following independence in Indonesia saw the secondary education system coping with quantitative growth in order to cope with the rapidly expanding population of secondary school students. As would be

expected, this focus on quantitative growth caused serious problems in terms of the quality of educational services provided, and these were to be eventually addressed by the Ministry of Education and Culture. Somerset (1988) identifies the writing of new textbooks, a new curriculum focussing on a student-centred pedagogical approach, and provision of laboratory facilities as the three essential elements of a major reform in science education that eventually opened the way for the implementation of an effective in-service professional development program for science teachers.

Prior to 1975, the science curriculum was subject-oriented and encouraged a teacher-centred approach in the classroom. A new curriculum, known as Curriculum 75, adopted a "student-centred" approach, and for science subjects specified that in addition to providing factual knowledge, students should develop a range of process skills that were to be developed through practical activities in laboratories and classrooms. In addition to these specific instructional objectives, and in keeping with the ideological and philosophical foundations of developing the country through the educational system, two other key features of all 1975 Curricula were the requirements that *Pancasila* (Indonesia's five basic philosophical principles) be integrated into all subjects, and the understanding that every subject was to contribute towards the nation's overall educational aims (Thomas, 1991).

The Curriculum 75 was introduced progressively into the secondary system between 1976 and 1978. While the curriculum provided instructional objectives, the problems of identifying and locating appropriate instructional materials and lesson planning were left entirely to individual classroom teachers. Thomas (1991) reported that following the implementation of Curriculum 75, many teachers were inadequately prepared to initiate effective learning strategies in order to fully realise the instructional objectives of the new curriculum, and that generally teachers continued to use traditional teacher-centred "chalk-and-talk" and lecturing methods in their classrooms, with a heavy emphasis on memory-type classroom activities.

During the implementation phase of Curriculum 75, between 1976 to 1979, a number of professional development programs were introduced in order to overcome the problems experienced by teachers in introducing the new curriculum; during this

period approximately 18,000 headmasters, administrators and teachers attended these programs (Penick & Amien, 1992). For teachers, this professional development had three separate components; the science content of the curriculum; use of scientific apparatus to carry out experiments; and thirdly the methodology involved in producing activity-based lessons in the classroom. Science teachers from around the nation were assembled in a central location for several weeks of intensive workshop activities involving demonstrations of effective science teaching methodology, preparation of lesson plans and materials conforming to the instructional objectives of the curriculum, and micro-teaching sessions (Thomas, 1991). As a low-cost strategy for further disseminating this information, a "cascade" model was adopted where these teachers were then expected to return to their schools and conduct further professional development programs at regional centres for local teachers.

However, the results to this approach to teacher professional development in the late 1970s were disappointing (van den Berg & Wilardjo, 1986), and in spite of the focus on practical laboratory activities in these programs, the majority of school laboratories remained under-utilised (Pietersz, 1982). A lot was expected of the teachers in terms of outcomes from these relatively short professional development programs, especially in terms of being able to carry out practical activities in laboratories and the adoption of activity-based methodologies in classrooms, where neither of these approaches would have been previously experienced by teachers during their own schooling or pre-service teacher training. Further, many of the professional development providers, while being subject specialists drawn from universities and IKIPs, had never taught within the secondary-school system. Further factors identified by van den Berg and Lunetta (1984) that would make student-centred classroom activities difficult for teachers to adopt, included the large class sizes and the heavy teaching loads of many teachers, lack of laboratory support staff and clerical assistance, noisy classrooms due to lack of soundproofing and classroom design, and very importantly within the context of Indonesian classroom culture, the authority of more senior staff members.

In response to these problems, the Ministry of Education and Culture responded by drawing up guidelines for a new teacher professional development approach that would use experienced teachers as trainers after they had received training overseas

in their subject areas; professional development spread over a longer period, and the inclusion of an in-service component where teachers would use student-centred approaches to teaching in their classroom under the guidance of teacher-training instructors. In 1979 a UNDP/UNESCO assisted training project was set up - Improvement of Science and Mathematics Teaching in the Secondary General Schools - and this project led to the development of the *Pemantapan Kerja Guru* (PKG) (Strengthening the Work of Teachers) system of in-service training in Indonesia (Mahady, Wardani, Irianto, Somerset, & Nielson, 1996). An important element of this particular approach was the encouragement of ownership of the PKG concept by classroom teachers, and efforts made to avoid the mistakes of earlier top-down approaches where the innovations were imposed on teachers with little, if any, opportunity for individual input (Tomlinson, 1990). The major purpose of this new initiative was to overcome the resilience of teachers to student-centred learning, thus changing student learning experiences from passive listening and writing to active participation in practical activities and to encourage thinking, which formed the basis of the PKG pedagogic style (van den Berg, 1993). What made PKG unique was the size of the program in that by the early 1990s it was the largest teacher in-service/on-service initiative in the world (Monk & Dillon, 1995). The PKG project began in 1980 with science, the end of 1981 with mathematics, and was extended to English in 1985 and Bahasa Indonesia in 1988.

The PKG System for Science. Following the appointment in December 1978 of a full time national coordinating officer, twelve science teachers were selected as in-service PKG instructors or "Master Teachers", and in 1979 began a 12 week training program in the Regional Centre for Science an Mathematics Education (RECSAM) in Penang, Malaysia (Somerset, 1988). Participants for PKG instructor training were selected from experienced secondary teachers, with the central government in Jakarta asking regional governments to nominate outstanding teachers (Mahady et al., 1996). Nominees were initially given English language training before attending the RECSAM course. The RECSAM training was conducted over three months and covered subject content, laboratory work, classroom methodology, and teacher training methodology (Somerset, 1988). This was followed by visits to Thailand and Australia in order to observe school systems in operation and to identify elements of these systems that could be transferred to the Indonesian classrooms and laboratories.

On their return to Indonesia, the role of these PKG instructors was to induct teachers who had very weak backgrounds in science, and almost no laboratory experience or concept of student-centred learning, into the PKG approach of active participation in classroom and laboratory activities. An important element of this process was to increase teacher confidence in dealing with subject content, as without this confidence it was unlikely that teachers would deviate from the chalk-and-talk approach, and encourage open communication with students. Once the PKG induction programs were running, a number of additional PKG instructors were selected for study overseas at Masters level, with participants primarily being sent to King's College at the University of London in the United Kingdom, and the Science and Mathematics Education Centre (SMEC) at Curtin University of Technology in Perth, Western Australia. This group of PKG instructors attending SMEC are the subjects of the current study.

The PKG system is popularly referred to as the "in-on" system, and when originally set up was scheduled over a sixteen-week period divided into two in-service cycles of two weeks each, and two on-service cycles of six weeks each (Pietersz, 1982). Each PKG induction cycle began with a two-week residential in-service program held at a provincial centre, and planned to fit into the beginning of a school semester. The on-service cycle began when teachers returned to their schools. A second two-week in-service cycle was held mid-semester, then teachers returned to their schools for the final on-service component of the sixteen-week cycle. PKG cycles were run twice a year prior to the beginning of each teaching semester in each province and were attended by approximately fifty teachers (Somerset, 1988), with different groups of teachers attending successive workshops so as to spread the induction across an increasing number of teachers.

During the first two-week in-service component, teaching for the first half of the semester was thoroughly planned. Teachers worked in groups according to subject area (mathematics, chemistry, physics or biology) and school level (lower secondary and upper secondary), and Pietersz (1982) describes a number of key elements, including a content analysis of each topic to be taught in the coming half semester, involving the identification of major concepts and skills and planning of teaching strategies. Further elements included the trialing of laboratory activities, the revision

of student worksheets for experiments and evaluation checklists for each experiment. Diagnostic tests also were tried and revised, and participants took part in constructing their own tests. A limited number of lectures were provided in order to deal with selected areas of weakness in subject knowledge by participants, and lecturers for these components were drawn from provincial universities and IKIPs. Microteaching was another component of the two-week in-service training, and initially involved PKG instructors giving demonstration lessons, and later the participating teachers preparing and delivering lessons to their colleagues.

Following the first two-week in-service cycle, participants returned to their respective schools for the on-service component of PKG induction and commenced the first half of the teaching semester, using worksheets and tests trialed or developed during the in-service cycle. PKG instructors visited teachers during their on-service cycle to observe lessons, and take the opportunity to discuss their observations or perhaps do demonstration lessons if these were requested (Pietersz, 1982). Studies of effective in-service professional development programs have shown that to have any real effect on teaching behaviour there needs to be an element of coaching or demonstration in the teachers' schools (Joyce & Showers, 1980). This component of the PKG cycle is therefore a significant element in the process of transferring new techniques into the normal teaching routine of schools.

An additional component of the on-service cycle was weekly meetings attended by participants and PKG instructors and held on Saturdays at local in-service sub-centres. These meetings were to discuss with PKG instructors and each other problems encountered during the previous week's teaching, and to prepare for the coming week. These meetings gave participants a further opportunity to discuss PKG experiments and worksheets and to actually try out the experiments and equipment in groups (Monk & Dillon, 1995). Other activities included the analysis of class tests and individual test items, discussion of proposals for the revision of worksheets and diagnostic tests, the results of which were recorded for input into the periodical revision of PKG materials, and micro teaching activities (Pietersz, 1982). This process was possible due to the highly centralised curriculum, where teachers in every school across the country teach the same topic in the same week.

The second two week residential in-service component occurred mid-semester, where teachers evaluated their on-service experience, and prepared for the second half of the semester in a similar fashion to the training held at the beginning of the semester. Following this second in-service period, teachers then returned to their schools again for the remainder of the semester, thus completing one full cycle of PKG induction. An important element in sustaining changes in teachers' classroom methodology was the feature of providing supervision and support for on-service following the in-service components of the induction (Monk & Dillon, 1995).

All administrative and financial duties associated with the PKG science programs were handled by a provincial science supervisor (Pietersz, 1982), and these duties included liaising with school principals in addition to organising the Saturday morning meetings and the distribution of materials. The role of PKG instructors was further enhanced by the appointment of assistant instructors from PKG alumni who had a role in providing on- service visits at the provincial level to schools they could reach within two hours (Pietersz, 1982).

A further component of the PKG system were the twice-yearly National Evaluation and Preparation Workshops held over three weeks at the National Science In-service Centre in Bandung, Java. This workshop was attended by provincial PKG instructors, national and UNESCO consultants, the evaluation team, and provincial supervisors (Pietersz, 1982). The objectives and activities of the national workshop were (Adey & Monk, 1988) to:

> (a) induct new instructors into PKG thinking and procedures,
> (b) revise and prepare materials, and
> (c) act as a national forum where PKG thinking can be moved forward through a process of mutual reinforcement and inputs from national and foreign consultants.

Role (c) has a unique and important function within the PKG project. Without this regular reinforcement and input of new ideas, PKG instructors in distant provinces would become isolated from project developments.

During this workshop, the previous PKG cycle was evaluated by collating feedback from teachers on previously trialed worksheets, and preparations were made for the

next cycle. New materials were trialed and revised during the National Semester Evaluation and Preparation Workshop prior to being duplicated and taken back to the provinces by workshop participants. Here, the worksheet masters were copied and retyped before being duplicated at the regional, local authority and school levels (Monk & Dillon, 1995).

Pietersz (1982) describes a rigorous process of continual evaluation of the PKG induction process. Each PKG cycle was evaluated through a system of questionnaires given to participants and PKG instructors, and visits to selected provinces were made by the National Evaluation Team. During these visits PKG participants and instructors were interviewed, and the team observed lessons and spoke to school principals. Evaluation reports were presented at the National Semester Evaluation and Preparation Workshop.

A key element of the PKG program in assisting teachers to adopt the PKG method of student-centred lessons were the PKG worksheets. Initially, these worksheets were produced by PKG instructors undergoing training at RECSAM and revised on a regular basis at the National Evaluation and Preparation Workshop held in Bandung at the start of each semester (Monk & Dillon, 1995). These revisions were based on feedback from teachers using the worksheets. During the two-week residential in-service workshops, new teachers were introduced to the worksheets, and were provided with master-copies for reproduction and student use in their own schools. A further initiative which assisted teachers in adopting the PKG methodology in their classrooms is outlined by Monk and Dillon (1995), where chemistry teachers attending PKG training during the 1980s were also provided with kits of chemicals and glassware provided specifically to enable PKG laboratory activities to be carried out in schools. These supplies were additional to equipment and chemical 'drops' provided by the central government.

Development of the Sanggar PKG. Following the completion of a PKG induction cycle, many participants continued to attend their Saturday meetings in order to become familiar with additional PKG materials not covered in their own PKG induction cycle (Pietersz, 1982). Further, Mahady et al. (1996) reported that sometimes these participants where accompanied by other teachers who had not had

the opportunity to attend PKG induction, thus increasing the rate and coverage of PKG material dissemination. Requests also were made from principals and teachers for faster dissemination of PKG materials (Pietersz, 1982), which ultimately led to the development of the *Sanggar Pemantapan Kerja Guru* (SPKG) system being introduced on a trial basis in August 1982, with two SPKGs being set up in each province, and further centres being established in 1984. So as not to disrupt student timetables, school principals rescheduled timetables for participating teachers to allow one day free each week from teaching responsibilities.

Essentially, the SPKG initiative was an attempt to disseminate the PKG methodology and materials at a more rapid rate and at a lower cost than the original PKG induction process. However, Somerset (1988) points out that this was done with some loss of quality and intensity of training, as the *Sanggar* approach has only one in-service cycle (as compared with two for a PKG cycle), and the in-service is only one-week non-residential (as compared to two weeks residential with PKG programs). By 1987, the SPKG system was providing in-service/ on-service inductions to a greater number of science and mathematics teachers than the original PKG program, and by 1988 there were only 26 PKG teams (one for each province, excluding East Timor), and more than 200 SPKG teams (one for each district) (Somerset, 1988). SPKG programs were led by Key Teachers (called *Guru Inti*) selected from successful teachers who had previous exposure to PKG induction programs or had acted as assistant instructors.

Replacement of Sanggar PKG Training by MGMP. During 1993, the Sanggar PKG teacher-development approach was replaced by a new program called *Musywara Guru Mata Pelajaran* (MGMP). Dillon (1993) indicates that this reflects the movement of the PKG project towards a phase of post-project sustainability, and suggested that a limiting factor may be financing available at local level to cover costs not provided by the PKG project.

Mahady et al. (1996) describes a number of modifications to teacher-development as a result of the introduction of the MGMP program. On-service school visits were discontinued, as compared to the three visits during each cycle of SPKG. This means that teachers had no guided monitoring and feedback in their own classrooms, and

training effectiveness of in-service programs were not monitored in schools. In-service meetings were less frequent, and Mahady et al. (1996) indicate that on average there was one meeting every three weeks.

A number of the PKG instructors who attended SMEC for the Masters program and are the subjects of the current study, continue to be involved in MGMP activities. However, the PKG project never became fully institutionalised and remains one of many projects administered in an *ad hoc* fashion across the education system.

2.2.3 *Australia*

Introduction. The emergence of Asian countries as major economic centres has impacted on Australia's economic, socio-political and cultural landscapes that were originally shaped from a British heritage. Effects of this impact identified by Singh and Gale (1996) include the rejection of Eurocentrism and efforts to relate the Australian identity to the Asia-Pacific region. In response to the changing economic influences in the South East Asian region, the Australian Federal Government has moved to deregulate the nation's economy and encourage increased competitiveness. As recommended in reports such as *Australia Reconstructed* (1987), this is being underpinned with increased flexibility and multiskilling in the workforce which is becoming more scientifically and technologically literate. Education is viewed by the Government as having a pivotal role in these developments, being the central link between socio-political and economic reform agendas and contributing to economic restructuring by responding to national economic needs (Gale & McNamee, 1994). Specifically, the role of education is seen as providing the skills and competencies required to develop and sustain a globally competitive private sector with a prime focus on "value-added" manufacturing in contrast to the previously dominant primary industries (Knight, 1993). Specific initiatives have included the formation of closer links between the general education sector and vocational training (Carmichael, 1992). Within this environment, teacher professional development is seen as underpinning these changing societal and economic landscapes. Coupled with these developments, Australia's increasing cultural diversity and changing technology and economic conditions require teachers to respond to rapidly changing community expectations. Indeed, teacher professional development initiatives in

various forms are the mechanisms by which teachers are empowered to respond to these changing needs. Hence, within the Australian context it is therefore necessary to consider teacher professional development within the contexts of the government's education reform agenda and the industrial implications associated with restructuring of the workforce.

The Education Reform Agenda. An outline of how the government's reform agenda has resulted in restructuring at all levels of Australian education is provided by Singh and Gale (1996). Examples provided by these authors include a broadening view of the participants and settings involved in education, changes in the status of certain subject areas, such as Languages-Other-Than-English (LOTE), and the movement towards managing education systems as corporate entities. Superimposed on these shifts are wider calls for greater efficiencies in the provision of public services, including education. The expectations are that for minimal government expenditure there will be maximum outputs which has driven the commercialisation of education in order to compensate for reduced public sector funding (Singh & Gale, 1996). Examples of this commercialisation include the marketing of higher-education institutions and secondary schooling overseas to attract fee-paying students. Singh and Gale (1996) suggest that with their educational "products" being packaged and marketed both nationally and internationally, teacher professional development providers are now expected to operate like businesses. Illustrating this trend, governments in recent years have applied "user pays" principles to university education, including teacher education (Chadbourne, 1997). Under this regime, university degrees in the science and engineering fields, for example, cost significantly more than those in the social sciences. Of particular concern is the cost to students taking the four year degree and one year teaching diploma route into science teaching which will be significantly higher than for student teachers of other subject areas (Chadbourne, 1997). Fees are also applicable to postgraduate programs for teachers. Within this framework, Chadbourne suggests that, because teachers lack salary incentives and have no occupational tradition of paying university fees, this form of teacher professional development may become increasingly unattractive. An outcome may be a resurgence in professional development programs offered by state education departments.

The Industrial Implications Associated with Teacher Professional Development. As outlined above, a significant concern in Australia since the 1980s has been the international competitiveness of the Australian economy and its positioning in a globally competitive community (Gale & McNamee, 1994). Historically, Australia was able to rely substantially on the export of primary products and natural resources; however, as markets for these products have weakened, there have been calls for a more scientifically and technologically literate workforce in reports such as *Australia Reconstructed* (ACTU/TDC Mission to Western Europe, 1987). A significant conclusion of this report was the need for an increased emphasis in the area of the on-going skilling of the workforce. This has manifested itself in the review of salary classifications and establishment of skill-related career paths encouraging workers to participate in continuing skill upgrading. There are implications here for the goals of education, with increasing focus on science and technology, on the teaching profession itself and the role of teacher professional development, and ultimately the quality of education.

Award restructuring in Australia is an attempt to address the concerns relating to global competitiveness and producing technologically literate workers, and highlights the significance of industrial implications associated with teacher professional development. These changes in awards have facilitated the establishment of advanced teacher scales and an important consideration here is the role that teacher professional development plays in determining advancement on these scales. Bluer (1991) suggests that award restructuring associated with teacher professional development reform will provide significant changes in terms of how teacher professional development and the role of teachers in classrooms is perceived in Australia. The newly introduced concept of Advanced Skills Teacher and the rewards associated with this classification acknowledges the value of knowledge and skills acquisition. To date, there are no reports in the research literature concerning the outcomes of this initiative (Marx, et al., 1998) which is one of the foundations for the development of standards-based professional development described by Ingvarson (1998). In recognising the quality of teaching and professional competency, as opposed to years of service and qualifications, the Advanced Skills Teacher system provides stronger incentive for teachers to attain improved teaching standards. Ingvarson (1998) suggests that:

> Career stages based on rigorous teaching standards, and a widening conception of teachers' work with years of experience, are more compatible with the development of professional learning communities. They reduce the negative micro-political effects of traditional career ladder hierarchies on competition for limited numbers of jobs or positions. (pp. 128-129)

Teacher Professional Development. Increasing autonomy for teachers in areas of professional development has occurred as subject and other professional associations have enlarged their teacher professional development activities. Illustrating this trend, France (1990) identified two professional associations with national memberships, the Australian College of Education and the Australian Council for Educational Administration that facilitate professional development through local and national conferences and publications. France (1990) also identified the Australian Council for Educational Research as having made important contributions to education through the publication of research results and training of researchers. Similarly, the Australian Science Teachers Association is a national professional organisation with State level professional bodies such as the Science Teachers Association of Western Australia (STAWA) that have become increasingly involved in teacher professional development activities. Examples of the types of activities provided include after school and evening sessions on data logging with graphics calculators, diving physiology, full day programs on curriculum, electrical safety in schools, and visits to organisations such as a wetlands centre and the Perth Observatory (Science Teachers Association of Western Australia, 1999). However, France (1990) suggests caution in drawing conclusions regarding the contributions these national and local associations have made to teacher professional development, citing reduced memberships since the mid-1960s. Similarly, Chadbourne (1997) questions the influence of teacher educators on national education policy making, citing that less than 10% of teacher educators are members of the Australian Teacher Education Association (ATEA).

A significant event in Australian teacher professional development initiatives was the 1973 Report of the Interim Committee of the Schools Commission (Australia Quality of Education Review Committee, 1985). This report initiated a major national commitment to teacher professional development resourcing in the form of the

Professional Development Program (PDP) which was to run until 1986. France (1990) identified three elements of the PDP that were indicative of teacher professional development initiatives in Australia during the 1980s. These included the involvement of both government and non-government schools, increased localised decision making, and the involvement of parent organisations. During this same period, the Quality of Education Review Committee (1985) identified challenges for teacher professional development, including how to respond to changing social, economic and cultural environments within the Australian educational system as outlined above. Other areas identified by the committee included curriculum, pedagogy and student assessment, which in effect would require a reconceptualisation of teaching (France, 1990).

An increasingly important element within the teaching profession in Australia is the predominance of mid-career teachers who, while competent and experienced, over recent years have been exposed to a lack of public support on the role of schools in Australian society (France, 1990). Within this environment, teacher attitudes and the influences of these on student learning is critical, thus highlighting the important role of teacher professional development in not only knowledge and skill development, but also in attitudes. Critical imperatives for teacher professional development in Australia include improved liaison between universities, employers and teachers in the design and delivery of teacher professional development and increased proportions of university resources in teacher education faculties directed towards teacher professional development (Bluer, 1991).

Within the context of award restructuring and teacher professional development, a significant development concerning science teachers in Australia was the Science Education Professional Development Project (SEPD) which was charged with the responsibility of developing a national strategy of enhancing professional development of science teachers (Ingvarson, 1992). This project was conducted within an environment of general apathy towards professional development among science teachers in Australia, as evidenced by interviews of secondary science teachers as part of the SEPD project (Ingvarson & Loughran, 1997). The interviews indicated a lack of understanding as to the direction of teacher professional development and an associated lack of extrinsic incentives for participation in

activities in terms of salary and career path. In response to the data gathered from interviews with senior policy officers, science teachers' associations, and secondary school science teachers, a strategy was recommended which consisted of two major thrusts - a strengthening of the professional community of teachers and integration of professional development and career development (Ingvarson, 1992). Recommendations for the professional community of science teachers included encouragement of increased collegiality and teacher professional development activities at the school level, and the provision of exemplary practice associated with the teaching of key science concepts. In terms of integrating professional and career development, recommendations were made regarding award restructuring.

Within the current industrial climate in Australia, as described above, the integration of teacher professional development and award restructuring has not been adopted unanimously and universally across the nation. Illustrating this trend, recent developments in Western Australia appear to indicate teachers in that State may be moving towards integrating professional development and award restructuring. Ashworth (1999) reports that the State Government is considering the establishment of a registration board as a means of maintaining standards within the teaching profession. In supporting these changes the Education Minister, Mr. Colin Barnett, indicated that "he would be looking for a greater focus on the professionalism and standards of teaching. The proposal had strong merit and there was quite a lot of support for it from within the profession" (Ashworth, 1999, p. 13). In response, the State School Teachers' Union president Mr. Brian Lindberg indicated that "teaching was one of the few professions that was not regulated" and also indicated that he hoped the proposed registration board "would be administered by the profession and not the government" (Ashworth, 1999, p. 13). Once the regulatory board is established this provides a mechanism whereby teachers are able to advance along defined salary scales in recognition of professional development and improved teaching standards. Ingvarson (1998) describes the advantages of this approach founded on profession-defined standards and values, stating that:

> The emerging system has the potential to overcome major limitations in traditional systems of in-service education for teachers; the lack of clarity about what teachers should get better at; the lack of incentives in the form of

advanced career steps based on the attainment of high teaching standards and the low level of personal ownership teachers felt for the in-service education system. (p. 127)

2.3 Approaches to Teacher Professional Development

2.3.1 *Introduction*

Science teacher professional development programs have been predominantly based on an approach in which teachers are taught to utilise science curricula materials designed by "experts" who do not work in the classroom. McTaggart (1989) suggests that many of the science curriculum projects of the 1960s had the effect of reducing teachers to technicians. These approaches viewed teachers as being deficient in some particular capacity or incapable of sophisticated educational thinking, and teacher-trainers were seen as having a better grasp of the teaching/learning process (Shaeffer, 1993). From a teacher professional development perspective, the premise adopted was that clearly identifiable teaching skills are able to produce specific student learning outcomes. Consequently, professional development activities were based around the acquisition of these specified teaching behaviours (Gilbert, 1994). The rationale employed was that educational research had demonstrated enhanced student outcomes when these teaching behaviours were utilised (Sprinthall, Reiman, & Thies-Sprinthall, 1996). This approach using specified teaching behaviours translated into teacher professional development programs consisting of lectures, tutorials and demonstration lessons evaluated in terms of skills transfer, which could be viewed as being anti-professional. In this context, Howe and Stubbs (1996) raise the issue of "teacher proof" curriculum materials which are considered safe from tampering or adaptation by teachers wishing to meet the particular needs and interests of their students. Approaches such as this continue to pervade science teacher professional development programs, with Howe and Stubbs (1996) suggesting:

> It seems clear that past and present methods and approaches to continuing professional development for teachers have not produced the desired results and that new methods and approaches are needed. If we continue to do the things we have always done, we will continue to get the results we have always gotten—and those results are not serving us well. (p. 168)

An alternative conceptualisation views teachers as independent professionals and teacher professional development as a process of individual empowerment (Gilbert, 1994). In moving from a position of teachers being dependent and reactive to one of being independent and autonomous, Howe and Stubbs (1996) suggest that the exact outcomes of teacher professional development activities cannot be specified in advance, as these occur along a continuum when individual teachers take control of their own professional development. Recognising this as a shift from a transmission approach to one concerned with the development of teachers, Ingvarson and Greenway (1984) highlighted the need for recognition of the commitment of individual teachers to professional development and the occupational culture of teachers. In highlighting the criticism that teachers have rarely had the opportunity to set the agenda and the parameters of their own professional development, Ingvarson (1998) cites the low level of personal ownership that teachers have traditionally had for in-service professional development.

Personal ownership is implicit in the constructivist and sociocultural perspectives informing many of the emerging approaches to teacher professional development. Constructivism is based on the preposition that knowledge is not transmitted and received passively but is actively constructed on the basis of what is already known, with the prime focus being on the way individuals construct knowledge (Treagust, Duit, & Fraser, 1996). In addition to these independent cognitive processes, Howe and Stubbs (1996) highlight the recent recognition among science educators of sociocultural factors as being another source of knowledge. This approach focuses on social interaction and proposes that knowledge is associated with the particular contexts within which this interaction takes place. Hence the recognition of the influences of language, interpersonal relationships and status, motives, values, beliefs and the location of social interaction (Howe & Stubbs, 1996). An additional factor highlighted by Tisher and Wideen (1990) is the ownership of teacher professional development activities. These authors conclude that in terms of the practical benefits to teachers, schools and students, the impact of teacher development activities will be greater if teachers have ownership of the planning, organisation and delivery of these programs.

The above approaches therefore highlight two extremes; one of a deficiency-based approach and the other where teachers are seen as having skills and experience that are of value in the professional development process and recognition is made of sociocultural influences. Between these two extremes, researchers and teacher professional development providers have shown limited consensus on the knowledge and skills that should be included in teacher professional development (Djalil & Anderson, 1989). While there has been some progress in identifying a professional knowledge base, Anderson and Mitchener (1994) indicate that there is no broad agreement in the areas of the nature of teaching and the implications in teacher professional development. A further area of concern is the balance between updated subject matter and teaching methodologies in teacher professional development programs, with little conclusive evidence for either side (Walberg, 1991).

These concerns raise a number of questions about the nature of teacher professional development generally, and in particular, the approaches adopted by teacher professional development programs. Tisher and Wideen (1990) argue the need for the development of more widely adopted theories on which to base conceptual frameworks. From these frameworks, more relevant theoretical foundations can guide future research efforts. Within this context, the review by Sprinthall, et al. (1996) identifies the need for a broader conception of research, suggesting a merging of qualitative and quantitative research methodologies as being desirable in understanding the effects of teacher professional development programs. These concerns are explored further in Section 2.3.2 which reviews science teacher professional development research and this is followed by a review of a number of current approaches to teacher professional development.

2.3.2 *Science Teacher Professional Development Research*

There has been a limited sustained focus on science teacher professional development issues in the *Handbook of research on teaching* (Wittrock, 1986) and the *Handbook of research on science teaching and learning* (Gabel, 1994). Anderson and Mitchener (1994) suggest that because of the general nature of science teacher professional development which focuses on the outcomes of particular initiatives and one-of workshops, there is limited value in providing summaries of research in

handbooks as broad generalisations are unable to be drawn. As a result, these authors conclude that science teacher professional development generally is lacking in comprehensiveness, has a limited theoretical foundation and that too much is expected of pre-service teacher education. As a result, a major limitation is that studies in science teacher professional development are unable to take into account the complexities of change, both in terms of teacher resistance, and the complexities of educational environments.

Further limitations are illustrated in a review of teacher professional development research by Tisher (1990), not limited specifically to science education, in Australia during the 1990s. Tisher (1990) concludes that studies generally involved the use of a captive group, usually in the researcher's institution, and published evaluations of teacher development programs were rare. Additionally, Tisher reports that few studies were repeated or replicated, were usually guided by the researcher's interests rather than national imperatives or policy, and there was little attempt to integrate the efforts and findings in pre-service and in-service activities.

A review by the researcher of articles published in the *Journal of Science Teacher Education* further supports a number of the above conclusions. For example, of the 42 articles published during 1997 and 1998, 15 were specifically related to pre-service science teacher development, whereas only four related to in-service activities, indicating a heavy bias towards pre-service activities. The articles covered a diverse range of issues, many were descriptive and of particular teacher development initiatives, and there appeared to be no overriding or clearly defined conceptual base or theme running through these various studies. Finally, there were no studies dealing with contextual issues affecting the delivery of science teacher professional development programs in areas such as administrative structures in schools and education systems, funding arrangements for schools and teacher professional development, and government policy on education.

2.3.3 *Approaches to Teacher Professional Development*

As outlined in Chapter 1, by not taking into account factors such as the complexity of school environments and teacher resistance to new initiatives, earlier approaches provided little meaningful input into a broad conceptualisation of teacher

professional development. More recent approaches have emerged, but to-date there is no wide acceptance of one particular approach. However, constructivist and sociocultural perspectives have widely influenced science teacher professional development (Northfield, Gunstone, & Erickson, 1996). These perspectives allow teachers to be viewed as learners who have an active role in professional development, recognise that other teachers are an important source of knowledge, and acknowledge the importance of teachers' beliefs and feelings (Gallagher, 1996).

These perspectives have produced a number of approaches including Participatory Teacher Training, Collaborative Action Research, the Professional Development Framework, the Constructivist/Sociocultural Framework, the Collaboration, Enactment, Extended Effort and Reflection (CEER) approach and the Professional/Personal/Social Development approach, which are reviewed below. These were selected and reviewed with the view of highlighting a number of common identifiable elements. Further, these approaches highlight the overriding theme of recent approaches to teacher professional development which recognises that this development is an individual process occurring within educational and administrative contexts. The review begins with the Participatory Teacher Training and the Collaborative Action Research approaches which, while not specifically related to science education, have basic concepts that are relevant across all subject areas and are selected because of their applicability to developing countries. The four approaches following are related to science education and are presented in order of increasingly broad conceptualisations of science teacher professional development, which is in keeping with the conceptual framework adopted for this study.

Participatory Teacher Training. Shaeffer (1993) outlines an approach that, while not specifically related to science teaching, would apply across all subject areas. Of particular interest is that his discussion is orientated specifically towards teachers in developing countries; this self-directed approach incorporates the active role of teachers in the training process, uses reflection and introspection, and recognises the realities of the day-to-day classroom. The particular approaches described by Shaeffer include cooperative learning, reflective self-instruction, training by simulation and situation, and the teacher as researcher. The suggested outcomes and

benefits of these approaches include empowerment, increased self-reliance and confidence which Shaeffer suggests is sustained throughout the lives of participating teachers, producing a more motivated, professional individual. Shaeffer suggests that the teachers involved in this alternative participatory teacher training are more open to new ideas and amenable to trying new teaching methods in their classrooms.

Collaborative Action Research. Feldman (1995) draws some relevant conclusions from teacher involvement in collaborative action research suggesting implications for science teacher professional development in developing countries. As a result of his study, Feldman suggests that, for most teachers, other teachers are an important source of knowledge about teaching. Here, an important element in gaining new understandings about teaching is the combination of sharing knowledge and understanding about what works in classrooms so that other teachers can experiment with these new ideas in their own classrooms. The approach has some similarities with the Constructivist/Sociocultural Framework described by Howe and Stubbs (1996) in that there is recognition of the importance of the role of other teachers and trying out new teaching ideas in their own classrooms. This approach, which is described later in this section, is in stark contrast to approaches where outside experts come into schools to "train" teachers in new teaching approaches. Similarly, Gallagher (1996) describes the Support Teacher Program that again recognises the importance of other teachers and the potential for research findings in teaching and learning to improve teaching practice. In this program, Support Teachers participated in training sessions informed by recent research findings to improve their own teaching and to develop skills in working with their peers before moving into schools teaching half-time and working in a support role half-time. Gallagher (1996) reported beneficial outcomes in the areas of changes in the Support Teachers' and their peers' beliefs and teaching practices, improved intellectual climates in school science departments and improvements in student learning.

Extending this argument to developing countries, Feldman (1995) suggests that a cost-effective approach would include more effort being devoted to helping teachers see one another as useful resources in teacher professional development. The approach proposed by Feldman includes the development of some teachers as facilitators and, when required, a mechanism to facilitate the availability of outsider

knowledge. The suggested approach would involve teachers meeting regularly to share stories, try out new practices, and participate in systematic inquiry into their own teaching practice. In many respects, the approach suggested by Feldman has a number of elements in common with the PKG approach (Thair & Treagust, 1997) for science teachers in Indonesia described in Section 2.2.2.

Professional Development Framework. Haney and Lumpe (1995) provide a synthesis of specific components of science teacher professional development and, using ideas from the teacher training literature, propose a professional development framework. In describing this framework, the authors highlight the limitations and failures of earlier approaches in which teachers received specific training in content and teaching methodologies. Haney and Lumpe suggest that more successful approaches, while maintaining the focus on teachers as a critical element in any change process, need to incorporate a number of other factors into the process of science teacher professional development. These factors include an acknowledgment that teacher beliefs are a critical factor determining what happens in classrooms and, besides implementing new ideas themselves, that teachers should be provided with the opportunity to observe others and be involved in a process of continuous reflective analysis. Suggested activities are journal writing, coaching, peer mentoring and video taping. Additionally, Haney and Lumpe emphasise that teachers need to move from a dependent and reactive role in professional development to one of being independent and autonomous, becoming involved in curricular and instructional decision-making in areas such as science program philosophy and policy guidelines. Also highlighted is the need for regular feedback from peers, opportunities for self-reflection, and the recognition that teacher beliefs will continue to evolve during any process of professional development. These authors also highlight the need to foster teacher self-efficacy throughout the development process using a number of mechanisms that include sharing the experience and observation of success.

Constructivist/Sociocultural Framework. In contrast to the framework proposed by Haney and Lumpe (1995) which is largely aimed at assisting schools to implement science education reform policies, the approach proposed by Howe and Stubbs (1996) is not specifically intended to facilitate the implementation of new reforms. Rather, these authors conceptualise teachers as learners, and the proposed approach

Enactment is viewed by these authors as a process of problem solving, where teachers translate instructional theory and their own craft knowledge into real learning activities within classrooms, thus requiring teachers to modify and tailor instruction to fit the local context in which student learning will take place. According to Marx, et al., teachers' understanding of new teaching approaches cannot be formulated until this enactment has occurred. The process of change and the time required is acknowledged by the authors; further, they highlight the need for extended effort to impact on the broad social environments of schools, politics at all levels, curriculum imperatives, along with the time involved in teachers to learn new teaching and learning approaches. Reflection is viewed as a private and public process - private involving, for example, the use of daily journals and public in the sense of teachers discussing their experiences with others.

Within this context, there is agreement with the work of Schon (1987) which acknowledges that reflection on teaching is a vitally important component in extracting knowledge. In facilitating the above elements of teacher professional development, Marx, et al. describe the utilisation of interpersonal interventions including institutes, meetings, school consultations, and a range of technological interventions. Importantly, the processes described here are distinguishable from the deficiency-based approaches to teacher professional development described above where the emphasis is on teachers acquiring a pre-determined suite of classroom practices.

Professional/Personal/Social Development Approach. A recent approach towards understanding the processes involved in science teacher professional development conceptualises this as consisting of components of professional, personal and social development (Bell & Gilbert, 1994, 1996). This approach views teacher professional development as a continual process throughout the professional life of a teacher and is based on a three-year research project in New Zealand utilising interpretive, descriptive and qualitative research. This holistic approach to science teacher professional development involves not just individual teachers, but the entire school environment. The approach encapsulates many of the essential elements of effective teacher professional development identified by Coble and Koballa (1996) and

Sprinthall, et al. (1996), in addition to sharing common elements with the other approaches reviewed above.

Bell and Gilbert (1996) see professional development as encompassing changing concepts and beliefs about science education and classroom activities. These changes include a teacher's use of different classroom activities, the development of beliefs associated with these activities, and the development of subject matter knowledge. Personal development as identified by these authors includes feelings about being a teacher and about science education. This personal development is viewed as the individual process of constructing, evaluating and deciding on the value of newly constructed knowledge about what it means to be a science teacher. In the areas of social development, Bell and Gilbert (1996) identify essential components as including working and relating to other teachers and students in new ways.

The approach proposed by Bell and Gilbert (1996) has three main features. First, the approach proposes development in all three areas - professional, personal and social development - and these three areas are seen as being interactive and interdependent; development in one aspect cannot proceed unless the other aspects are developed also. Therefore, Bell and Gilbert (1996) argue that to focus on one area alone will not provide the desired teacher professional development and that when all three aspects are addressed teacher professional development is promoted. Second, teacher professional development occurs according to the effective components of a teacher-development program. Here, it is suggested that these components do not refer to the overall specified program, but that these effective components are support, feedback, and reflection, and that these elements help teachers to develop professionally, personally and socially. Third, Bell and Gilbert (1996) argue that the proposed approach implies a flexible sequence that loosely describes a progression for individual teachers to monitor change. Within this context, the authors are not proposing a stage approach but view the nature of learning achieved for individual teachers as being influenced by perceptions of individual circumstances. Here, Bell and Gilbert (1996) suggest that perhaps the most significant influence on the development of teachers is the context of teaching and learning, including the educational system, school management, student expectations, the curriculum, the

nature of teaching, approaches to student assessment, and the nature of teacher professional development programs.

In summary, the Professional/Personal/Social Development approach proposed by Bell and Gilbert (1996) is conceptualised from a social constructivist perspective, where learning is seen as taking place within the social contexts of classrooms and the wider context of society. There are a number of compelling reasons why this approach has been adopted as the conceptual framework for the current study. Primarily, the approach is based on constructivist and sociocultural theory which have become prominent theoretical positions in science education, with some authors suggesting areas of commonality between these two positions (Tudge & Winterhoff, 1993). Constructivism forms a basic premise for all of the approaches to teacher professional development reviewed above, as do a number of other elements including collegiality, applying ideas in practice, teacher beliefs, self-efficacy, and the reflection and modification of ideas, which are discussed in more detail in Section 2.4.

In deciding on the Professional/Personal/Social Development approach (Bell & Gilbert, 1996) for science teacher professional development as the conceptual framework for the current study, comparisons were made with the approaches discussed above. While the Participatory Teacher Training and Collaborative Action Research approaches have broad applications, a major limitation is that they are not specifically related to science education. Similarly, the Professional Development Framework approach is limited because its prime focus is in facilitating the implementation of science education reform policies in schools. While acknowledging the influence of the approach adopted by Bell and Gilbert (1996), the Constructivist/Sociocultural Framework proposed by Howe and Stubbs (1996) is primarily based around a workshop process and as a result does not provide the broad conceptual framework that is required in the current study. Finally, the CEER approach proposed by Marx, et al. (1998) provides a sophisticated conceptualisation of science teacher professional development; however, for the purposes of the current study this framework does not pay sufficient attention to the broad institutional and classroom contexts of teaching and learning. In contrast, the Professional/Personal/Social Development framework proposed by Bell and Gilbert

(1996) recognises the significant influences on teacher professional development of the education system and elements such as school management, the nature of teaching and student assessment. The author has found the focus on these elements by the Bell and Gilbert (1996) framework to be particularly useful in describing and encapsulating the essential components of science teacher professional development with his work in facilitating improvements to science teacher in-service programs in Vietnam. These elements also are important when comparing classrooms in different education systems, making this framework particularly relevant to the current study, which compares classrooms in Indonesia and Australia, and on this basis was selected as the conceptual framework of the current study.

2.4 Identifiable Elements for Effective Teacher Professional Development

2.4.1 *Introduction*

As outlined above, there are a number of recurring elements in the various approaches to teacher development, including science teacher development. These elements are constructivist and sociocultural theory, collegiality, teachers' beliefs, reflection and self-efficacy. Similarly, Griffin (1987) suggests that identifiable elements of effective teacher professional development include acknowledgment of the interrelated complexities of community, school, and classroom, sensitivity to teachers' thoughts, feelings, and the way they extract meaning from their experiences. Marx, et al. (1998) highlight a number of elements that enhance teacher professional development activities. These include collegiality and collaboration, experimentation and risk taking, extended time for the assimilation of new knowledge, sustained support and feedback, and the need to view teacher professional development within a broad framework encompassing elements of education policy and school context. All of these elements are components of the Professional/Personal/Social Development approach to science teacher professional development proposed by Bell and Gilbert (1996) which forms the conceptual framework for the current study. The following sections expand on these elements, discussing a range of concepts that have become the focus of a number of teacher professional development initiatives.

2.4.2 *Teacher Reflection*

Richardson (1990) provides an overview of the concept of reflection in teacher professional development, which is an alternative to the competency-based and performance-based teacher education approaches of the 1970s, linking clearly identifiable teaching skills to specific student learning outcomes. In defining reflective teaching, Calderhead (1989) identifies the origins of the concept from theorists including Schon (1983, 1987) and Habermas (1974). Schon (1987) highlights the importance of experience, where teachers will interact with a particular situation based on experience in similar circumstances. Reflection is viewed by Habermas (1974) as involving an increased awareness and understanding of one's context and the constraints operating in this context, with the result being an increased ability to control the impact of these influences. Within this context, Munby and Russell (1998) highlight the need for science teacher professional development programs to recognise that the context and school experience of teachers is perhaps the most influential factor in teacher professional development.

Richardson (1990) suggests that the environment for exploring approaches to understanding these beliefs and thought processes of teachers and the interaction of these with the teaching-learning process was created with the acceptance of qualitative research methods for studying teaching, especially ethnographic approaches, within the context of complex school cultures. These approaches have provided significant advances in the understanding of teachers' beliefs and knowledge, facilitating a shift in the perception of teachers from being "technicians" to "professionals" who have the ability to analyse and provide solutions to complex and ambiguous problems (Munby & Russell, 1998).

In describing teacher reflection, Richardson (1990) suggests that because it is not based on a linear series of conscious steps in a decision-making process, individuals may not be able to clearly articulate the process leading to a particular action. This may be problematic within the context of traditional teacher professional development programs based around the acquisition of defined teaching skills where there is a requirement for a logical and clear relationship between desired competencies and program content. As a result, Anderson and Mitchener (1994) suggest that within the context of science teacher education, while some changes

may be occurring, these have not had a significant or widespread impact on the traditional approaches to professional education. Therefore, a clear definition of reflective teaching and the implications for teacher professional development are not widely agreed upon. To illustrate this point, Calderhead (1989) identifies terms such as "reflective practice," "inquiry-orientated teacher education," "reflection-in-action," "teacher as researcher," and "teacher as problem-solver" which all imply some component of reflection, but at the same time demonstrate a broad range of conceptions. Within this environment, a number of reflective teacher professional development programs have been established, and there is a growing abundance of literature concerning the importance of reflection in pre-service and ongoing professional development (Marx, et al., 1998; Munby & Russell, 1994; Richardson, 1990; Sprinthall, et al., 1996).

Avalos (1993), while not referring to reflective-practices specifically, suggests that teachers should be allowed to reflect on their experiences within the context of constraints operating in their classrooms. With reference to developing countries, Avalos suggests that teacher professional development programs should take a more holistic stance in terms of considering limitations imposed by contextual conditions and give more consideration to the nature of change. Similarly, Shaeffer (1993) describes what he calls participatory teacher training which has as its central focus teachers who take an active role in determining the focus and content of teacher professional development. In this situation the teacher is seen as the agent of change as opposed to the focus of change. As a result, teacher professional development becomes self-directed and this is based on reflection and introspection. Consequently, the needs and problems of teachers are not decided by external experts but are delineated, examined and analysed by the teachers themselves. Shaeffer (1993) suggests that the participatory teacher training approach focuses introspection on the actual day-to-day reality of teachers in classrooms. In many cases, this reality may extend to problems outside the classroom, to areas such as local issues, and elements of the education system itself which impact on the problems and roles of teachers.

2.4.3 Teacher Beliefs

Teachers develop their beliefs about teaching over years of being students themselves and from their own experiences as teachers (Perry, 1990). Interpretation of their experiences and knowledge produces learning that influences classroom practices (Tobin, 1996). This learning occurs informally and suggests that teachers rarely engage in formal analyses of their teaching practices. In terms of the effectiveness of this learning Tobin (1996) suggests:

> This holistic, informal way of learning to teach seems to be effective, particularly because of the extended duration of the experience that begins in kindergarten and extends through the professional lives of teachers. This approach stands in stark contrast to the analytical approach adopted in most formal teacher education programs. (p. 177)

Considering the effectiveness of this learning, Kagan (1992) suggests that teachers' beliefs are highly stable and resistant to change, older beliefs being the most resistant to change (Pajares, 1992). Indeed, the importance of teachers' beliefs cannot be under-estimated: Their beliefs concerning instruction may be incompatible with contemporary views of learning and good teaching practice. According to Nespor (1987), although teachers may have similar scientific knowledge, they are likely to teach in different ways because teachers' beliefs are more powerful than their knowledge in influencing the way in which they teach.

Illustrating this point, Bell and Gilbert (1996) outline two extreme positions concerning the nature of teaching that can take place in a given classroom. The first is where the predominant belief is that knowledge is a real entity existing independently of individuals, and that the role of a teacher, as an expert in this knowledge, is to present this directly to students in a logical sequence. The second position is based on the belief that knowledge is constructed by individuals and that the role of the teacher is as a facilitator allowing students to reconstruct, extend or replace their existing knowledge. Hewson and Hewson (1988) use the term "conception of teaching science" (p. 5) to describe these types of thoughts that teachers have about science content and the students they teach. These conceptions are used by teachers when making decisions about the planning and implementation

of teaching activities (Hewson & Hewson, 1988) and include components of teaching style, content, learners and their knowledge, learning style, and instruction.

Similarly, Gallagher (1996) describes the culture of science teaching where the belief of many teachers is that their central task is to cover the content of a curriculum or a prescribed text in response to various accountability mechanisms in place within schools or education systems. In contrast, Gallagher (1996) describes exemplary teachers who are far less focussed with the presentation of content, showing greater concern for facilitating students' understanding of subject matter and applying this to real problems outside of the classroom and developing positive attitudes towards science.

Within a broader context, Czerniak and Lumpe (1996) discuss the relationship between teacher beliefs and national science education reform in the areas of curriculum, teaching and student assessment, which are aimed at producing a more scientifically literate workforce. However, many of these reform initiatives ignore the beliefs of classroom teachers. Indeed, a number of studies have warned of the dangers of ignoring the incompatibilities of reform agendas and teacher beliefs which in many cases are aimed at maintaining the status quo in education systems (Cuban, 1990; McLaughlin, 1990; Tobin, Tippins, & Gallard, 1994).

The examples reviewed above suggest that when planning science teacher professional development programs there is a need to take into account the conceptions of teaching science held by participants. This is important within the context of this study which examines the responsiveness of a science teacher professional development program to the needs of Australian and Indonesian teachers and their particular beliefs about teaching and learning.

2.4.4 *Self-efficacy*

A social learning theory called self-efficacy (Bandura, 1977) proposes that individuals guide their actions on the basis of observed consequences and on the beliefs that they have created for themselves. According to Bandura, behaviour is based on the principle that people not only expect specific behaviours to produce desirable outcomes (outcome expectancy), but they also have a belief in their ability

to perform these behaviours (self-efficacy). Therefore, individuals with high outcome expectancy and self-efficacy could be expected to demonstrate behaviour and act in a confident and decided manner. In contrast, individuals with low outcome expectancy coupled with high self-efficacy may be observed in certain situations to intensify efforts for a short period but eventually become frustrated. Individuals low on both scales would give up easily if desired outcomes were not readily forthcoming.

Within the context of teacher effectiveness, Gibson and Dembo (1984) predict that:

> Teachers who believe student learning can be influenced by effective teaching (outcome expectancy beliefs) and who also have confidence in their own teaching abilities (self-efficacy) should persist longer, provide a greater academic focus in the classroom, and exhibit different types of feedback than teachers who have lower expectations concerning their ability to influence student learning. (p. 570)

Therefore, within an educational context, self-efficacy is seen as the belief that teaching ability is related to positive outcomes in terms of student behaviour and achievement, and outcome expectancy. The teacher, in spite of all other factors, is able to bring about these positive changes. Czerniak and Lumpe (1996) highlight the relationship between science teaching efficacy and the instructional methods that teachers use most often to teach science. Teachers displaying high efficacy may be more likely to use student-centred teaching strategies, whereas teachers with a low sense of efficacy may have a tendency to use approaches that are more didactic.

2.4.5 *Collegiality*

Collegiality among teachers has been recognised by a number of authors as an important element in on-going teacher professional development (Little, 1982; Zahorik, 1987). However, while the benefit of collegiality among teachers is recognised and teacher professional development programs do incorporate teacher-teacher collegiality, this is not an area that has been widely researched in recent years (Zahorik, 1987). However, social interaction between teachers is an important element recognised in the sociocultural influences on teacher professional development (Howe & Stubbs, 1996).

A year-long study by Little (1982) across six schools found that schools having relatively high achievement and high acceptance of staff development activities were differentiated from schools with lower achievement and a lower acceptance of staff development by certain patterns of interaction among staff. These patterns of interaction included frequent interactions with fellow teachers and administrators that included talk about teaching practice; shared planning, design, and preparation of teaching materials; frequent observation and critiques of teaching; and teachers learning from each other the practice of teaching.

In an attempt to understand collegiality as it occurs on a day-to-day basis, Zahorik (1987) interviewed 52 teachers in six schools in order to record the type of information exchanged and with whom and where these exchanges occurred. Results indicated that teachers spent approximately 40 minutes per day conversing with other teachers about classroom teaching. Frequently discussed topics included materials, student discipline, and classroom activities. Topics discussed less frequently included evaluation, teaching methods, how to praise or reward students for successful completion of tasks, and classroom organisation. The teachers in this study indicated that these latter topics were discussed less frequently because they were viewed as being less important, personal and private, idiosyncratic and intuitive, and time consuming to discuss. Zahorik (1987) also found that school organisational patterns that required some degree of teacher interaction also promoted increased collegiality.

2.5 Constraints on Teacher Professional Development in Developing Countries

2.5.1 *Introduction*

The science teacher professional development approaches and elements of effective teacher professional development discussed above are all based on concepts originating from developed countries. Many of these concepts are most likely covered in Australian and other developed country science teacher professional development programs. Consequently, it is important that concepts such as teacher beliefs, collegiality, self-efficacy and reflection be considered alongside imperatives

operating in developing countries and the constraints that may limit the effectiveness of teacher professional development initiatives in these areas.

On a global scale, unanimous adoption of the World Declaration on Education for All at the United Nations world conference held in Lomtien, Thailand, in 1990 has been the strongest call to date on action to address globally the basic learning needs of all children, youth, and adults. This declaration is in harmony with various initiatives which began during the 1980s associated with the changing goals of science education, which called for science education to become more aligned with individual needs, and the needs of society as a whole. For example, these have been encapsulated since the early 1980s in calls for "Education for All", "Science for All", and "Inclusive Science" (Hegarty-Hazel, 1995) where individual experience and expectations, societal needs, in addition to the gender, ethnicity, and culture of the learner are acknowledged. Emphasising this point, Hegarty-Hazel (1995) suggests that science education needs to remain closely aligned to the world of the learner so that it does not become alienating, unsatisfying and therefore unsuccessful in its goals. Science education can play a role in identifying and strengthening the basic knowledge required in areas such as health, nutrition, and the provision of safe drinking water (Hegarty-Hazel, 1995). A range of other issues are identified by Haggis (1995), including population, environment, finite resources, global change, and sustainable development as areas requiring increasing degrees of scientific understanding within the populace of any nation. Haggis makes the point that science and technology are a significant component of all societies and should not be considered in isolation.

Within the context of the current study, it is therefore important to recognise that science teacher professional development initiatives must take on board a number of these imperatives. Of particular importance is the need to ensure that professional development inputs do not encourage the alienation of certain sections of a society. Therefore, in the cases where science education postgraduate programs in developed countries are offered to teachers from developing countries, ideally it is important that the host institution is fully conversant with the social contexts of classrooms and the wider imperatives operating in the society into which the program participants will return.

2.5.2 *External Influences on the Introduction of Science Education Reform in Developing Countries*

Within the context of science education reform, Krasilchik (1989) provides the example of the impact of American curriculum projects in Brazil and explores the question of whether these initiatives did in fact lead to genuine reform or were a means of establishing relationships of dependence. Indeed, this same process of importing foreign materials was common in most developing countries following independence (Jegede, 1995; Lee, 1992; McTaggart, 1989). Gray (1999) expressed concerns about the major curriculum reform currently occurring in South Africa and questions the relevance of these reforms to the context and availability of resources in South Africa, as these appear to closely resemble current curriculum initiatives in Australia. Cobern (1998) describes the problems associated with the transfer of science curricula:

> From the time transfer efforts began, expatriate teachers in Third World schools, expatriate teacher education professors preparing nationals to be teachers of science, and many, many nationals with broad cross-cultural experience discovered that transferring a science education curriculum is one thing. Employing it with desired effect is quite another. (p. 15)

It could be argued that this activity of transplanting foreign materials is an instrument of subordination among nations. On the other hand, Krasilchik (1989) believes that the importation of foreign science education materials in Brazil was necessary in the process of modernisation. These materials can be viewed as being critical in raising awareness about the state of science education and thereby producing momentum towards educational transformation. However, in order to maintain a relationship with foreign sources that produce development without the establishment of subordination and dependence, Krasilchik (1989) identifies a number of critical conditions. Materials cannot be simply introduced into educational systems for which they were not specifically designed, a process of adaptation must be undertaken. The creators or disseminators of new ideas in science education should be united with classroom teachers who have a deep understanding of the reality and context into which new initiatives will be introduced. The simple transfer of techniques and materials during international collaboration aimed at improving

science education is insufficient, there needs to be included a process allowing reflection on the problems encountered, human resource development, and a strategy to develop work methodologies. In this context, Krasilchik (1989) suggests that the focus should not be on the product but rather the process that should identify the types of constraints discussed in Section 2.5.3. Similarly, Hand and Treagust (1995) outline an approach using teachers' concerns as indicators of difficulties or constraints encountered by teachers implementing new teaching approaches. These concerns provide a means of monitoring the extent to which teachers have incorporated new teaching/learning approaches into their classroom practices and again the active involvement of classroom teachers is identified by Hand and Treagust (1995) as an important element in teacher professional development. These authors highlight the improved collegial atmosphere produced by this involvement of science teachers, thus further facilitating the process of change.

2.5.3 *Constraints on Teacher Professional Development in Developing Countries*

It is generally assumed that the quality of education in schools, whether it be in a developing or developed nation, is linked directly to the professional development of teachers in the areas of subject knowledge and teaching methodologies (Klinzing & Tisher, 1993). This assumption is reflected in developing countries where the World Bank during the 1980s devoted two thirds of its education budget to teacher professional development initiatives (Fuller, 1987). However, in questioning this level of input into teacher professional development, Fuller suggests that there is very little evidence demonstrating the effectiveness of these programs.

Shaeffer (1993) identifies a number of constraints that may operate in developing countries and these would apply to most of the approaches to teacher professional development described above which contain, for example, elements of small group discussions, reflection, and action research. Shaeffer contends that these particular elements are slow to implement and time consuming when compared to the more prescriptive top-down approaches; also in many countries teachers may become uncomfortable with the group dynamics involved in activities such as self-analysis. Further, initiatives such as Collaborative Action Research, Participatory Teacher Training and the Professional/Personal/Social Development approach are based on

the premise that, as professionals, teachers are expected to take the initiative and that there is a supportive climate to facilitate these initiatives. However, this climate or these expectations may not exist in many developing countries (Shaeffer, 1993). In addition, teachers may not have time to attend professional development activities and, as outlined by Thair and Treagust (1997), teachers spread their time across multiple teaching positions in different schools to earn a reasonable income, leaving very little time for additional professional activities. Unfortunately, improvement of teaching effectiveness generally will not provide an increase in income.

Compounding these problems, Shaeffer (1993) suggests that in many developing countries the ministries of education, and schools themselves, are very often not conducive to accommodating change. This may stem from structural and financial constraints or administrators who are more comfortable with traditional approaches. Shaeffer highlights the overriding expectation in many developing countries that teachers remain subservient to the education bureaucracy and within this environment new initiatives are not encouraged. Finally, while having the potential to create a positive attitude change among teachers, many of the approaches suggested may not provide teachers with the necessary resources or direction to deal with constraints such as the lack of equipment, poor teaching conditions, and students with learning difficulties.

Ultimately, teacher professional development initiatives must be translated into sustainable classroom teaching practices, therefore it is important to understand what is happening in classrooms. As mentioned previously, the international science education community has been slow to recognise that pedagogical approaches from developed countries may, to a large extent, be inappropriate to the learning styles found in the classrooms of many developing countries (Kerrison, 1992; Morris, 1996). For example, Tobin (1995) suggests that while it may be appropriate in developed countries to advocate student-centred teaching approaches, in certain cultures the respect for the authority of teachers may produce a situation where student learning occurs more optimally in a teacher-centred classroom. Additionally, in many developing countries where large class sizes and lack of resources are the norm, didactic approaches may be the expedient option for teachers. Compounding these problems, science education research makes use of theoretical frameworks that

essentially originated in developed countries; when examining science education in developing countries these cultural issues may be ignored. Additionally, it is inappropriate to make claims about the applicability of research undertaken in a developed country to the situations found in developing countries (Tobin, 1995). This then raises questions regarding the transferability of educational theories and approaches to developing country cultures.

2.6 The Impact of Culture on Science Education and the Implications for Teacher Professional Development

2.6.1 *Introduction*

In addressing basic education needs, formulating national science policies, and linking these to science education in developing countries, Lewin (1990b) highlights the increasing numbers of children studying science and the achievement in many countries of universal enrolment in lower secondary school. As a result, science education and the associated practical activities have become an established component of most education systems in developing countries. However, Lewin (1990b) suggests caution in drawing conclusions from these achievements:

> And yet we know relatively little about the effects of the last two decades of effort. We know that far more children study science in developing countries than earlier but the evidence suggests that the great majority do not master more than a small proportion of the goals set for them. We know that science education absorbs large parts of non-salary recurrent budgets and that it is these that have deteriorated most dramatically in the poorest and most heavily indebted countries. As a consequence, much science is being taught using materials that assume the existence of learning resources that are not available. (p. 1)

In describing the development of science education in developing countries, Lewin (1990b) highlights the colonial influences on post-independence development of science curricula. Essentially, curricula from developed countries were implemented with little, if any, consideration to local conditions.

2.6.2 *Science and Culture*

Development of science education in many developing countries was driven by the North American and European science curriculum reforms occurring during the 1960s, which were transferred without modification to developing country classrooms. During this process there was little, if any, regard for indigenous cultures (Jegede, 1995). Examples include the adoption of the Scottish Integrated Science course by Malaysia, the West Indies, Botswana, Swaziland, and Nigeria (Wilson, 1981), the Biological Sciences Curriculum Study (BSCS) which was disseminated to 63 countries in 21 different languages (McTaggart, 1989), the importation of Nuffield science materials into African countries (Jegede, 1995), and the science curriculum reform that occurred in Malaysia following independence (Lee, 1992). This adoption of what was seen as being good practice in developed countries came about largely as a result of international conferences on science and science teaching and the professional and financial assistance from a number of organisations such as The British Council and the Centre for Education and Research Development Overseas (CERDO) (Lee, 1992).

Baker and Taylor (1995) suggest that while it may be argued that science knowledge is universal, the world views of different cultures and the needs of different economies are not; hence, there may be a poor "fit" between the culture and beliefs of developing country students and the culture embedded in science education originating from a developed country. While a number of approaches in developed countries have attempted to view science as an interaction between society, science, and technology, Ogawa (1986) suggests that these approaches may not necessarily provide a clear rationale for science education in other societies. The suggestion is that science has evolved from developed countries, and therefore should not be seen as the norm for all cultures and that, in effect, different societies may develop their own rationale for science education. Within this context, a concern raised by Ogawa is how science, which itself can be considered a culture, can be integrated into a traditional foreign culture. This need arises because science and technology have become so widespread and Ogawa sees developing countries as having no choice but to consider this integration. Within this framework, Ogawa maintains that these societies must view science within the framework of their traditional culture, never vice-versa, as this implies a loss of identity for that culture.

As a result of the tendency to view the developed country perspective as the only legitimate approach to science, and thereby denigrating indigenous beliefs, Jegede (1995) describes the aggressive manner in which science materials and instruction have been implemented into African classrooms. This viewpoint is supported by Baker and Taylor (1995) who suggest that a prerequisite of science education in developing countries should not be the adoption of a developed country worldview. Further, these authors caution against what they term "cosmetic" (p. 695) attempts to introduce developed country science curricula into developing countries, because the cultural background of students in terms of their world-views, language, and prior beliefs is likely to affect the intended outcomes of the science education based on these materials. Citing the increasing disinterest in science among students, Cobern (1998) broadens this view to developed countries:

> Even within the West it is important for science educators to understand the fundamental, culturally based beliefs about the world that students and teachers bring to class, and how these beliefs are supported by culture; because, science education is successful only to the extent that science can find a niche in the cognitive and cultural milieu of students. (pp. 7-8)

2.6.3 *Teaching Strategies and Cultural Beliefs*

Baker and Taylor (1995) suggest one potential approach in bridging the gap between the world-view of learners and the world-view inherent in science education is the adoption of teaching strategies that allow students to explore their own prior cultural beliefs, then to examine these beliefs within the context of the introduced science materials. While suggesting that constructivist approaches offer some scope for developing learning approaches in science education that may be suited to developing countries, the authors caution that these should be examined very closely to ensure that they are culturally appropriate.

An approach described by Hewson (1988) incorporating conceptual change differs from the usual responses to failures in teaching imported science curricula in developing countries. For example, Hewson (1988) suggests that "when teaching science in other cultures fails, the response is frequently to do more of the same" (p. 323). Hewson provides an example from Africa where foreign science materials

were simplified and Africanised by including illustrations of African children and local flora and fauna. Similarly, Cobern (1998) provides examples where cultural adaptation has simply meant changing scientific units, currencies used, capital cities in examples and increased reaction rates allowing for warmer climates. These approaches are based on the assumption that only science originating from developed countries should be taught and, as outlined by Hewson (1988) and Cobern (1998) this is generally unsatisfactory because there is no recognition that science exists in the developing country receiving these materials. As a result, and based on this erroneous assumption, attempts to improve science education are generally limited to improvements in teaching facilities, science teacher professional development, and the production of new textbooks. However, Hewson (1988) highlights the need "to face what actually goes on in the minds of learners when presented with Western science" (p. 323). Within this context, Hewson suggests the conceptual change approach as one way of remedying these problems.

The conceptual change approach outlined by Hewson (1996) is based on the assumption that student learning is not simply the addition of new learning material to existing information but involves "a process in which a person changes his or her conceptions by capturing new conceptions, restructuring existing conceptions, or exchanging existing conceptions for new conceptions (i.e., a process of conceptual change)" (p. 132). Within a developing country context, Hewson (1988) suggests that this approach:

> Offers a perspective on the cognitive processing used on Western scientific concepts by learners. It suggests the interactions that may take place between competing conceptual frameworks, and offers the teacher a way of working through the conflict with the learner in a cooperative fashion. (p. 325)

The adoption of new conceptions must be more useful in problem solving and making predictions than existing conceptions and Hewson (1988) suggests that learners may adopt some aspects of science while rejecting others, which she describes as "negotiated knowledge acquisition" (p. 324).

In applying some of these concepts, Jegede (1995) describes the transition that a child makes from traditional society to formal schooling, providing a detailed account of the cognitive processes of African science students as their traditional

worldview interacts with the worldview of developed countries. Based on these processes, Jegede suggests that the teaching of science in Africa must establish a very close relationship with the world of the student and that a clear understanding is required of the cultural basis of learning among students. Jegede proposes the use of a conceptual ecocultural paradigm in which the teaching approach is to develop an individual's understanding of science by drawing upon the elements of the sociocultural environment in which the learner lives. Particular elements identified by Jegede include the provision of information about the African environment explaining natural phenomena, use of indigenous scientific theories and concepts, and the teaching of indigenous values within the context of technology and science. This approach therefore is constructivist in nature, allowing learners to construct their own knowledge based on new experiences within the context of an existing and known conceptual framework. Second, the approach is cognisant of the worldview of learners from traditional societies in a developing country.

Cobern and Aikenhead (1998) broaden the above discussion by including students in developed countries and their cultural view of learning science. Within this context, the authors suggest that these students, as do developing country students, cross "cultural borders" (p. 40), from their worlds formulated by family and community into the world of school science. Science therefore is seen as a subculture of developed country culture. Attempts to assimilate developed country science into developing countries can be perceived as being threatening; similarly, attempts to assimilate developed country students into the subculture of science can create alienation and the production of anti-science attitudes (Cobern & Aikenhead, 1998). It is concluded by these authors, that for the majority of students, the threatening aspects of science are reduced, or the crossing of these cultural borders is facilitated when the culture of their world is compatible with the culture of science, or more specifically, school science. In terms of the implications for science teaching, Cobern and Aikenhead (1998) suggest that teaching methodologies and materials need to be employed in order to facilitate these crossings from the everyday world of students into the world of science.

By broadening the discussion to include students in developed countries, Cobern and Aikenhead (1998) suggest that the learning difficulties identified by Jegede (1995)

among African students are not specific to that one culture. Expanding on this further, Dzama and Osborne (1999) suggest that poor performance in science in developing countries is caused by a lack of employment opportunities and incentives rather than a conflict between science and traditional values and beliefs. In support of this argument, parallels are drawn by Dzama and Osborne (1999) with what is occurring in developed countries, linking student effort in learning science and perceived economic rewards. "This last point is a universal truism, as applicable to the problems facing the decline in interest among Western youth as it is to the problems facing science education in Africa" (Dzama & Osborne, 1999, p. 402). These authors conclude that:

> In the growth of science in developed countries, improvement in the performance of students succeeded rather than preceded industrial and technological development. Consequently, developing countries put the cart before the horse when they attempt to train more scientists than can be absorbed by the existing job markets for scientists in these countries. (p. 387)

2.6.4 *Implications for Teacher Professional Development*

Based on the above review, there is clearly a need for teacher professional development programs to take into account the worldview and prior experience of participants, in addition to the perceived employment opportunities and incentives, thereby responding to the learners' context. This is the basis for constructivist approaches to learning and, while these are probably a theoretical component of teacher professional development programs, it is also important that these programs themselves are designed, planned and implemented from a constructivist perspective. Based on this premise, teacher professional development programs should become involved in negotiation with participants to meet the needs of particular countries' or perhaps individual's needs. This process would promote border crossings from the everyday world of developing country participants into the developed country world-view.

Taking the above implications into consideration, it is clear that a predetermined teacher professional development program may be unsuitable to meet the needs of both developed country and developing country participants. In recognising that teaching practices are culturally bound and context dependent and that developed

country science education cannot be easily transferred to developing country participants, teacher development programs may need to be tailored to meet individual needs. These considerations also raise the question of the experience and knowledge of developing country cultures of academic staff involved in professional development programs attracting overseas students. If programs are to be designed and implemented from a constructivist perspective to meet the needs of particular countries, the negotiation and conceptualisation of these needs may be enhanced by academic staff with experience in developing countries. The implication therefore is for close links and exchange of staff between institutions in both countries.

2.7 Summary of Chapter

As stated above, the literature review has taken a broad holistic view of the imperatives impacting on science teacher professional development generally and more specifically on the issues related to teachers from both developed and developing countries completing science education postgraduate programs in developed countries.

What is clear from the review is that, in terms of transfer between cultures, the research and approaches towards science teacher professional development are inconclusive. Perhaps of greater value to program providers are the identifiable elements of effective teacher professional development identified above. However, the literature suggests that these elements, which have originated from developed countries, are not readily transferable to developing countries. In addition to differing reform agendas and expectations placed on education systems, the literature identifies issues of science and culture that have implications for science teacher professional development in developing countries.

More specifically, the literature review highlights a number of differences between science teacher professional development in a developing country like Indonesia and a developed country like Australia. Science teacher professional development in Indonesia is highly centralised and essentially driven by manpower issues, under-qualified teachers and the need to upgrade teachers' academic and teaching skills.

Within this context, significant resources are directed towards the implementation of national teacher professional development initiatives such as the PKG project involving the Indonesian participants of this current study. The situation in Australia is quite different. Within a complex environment created by a government driven education reform agenda and the evolving industrial implications associated with award restructuring and teacher professional development are important issues associated with the links between career development and professional development. In Australia, these initiatives are more autonomous and usually contained at the State level.

In summary, the literature review suggests that there are significant differences between the professional development needs of teachers in developing and developed countries. This is particularly evident in the areas of constraints on teacher professional development and culture. Consequently, it is important for host institutions enrolling science teachers from developing countries to become fully conversant with the classroom and social contexts of societies to which teachers will return. It is from this perspective that the Professional/Personal/Social Development approach (Bell & Gilbert, 1996) has been adopted as the conceptual framework for the current study. Also, host institutions must realise that in some cases the approaches used in developed countries may be inappropriate to developing countries. The literature suggests a need for host institutions to implement programs from a constructivist perspective.

In recognising the differences between science teacher professional development in a developing country like Indonesia and a developed country like Australia and the need to approach teacher professional development from a constructivist and sociocultural viewpoint, Chapter 3 describes the methodology adopted for the study. The rationale employed in the selection of research instruments is described in addition to a full description of each instrument used.

Chapter 3

Methodology

3.1 Introduction

A major issue identified by Sprinthall, Reiman, and Thies-Sprinthall (1996) is the need for a broader conception of teacher professional development research, including the merging of qualitative and quantitative approaches. Suggestions by these authors include the use of participant observations and interview material along with quantitative data. A number of advantages have been identified using these approaches, including the added richness of data provided by the combined inputs from qualitative and quantitative sources and the improved credibility of research findings provided by the triangulation of data from different data collection approaches (Firestone, 1987; Fraser & Tobin, 1991). The selection of research methodology for this study combining both quantitative and qualitative methods was therefore guided by these recent research trends in the field of teacher professional development.

The following sections firstly describe the program setting and study participants, secondly the selection of research instruments and an outline of the relationship between these and the research questions. This is followed by a detailed description of the instruments used in the postal questionnaire, teacher interviews, classroom observations, construction of case studies, and interviews with Science and Mathematics Education Centre (SMEC) staff. The chapter concludes with a brief summary.

3.2 Program Setting and Selection of Study Participants

Program Setting. As outlined in Chapter 1, the participants in this study are graduates from SMEC at Curtin University of Technology located in Western

Australia which offers a range of postgraduate studies in science, mathematics and technology education. The programs offered include Doctor of Philosophy (PhD) by thesis, Doctor of Science Education (SciEdD) by coursework and thesis, Doctor of Mathematics Education (MathEdD) by coursework and thesis, Master of Science in Science Education or Mathematics Education by thesis or by coursework and project, and the Postgraduate Diploma in Science, Mathematics, or Technology Education.

Students enrolling in these programs include local and Australian distance education students, as well as fee-paying students from overseas. Across all programs, local, distance education and overseas students essentially follow similar programs of study. Typically, the Postgraduate Diploma is completed in a minimum of one-year full-time study, and students complete five core units of science/mathematics education in addition to between four and six elective units. Program participants also must complete a science or mathematics education project that involves developing a proposal based on a literature review, then a pilot study or development of curriculum materials. The Master of Science (Science Education) by coursework-and-project in science or mathematics education consists of coursework, and the completion of a project. The minimum time requirements are one year full-time or two years part-time. The project is generally in an area of applied research related to the interest of participants and the research interests of SMEC academic staff.

Selection of Study Participants. As this study is primarily focused on practicing science educators, efforts were taken to identify and exclude from the study alumni who were involved in mathematics areas or who where no longer engaged in education. These efforts included a search of thesis and project titles indicating particular areas of professional expertise and discussions with faculty members who may have had ongoing contact with alumni members through continuing studies at SMEC. While this approach was not conclusive, the sample size was reduced to 168 Australian and 41 Indonesian participants as shown in Table 1 (Chapter 1).

The largest group of overseas alumni were from Indonesia, with 41 being identified as being involved in science education. As outlined in Chapter 1, considering this

teaching and learning" (pp. 151-160) which includes influences of the education system.

Table 2
The Relationship between the Research Questions and Instruments

Research Questions	Instrument	Item Numbers	Form of data
RESEARCH QUESTION 1 (Personal Development)			
- feelings about being a science teacher, and beliefs about science education	Postal Questionnaire:		
	Part C	All 25 items	Likert coded data
	Part E	All 49 items	Likert coded data
	Teacher Interview	Items 1 and 2	Open-ended responses
RESEARCH QUESTION 2 (Professional Development)			
- classroom practices generally	Postal Questionnaire:		
	Part F	All 11 items	Likert coded data
	Teacher Interview	Items 4, 5, 6, 7, 8, 9, 10	Open-ended
	Classroom observations	All items	Open-ended/Likert
- the introduction of new teaching activities	Postal Questionnaire:		
	Part B	All 19 items	Likert coded data
	Teacher Interview	Item 3	Open-ended
RESEARCH QUESTION 3 (Social Development)			
- ways of relating to other teachers	Postal Questionnaire:		
	Part G	All 19 items	Likert coded data
	Part H	All 8 items	Likert coded data
- notions of teacher development	Postal Questionnaire:		
	Part D	All 22 items	Likert coded data
	Teacher Interview	Item 11	Open-ended
RESEARCH QUESTION 4 (Education System)			
- the education system	N/A	N/A	Review by researcher
- school management	Postal Questionnaire		
	Part A	Items 7 and 8.	Self-completion
- availability of inservice training	Postal Questionnaire		
	Part A	Items 9 and 10.	Self-completion

As outlined by Bell and Gilbert (1996), personal development includes feelings

about being a science teacher and about science education, while professional development is seen as involving changing concepts and beliefs about science teaching and classroom practices. Social development encompasses working and relating to other teachers and students in new ways. Science teacher development is conceptualised by Bell and Gilbert from a social constructivist perspective where learning is seen as taking place not only within the social contexts of classrooms but the wider context of society, thus the consideration of what they describe as the "cultural landscape of teaching and learning."

Some components of the instruments were developed from the work of Bell and Gilbert (1993) where they were used for the ongoing monitoring of science teachers. Other instruments used include the *Science Teacher Efficacy Belief Instrument* (STEBI) developed by Riggs and Enochs (1990), a questionnaire on teacher interaction based on the work of Little (1982), and a number of instruments developed by the researcher. The various instruments are discussed in more detail in the following sections.

3.4 Postal Questionnaire

3.4.1 *Postal Questionnaire Design*

Within the context of the present study involving Australian and Indonesian alumni who have graduated a number years ago, the design of the questionnaire was important in determining the quality of data and response rates. At the time of data collection, Indonesia was undergoing a period of extensive political and economic upheaval, therefore the questionnaire design was seen as being particularly critical if an acceptable response rate was to be achieved from these participants. A number of studies examining questionnaire design were reviewed and these indicated that critical design elements include the structure, length, appearance and colour of the questionnaire, the accompanying covering letter, and approaches used in follow-up reminders to questionnaire participants (Boser & Clark, 1992; Fox, Crask, & Kim, 1988; Lindsay, 1985; Sudman, 1985). An overview of the postal questionnaire design adopted for the study and incorporating these design elements is shown in Table 3. A copy of the postal questionnaire is included in Appendix A.

Table 3
Summary of Questionnaire Design Elements Used For Postal Questionnaires

Design element	Questionnaire
Questionnaire items	• predominant use of Likert scales; a number of items use open-ended and structured formats • each item and response scales appear on the same age
Questionnaire length	• 163 items on 9 pages.
Questionnaire appearance	• professionally printed • Curtin University logo • one blank page at the end of questionnaires for additional respondent comments • green coloured paper • instructions for completion of questionnaire placed on cover page
Covering letter	• use of SMEC letterhead • personally addressed to each respondent • personal signature of researcher • reply paid envelope • brief explanation of proposed research and outline of benefits • statement on confidentiality • provision for respondents to return questionnaire if unwilling to participate in research
Follow-up reminders	• postcard approximately 2 months following initial posting • re-post questionnaire to non-respondents after 3 months

3.4.2 *Part A: Teachers' Background Information*

The first section of the postal questionnaire contains 10 questions designed to elicit basic background information from the study participants. The particular aspects examined include gender, age, years of teaching, educational qualifications, areas of teaching expertise, membership of professional organisations, details of teacher

professional development provisions, and how participants became involved in the SMEC postgraduate program. This information also was used by the researcher to provide a profile of each group of teachers, enabling the selection of representative teachers for interviews and classroom observations.

3.4.3 *Part B: Introducing New Teaching Activities*

Teacher professional development does not occur in a vacuum and therefore this development must fit into the constraints of the school and educational system in which a teacher is operating. This is especially relevant in the area of introducing new teaching activities or behaving differently in the classroom. The extent and nature of constraints may be perceived differently by different teachers in one particular education system or school and differently by teachers in different education systems. Bell (1993) suggests that teacher professional development is more likely to occur if this conflict between introducing new teaching activities and perceived constraints can be resolved. The areas of constraints identified by Bell include covering the curriculum, classroom control, available time, resources, and support from school management.

Part B of the postal questionnaire consists of 19 items presented in random order based on these areas of conflict. For example, item 4 considers classroom control, asking respondents, "When introducing new teaching activities it is important to consider if students may become noisy." Similarly, item 7 dealing with available time asks respondents, "When introducing new teaching activities it is important to consider if the timetable will allow it." The response categories for each item are arranged on a 5-point Likert scale of *strongly disagree*, *disagree*, *neither agree or disagree*, *agree*, and *strongly agree*. Scoring was accomplished by allocating a score of five to items receiving a *strongly agree* response, a score of four to *agree* and so on throughout the response scale to a score of one for *strongly disagree*.

3.4.4 *Part C: Teachers' Beliefs about Science Teaching and Learning*

Within the context of the current study, use of the *Science Teacher Efficacy Belief Instrument* (STEBI) (Riggs & Enochs, 1990) offers some potential for examining elements of science teacher professional and personal development. The 25-item

STEBI used in Part C of the questionnaire consists of the two scales identified by Riggs and Enochs (1990) - self-efficacy and outcome expectancy. Teachers who are low in outcome expectancy beliefs in terms of their belief that student learning can be influenced by effective teaching should be exposed to different teacher professional development inputs than those teachers who only have low confidence in their teaching abilities (low self-efficacy).

High reliability and validity have been previously established for pre-service and in-service versions of the STEBI scale for elementary science teachers (Enochs & Riggs, 1990; Riggs & Enochs, 1990). Considering this prior focus in the use of the STEBI with elementary science teachers, the author, his supervisor and an expert panel of 15 experienced Australian and overseas secondary school science teachers studying postgraduate science education at SMEC reviewed all items. The prime focus of this review was to check that items reflected a predominantly secondary school science classroom setting; subsequently, minor wording modifications were made to the original instrument.

As in the original instrument, the response categories for each item were arranged on a 5-point Likert scale of *strongly disagree*, *disagree*, *neither agree or disagree*, *agree*, and *strongly agree*. Scoring was accomplished by allocating a score of five to positively phrased items receiving a *strongly agree* response, a score of four to *agree* and so on throughout the response scale. Examples of positively worded items include, "I am continually finding better ways to teach science" and, "When teaching science, I usually welcome student questions." Negatively worded items such as, "I generally teach science ineffectively" and "I find it difficult to explain to students why experiments work" were scored in the opposite direction with *strongly agree* being allocated a score of one. Scores for the STEBI scales were computed by adding the items on the respective scales for each questionnaire respondent.

3.4.5 *Part D: Teacher Professional Development*

This section of the questionnaire is designed to elicit teacher opinions on various situations or sources of teacher professional development. A common approach to

teacher professional development is characterised by the Joyce and Showers' (1980; 1988) approach of comprehensive instructional models of teaching. Within this context, training in new forms of pedagogy and knowledge derived from educational research is provided from external sources. From a different perspective, research by Feldman (1995) suggests that, for many teachers, other teachers within a school setting are an important source of teacher professional development in terms of facilitating knowledge and understanding about teaching and trying out these ideas in a teachers' classroom. Within the context of a changing relationship between the teacher and students, students are seen by Thiessen (1992) as a source of teacher professional development in that they can provide feedback and support for the teacher. Bell and Gilbert (1996) suggest that teachers may prefer to work with students when a school environment or culture does not support collegial relationships among teachers.

In response to the above considerations, Part D of the postal questionnaire consisted of 22 items covering areas of teacher professional development including collegiality and interaction with other teachers, the involvement of students, and elements that are external to the school environment. These items were based on the work done by Bell (1993) with science teachers in New Zealand. Examples of items included in this section of the questionnaire dealing with teacher-teacher interactions were, "In my opinion, the best teacher development occurs when talking with other teachers," and "In my opinion, the best teacher development occurs when sharing problems with other teachers." An example of an item covering elements external to the school environment was "In my opinion, the best teacher development occurs when listening to a lecture." Teachers were asked to indicate their level of agreement or disagreement with the 22 statements using a 5-point Likert scale of *strongly disagree*, *disagree*, *neither agree or disagree*, *agree*, and *strongly agree*. Scoring was accomplished by allocating a score of five to items receiving a *strongly agree* response, a score of four to *agree* and so on throughout the response scale to a score of one for *strongly disagree*.

3.4.6 *Part E: Teaching and Learning in Science*

This part of the postal questionnaire is divided into two sections. The first deals with teaching science (22 items) and focuses on teachers' concept of teaching, with items ranging between the two extreme positions concerning the nature of teaching and learning identified by Bell and Gilbert (1996). The first position sees students as passive recipients of knowledge and examples of items used were "Teaching science involves giving knowledge to students," and "Teaching science involves giving instructions." The second position described by Bell and Gilbert recognises that students learn by reconstructing their own knowledge and examples of items used were, "Teaching science involves finding out what students are thinking," and "Teaching science involves using student ideas in class."

The second section of Part E provides statements related to a range of concepts associated with student learning in science (27 items) and again is based on work done by Bell (1993) reflecting the two extreme positions concerning the nature of student learning described above. Examples of items within these two positions include, "For students, learning in science involves memorising facts and knowledge", indicating the view that students are passive recipients of knowledge provided by teachers, and "For students, learning in science involves linking new ideas to existing ideas" which recognises the ability of students to learn through the reconstruction of their own knowledge. Questionnaire respondents were asked to indicate their level of agreement or disagreement statements on both sections of Part E using a 5-point Likert scale of *strongly disagree*, *disagree*, *neither agree or disagree*, *agree*, and *strongly agree*. Scoring was accomplished by allocating a score of five to items receiving a *strongly agree* response, a score of four to *agree* and so on throughout the response scale to a score of one for *strongly disagree*.

3.4.7 *Part F: Classroom Practice*

This section of the postal questionnaire provides respondents with an opportunity to identify the frequency of a number of teaching practices in their science classroom. The researcher identified 11 examples of teaching practice from discussions with SMEC colleagues who were classroom science teachers and part-time postgraduate students. The questionnaire respondents were required to select the frequency of

these classroom practices that best matched their particular circumstances. The items have response categories for each item arranged on a 5-point Likert scale of *each lesson*, *daily*, *weekly*, *monthly*, and *rarely*. Examples of items included in this section of the questionnaire were "Teaching science in my classroom involves students doing self-initiated investigations," and "Teaching science in my classroom involves teacher demonstrations." Scoring was accomplished by allocating a score of five to items receiving a rarely response, a score of four to a response of monthly and so on throughout the response scale to a score of one for practices taking place during each lesson.

3.4.8 *Part G: Frequency of Interactions Between Teachers and Part H: Places Where Interaction Between Teachers Occurs*

As discussed in Chapter 2, an environment in which teachers can seek out exchanges with other teachers is an important element in teacher professional development. High acceptance and achievement in teacher professional development activities occurs in environments allowing frequent interaction about teaching practices between staff, frequent observations of teaching and teachers learning from each other (Little, 1982). Sections G and H of the postal questionnaire are loosely based on a number of descriptive statements generated from interviews conducted by Little (1982). In both sections, respondents were asked to choose the frequency in which they engaged in each activity by choosing from a 5-point Likert scale including *each lesson*, *daily*, *weekly*, *monthly* and *rarely*. In Section G respondents were asked for example how often they would "Borrow materials from other teachers," and "Invite other teachers to observe my teaching." In section H, respondents were asked to identify the frequency and where interactions between teachers occur, choosing from eight locations in and outside of school including "When moving between classrooms," and "After school hours." For both sections, scoring was accomplished by allocating a score of five to items receiving a rarely response, a score of four to a response of monthly and so on throughout the response scale to a score of one for practices taking place during each lesson.

3.5 Postal Questionnaire Review and Analysis of Questionnaire Responses

The validity of the instruments was established by the use of an expert review panel consisting of a science education professor and 11 experienced Australian and overseas science teachers involved in postgraduate studies at SMEC. Two experienced Indonesian science teachers involved in postgraduate studies at SMEC also reviewed the instruments following the initial review by the expert panel. All reviewers were asked to check for meaning, ambiguities, areas of potential misunderstanding, spelling errors, and if the questions were relevant to their particular school setting. A number of minor modifications were suggested during the reviews and these were incorporated into the final drafts of the instruments.

Considering that the instruments were used to make comparisons between two groups of teachers, all of whom were SMEC alumni, and that one group of teachers were located overseas, the researcher did not have the opportunity to evaluate and trial the questionnaire items statistically before use. An equivalent group of Indonesian teachers was not available. Consequently, determination of the validity of instruments was important. As stated by Munby (1997), "While the panel of judges technique for validating instruments has some acceptability, it is not without detractors" (p. 338). This statement is argued on the assumption that the meanings of instrument items for judges on review panels are somehow equivalent to those responding to the instrument. The context of this argument was the administration of a scientific attitude instrument to students, and within this context, the argument presented by Munby (1997) may be legitimate. However, in the case of the current study the members of the review panel were science teachers and therefore similar to the study participants. Consequently, the evidence of validity obtained from the expert review panel used in this study can be accepted with greater confidence than if the instruments were administered to students. Factor analyses were used to examine the fit of the conceptually derived instrument scales with statistically derived factors (Tabachnick & Fidell, 1996), and details of these analyses are provided in Chapter 4. As stated earlier, some parts of the questionnaire were based on established published studies.

The analysis of Part A of the postal questionnaire consisted of percentage responses from the two groups for each item. Cronbach alpha reliabilities were calculated for Parts B, C, D, E, F, G and H. Additionally, exploratory factor analyses were performed on the items in these sections of the postal questionnaire and Cronbach alpha reliabilities calculated for groupings of items. Inferential statistical analysis performed included *t* tests and probability levels with alpha reliabilities calculated for these tests. In addition, means were calculated with the associated standard deviations. Further details of the statistical analysis are provided in Chapter 4.

3.6 Teacher Interviews

Teacher interviews were used in conjunction with the other research methods in order to validate data and findings and to explore further the responses to postal questionnaire items (Cohen & Manion, 1994). Consequently, following the initial analysis of the postal questionnaire data, interview questions were selected in order to explore more fully a number of areas. These included feelings about science teaching, the introduction of new teaching activities, the curriculum, examinations, and involvement in teacher professional development activities. Questions were open-ended, allowing the interviewer the opportunity to determine the limits of the respondent's knowledge and understanding on each question and allowing probing in order to clarify misunderstandings (Cohen & Manion, 1994). A copy of the interview guide questions is included in Appendix B.

The seven Indonesian and six Australian teachers interviewed were specifically selected (Patton, 1990) following analysis of Part A of the postal questionnaire. Based on details of age, years of teaching, educational qualifications and areas of teaching expertise, those selected were generally representative of the profiles of experience and background for their particular group. Another consideration was that a cross-section of levels within the education system be represented and that this reflected teacher promotions within the two education systems that had occurred since participants had completed the program at SMEC. This selection process resulted in interviews with two classroom teachers, two principals with science

teaching duties, one in-service science teacher trainer and two inspectors, who were all government employees selected from the Indonesian respondents. In Western Australia, the interviewees came from both the public and private education sector and included three Heads of Science Departments with teaching duties, a Deputy Principal, and the Head of a Junior School with teaching duties in science.

In deciding how the interviews would be recorded, the researcher followed suggestions made by Vulliamy (1990a) which are applicable to developing and developed countries. Notwithstanding the problems of carrying a small recorder through Indonesia and the potential for theft, mechanical breakdowns and the effects of high humidity, Vulliamy (1990a) highlights the problem of the possible effect of tape recording interviews on the validity of data in both developing and developed countries. While tape recording has the benefit of providing an accurate record of interviews, this author suggests that it can also make interviewees guarded in their response to questions. As stated by Vulliamy (1990a):

> If there is to be any potential conflict between validity and full and accurate recording, then it is validity that is the most important. Put simply, it is better to have a limited record of a respondent's real feelings than a very accurate transcription of a series of highly guarded or dishonest responses. (p. 105)

As a result of these considerations, extensive notes were taken during the interviews which lasted approximately 90 minutes. Immediately after each interview, full fieldnotes were written within one hour of the interview and therefore always before another interview was undertaken.

3.7 Classroom Observations

The approach to classroom observations was that of a non-participant (Merriam, 1990) and structured observations were made using a checklist of pre-specified behaviours. McKernan (1991) outlines a number of advantages of observation as a research technique and these are particularly relevant to the study. This approach took place in normal classroom environments, therefore introducing the likelihood of sampling unlikely as well as likely classroom occurrences which is particularly important in facilitating the comparison of Indonesian and Australian classrooms.

A classroom observation schedule was developed for use in the study and is shown in Appendix C. This schedule is based on guidelines provided by McKernan (1991) and specific elements relating to teaching and learning behaviour covered in the postal questionnaire. The areas examined included overall classroom ethos, lesson activities, approaches used to facilitate student learning, general classroom climate and participation by students.

Classroom observations were made by the researcher of one Australian and one Indonesian teacher. The two teachers selected for the case studies were specifically selected (Patton, 1990). Following the teacher interviews described above, the decisions on the final selection for classroom observation and inclusion in the case studies was based on the enthusiasm and willingness of teachers to open their classroom to outside scrutiny, and a willingness to be open and candid with the researcher. Further, based on the analysis of postal questionnaire data, the teachers selected were representative of the profile of teachers from which they were drawn. More importantly, the selection identified teachers who within their particular education system had a broad perspective of classroom teaching, the education system as a whole and issues of teacher professional development. In the case of the Indonesian participant, she was a classroom teacher in addition to having responsibilities in science teacher professional development in the MGMP (*Musyawarah Guru Mata Pelajaran*) program. This program on average conducts teacher professional development activities every three weeks and has a strong focus on classroom teaching methodology (Thair, 1996a). The Australian participant was the Head of a Science Department in a public school who, in addition to administrative duties, was a classroom teacher across most of the lower and senior high school grades. He was also responsible for administrating a budget for teacher professional development.

3.8 Case Studies

In a review of teacher education research in Australia, Tisher (1990) found that case studies and action research were the most prominent approaches to research

dealing with professional development. This is in line with developments in other countries where there have been increases in the use of qualitative research methodologies and case studies in particular (Broudy, 1990; Shulman, 1984). In keeping with the holistic conceptual framework adopted for the study, collection of data by selecting cases offers the opportunity to explore the interaction of factors identified by the other research instruments (Merriam, 1990). Further, this approach provides the opportunity to present the research variables in context, in this case science classrooms in Indonesia and Australia.

One Indonesian and one Australian case study was constructed by incorporating elements of the structured interview and insights gained from the classroom observation. This involved one school visit for the teacher interview, followed by a second visit for the observation of classroom teaching.

3.9 SMEC Staff Interviews

In order to determine more clearly the nature of the postgraduate program at SMEC and contextualise data from the other research instruments, individual interviews were conducted with SMEC staff members. The limitations described above associated with the teacher interviews and highlighted by Vulliamy (1990a) were considered not to be applicable to the SMEC staff. As the researcher has known the SMEC staff over a number of years it was considered unlikely that their responses to the interview questions would be guarded or defensive. As stated by Vulliamy (1990a), he rarely used tape recorders with teachers, "the only exceptions were with those that I have got to know extremely well." Therefore, the interviews with SMEC staff were tape recorded and full transcripts made following the interviews.

The first interview was quite broad in nature, with the interviewee being a Professor of Science Education at SMEC. In addition to having been involved in the initial discussions with the Indonesian government concerning the SMEC program, this staff member had taught all of the groups of Indonesians between 1988 and 1995. Therefore it was considered appropriate that this interview cover the historical

background of how the Indonesian program was established at SMEC and the overall goals of the program for both overseas students and Australian students. The main questions included were:

1. How did the Indonesian students come to attend postgraduate programs at SMEC
2. What were the overall goals of the Masters program for overseas and Australian participants?
3. What was done differently for the Indonesian group?

A second group of more specific questions were directed to two other SMEC staff members in separate interviews. The staff interviewed were a Senior Lecturer in Science Education and a Professor of Mathematics Education, each of who had extensive involvement with the groups of Indonesians. The interview questions were concerned with program content and some of the differences and similarities between Indonesian and Australian participants in the SMEC programs. The questions directed to these staff members were:

1. What involvement did you have with the Indonesians between 1988 and 1995?
2. In your opinion, what are some of the differences and similarities between the classroom practices generally of Indonesian and Australian science teachers?
3. What are some of the differences between Indonesia and Australia in terms of the structure of the education system and school management?
4. How do you think these differences impact on classroom teaching practices?
5. What steps were taken to ensure that the experiences and theoretical frameworks the Indonesian participants were exposed to at SMEC were compatible with the beliefs, value systems and sociological environment of Indonesia?
6. What particular skills and theoretical frameworks did the Indonesian participants take from SMEC that would be directly applicable to secondary school settings in Indonesia?
7. What constraints do you think are operating in Indonesia that would limit the classroom implementation of these skills?

8. While at SMEC, were strategies developed/discussed by the Indonesian participants in order to overcome these constraints?
9. Have you had any classroom teaching experience in Indonesia or another developing country?

The data from these interviews are presented in Chapter 4 and considered within the context of the results from the other research instruments.

3.10 Summary

The selection of methodology and mix of quantitative and qualitative research instruments is in keeping with the holistic conceptual framework adopted for the study. This approach follows recent trends in teacher professional development research which have seen a broadening scope of research methodologies. The instruments used in this study included a postal questionnaire, classroom observation schedule and a structured teacher interview. Quantitative data are provided by statistical analysis of the postal questionnaire and this was balanced by qualitative data provided from the classroom observations and teacher interviews which were used to construct case studies for Indonesian and Australian teachers.

Chapter 4 provides the statistical analysis of the postal questionnaire and these results are summarised within the conceptual framework described in Chapter 1 in terms of professional, personal and social development, and influences of the Indonesian and Australian educational systems. Qualitative data are presented from teacher interviews in Indonesia and Australia and interviews with SMEC staff. Finally, two case studies are presented for Indonesian and Australian teachers.

Chapter 4

Results

4.1 Introduction

As previously described in the methodology, a postal questionnaire was administered to a sample of 168 Australian and 41 Indonesian graduates from the Science and Mathematics Education Centre (SMEC) at Curtin University. The intent of the questionnaire was to encourage responses from participants in a range of areas including their teaching practices, beliefs about science teaching and learning, and interactions with other teachers. Percentage responses from the two groups for items in Part A of the postal questionnaire provided information on teachers' background. Areas covered included sex, age, years employed in education, qualifications, areas of specialisation, membership of professional organisations, how respondents became involved in the SMEC program and levels of involvement in teacher development activities. Results for Parts B, C, D, E, F, G and H of the postal questionnaire are summarised according to the conceptual framework adopted for the study. Comparisons are made between the responses from Indonesian and Australian respondents in terms of their professional, personal and social development, in addition to the influences of their respective education systems.

Following the analysis of the postal questionnaires, seven Indonesian and six Australian participants were selected for structured interviews. Those selected were representative of the profiles of Indonesian and Australian respondents produced by the analysis of postal questionnaire data. These results are summarised within three of the parameters of the conceptual framework adopted for the study; professional development, personal development and the influences of the educational system. From those interviewed, one Indonesian and one Australian teacher seen as being representative of the two groups was selected for classroom observation and these data are used to construct two case studies. Finally, further triangulation of data is

provided by interviews with Science and Mathematics Education Centre staff at Curtin University of Technology.

4.2 Postal Questionnaire

4.2.1 *Questionnaire Response Rates*

Two hundred and nine questionnaires were posted out; the response rate was 70% for Australian graduates and 71% for the Indonesian graduates. While the majority of questionnaire responses were from Western Australia, all other states and territories, except the Australian Capital Territory (ACT), were represented. Apart from Irian Jaya, all of the main islands of Indonesia were represented, with the majority of responses (34%) from Java, the most densely populated island with approximately 60% of Indonesia's population (Turner, Delahunty, Greenway, Lyon, McAsey, & Willett, 1995).

Due to several of the respondents being mathematics or computing teachers, or no longer in education, a number of responses were not included in the statistical analysis and details of these are provided in Table 4. This reduced the number of questionnaires used in the analysis to 79 from Australia and 27 from Indonesia.

Table 4
Reasons for Non-inclusion of Returned Questionnaires from Australian and Indonesian SMEC Graduates

Country	Number of respondents	Reasons for non-inclusion in study	Number	Number used
Australia	117	Mathematics teachers	19	
		Computing teacher	1	
		No longer teaching	18	79
Indonesia	29	Mathematics teachers	2	27

4.2.2 *Cronbach Alpha Reliabilities for Questionnaire Responses*

Table 5 shows the Cronbach alpha reliabilities for Parts B, C, D, E, F, G and H of the postal questionnaire. In interpreting reliability coefficients, McMillan and Schumacher (1993) indicate that an acceptable range for most instruments is .70 to .90. However, these authors suggest that as reliability is essentially a function of the nature of the trait being examined, measures of achievement should generally have high reliabilities. On the other hand, measures such as personality may have lower reliabilities, with values of .65 being acceptable. Further, high reliability is required if results are used to make decisions about individuals; whereas studies of groups can tolerate lower reliability. In some cases McMillan and Schumacher (1993) suggest that a reliability of .50 may be acceptable in exploratory research.

Table 5
Cronbach Alpha Reliabilities For Responses From Indonesian and Australian Respondents to Parts B, C, D, E, F, G and H of the Postal Questionnaire

Scale	Number of items	Group	Alpha Reliability
Part B:			
Introducing new activities	19	Indonesian	.69
		Australian	.85
Part C:			
Teachers' beliefs about science teaching and learning			
Self-efficacy	13	Indonesian	.34
		Australian	.82
Outcome expectancy	12	Indonesian	.19
		Australian	.79
Part D:			
Teacher development	22	Indonesian	.88
		Australian	.90
Part E:			
Teaching and learning in science	49	Indonesian	.94
		Australian	.95
Part F:			
Classroom practice	11	Indonesian	.54
		Australian	.60
Part G:			
Frequency of teacher interaction	19	Indonesian	.78
		Australian	.89
Part H:			
Places where interaction occurs	8	Indonesian	.65
		Australian	.69

Based on an acceptable range of between .65 and .90, the Cronbach alpha reliabilities shown in Table 5 are satisfactory for the responses to items in Parts B, D, E, G and H of the questionnaire. As it is generally recognised that the more items there are in an instrument, the higher the reliability (McMillan & Schumacher, 1993), the low number of items in Part F may account for the lower reliability here. However, considering that it is group data with reliability above .50, the results for Part F are within an acceptable range.

Of particular concern are the reliabilities for Indonesian responses to Part C of the questionnaire. Based on the above criteria, these reliabilities are unacceptable, indicating caution in drawing conclusions from these results for Indonesian participants.

4.2.3 *Part A: Questionnaire Respondents' Background Information*

Sex. The breakdown according to sex for questionnaires posted to Indonesians was 68% male and 32% female. Of those returned, 74% were from males and 26% from females. Similarly, for Australians the sex breakdown for questionnaires posted was 63% male and 37% female, with responses being 69% male and 31% female. For both groups, the participation is in the region of 70% male and 30% female, with a slightly better female representation from Australian respondents.

Age. The age range of the Indonesian and Australian respondents is very similar. Among the Australians, 2% were under 30 years of age, 36% in the 30-45 years age group, and 62% were over 45 years of age. For Indonesian respondents, 37% were aged between 30 and 40 years, 63% were over 45 years of age, with none being under 30 years of age.

Years Employed in Education. The mean number of years employed for the entire sample was 22 years (Median = 22 years). Figure 1 shows the breakdown for both groups of the years employed in education and highlights the broad spread of years among the Australian respondents. In contrast, the Indonesians are a reasonably homogenous group with the majority of respondents having between 16 and 25 years

experience. These results reflect the selection process undertaken by the Indonesian Government, where years of service was a selection criteria for their initial involvement in the PKG project and subsequent study overseas (Thair, 1996a).

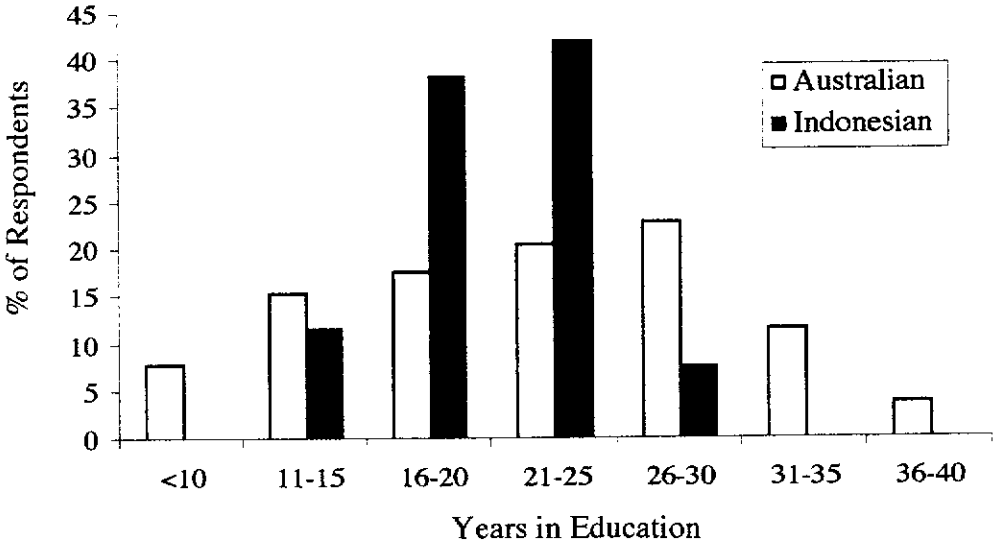

Figure 1. Years employed in education for Indonesian (n= 27) and Australian (n= 79) respondents

Highest Qualification Held. There were differences between the highest qualifications held by Australian and Indonesian respondents. Among the Australians, 53% had a Postgraduate Diploma, 37% a Masters degree and 10% a PhD. In contrast, 96% of the Indonesians had a Masters degree with 4% holding a PhD. Again, these results reflect the fact that the Indonesians were selected and sponsored specifically as a group to complete the Masters qualification at SMEC. The data in Figure 2 showing the year of graduation also reflects the selection and sponsorship arrangements for Indonesian respondents. Here, Indonesian graduations are associated with the particular years that sponsorship for Masters studies at SMEC was made available. In the case of Australian teachers, there is a gradual increase in the numbers graduating between 1976 and 1996, reflecting the self-selection processes that are occurring.

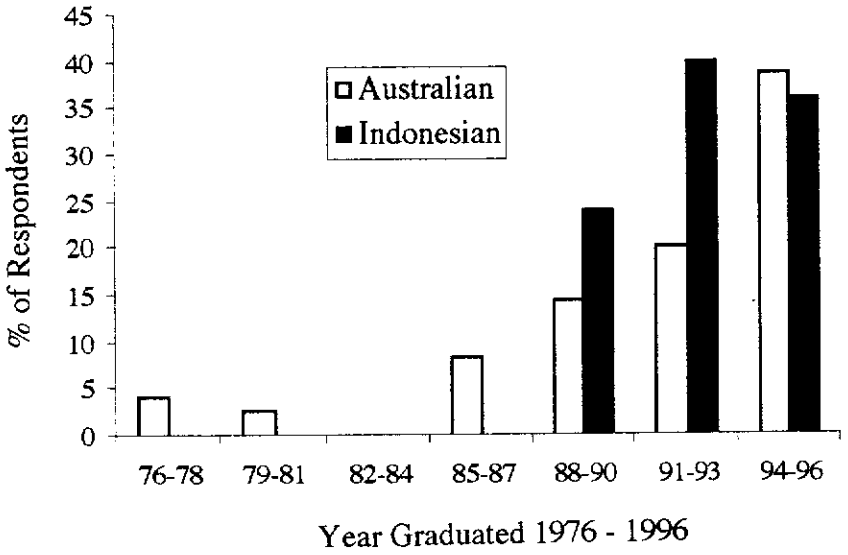

Figure 2. Year of graduation for highest qualification held by Indonesian and Australian respondents

Areas of Specialisation. The results indicate that similar percentages of Australian (10%) and Indonesian (11%) respondents were teaching at primary school level. The majority of Indonesians (74%) were employed in upper secondary schools, with 26% employed at the lower secondary level. This relatively high concentration of Indonesian teachers at the upper secondary level again reflects the selection criteria used by the Indonesian Government in identifying teachers to attend SMEC as part of the teacher upgrading strategy associated with the PKG project. The prime focus of this project at the time that teachers were selected was the upper secondary sector of the Indonesian education system. The structure of the school system in Indonesia separates lower and upper secondary schools whereas Western Australian high schools include both lower and upper secondary students in one school. Australian teachers employed at lower secondary and upper secondary levels were 43% and 45% respectively.

In terms of subject areas taught, Table 6 shows the breakdown for Australian and Indonesian respondents, and these reflect the national curriculum frameworks in place for each country. For example, the data show that a higher percentage of Australian teachers are involved in teaching General Science, whereas the low percentage (15%) of Indonesian respondents teaching this subject is reflective of this not being a discrete teaching area in the Indonesian secondary school science curricula. At the lower secondary level, students are taught a single science subject (*Ilmu Pengetahuan Alam*) which consists of physics and biology components taught by two separate subject specialists. At the upper secondary level, students study physics, biology and chemistry (Thair, 1996a). The data in Table 6 indicates that a small percentage of science teachers in Indonesia and Australia also teach mathematics.

Table 6
Subject Areas Taught by Australian and Indonesian Respondents

Subject area	% Australian respondents	%Indonesian respondents
General Science	46	15
Biology	27	22
Physics	32	37
Chemistry	37	37
Mathematics	8	4

In addition to these teaching areas, respondents also identified a number of other areas of specialisation as summarised in Table 7. Of interest is the comparatively large percentage of Indonesians indicating teacher development as an area of specialisation which reflects their involvement in the PKG program as in-service teacher trainers. Also of interest is the percentage of Australians identifying administration as an area of specialisation. Other comparisons suggest a high level of

involvement of Australian teachers in curriculum activities in comparison to the Indonesians, and a lower level of involvement of the Australians in resource development and instructional design.

Table 7
Other Areas of Specialisation by Australian and Indonesian Respondents

Area of specialisation	% Australian respondents	% Indonesian respondents
Administration	37	4
Teacher development	21	85
Policy & planning	10	15
Curriculum	32	15
Resource development	14	22
Instructional design	5	41
Other	14	15

In comparing the responses provided under the "other" category for areas of specialisation in Table 7, Australian respondents predominantly identified additional subject areas taught that were not listed as alternatives in the questionnaire. These responses included environmental education, computer science, geology, earth sciences, and information technology. In contrast, the Indonesians identified specialisations in the areas of classroom evaluation and teacher training which again reflects their involvement in the PKG program as in-service trainers.

Enrolment for Further Qualifications. There were differences between the two groups in terms of their enrolments for higher qualifications. Here, 25% of the Australians indicated that they were enrolled in further qualifications, compared to only 7% of the Indonesians. This probably reflects the lack of availability of part-time postgraduate studies for teachers in Indonesia and that 96% of the Indonesians had already completed studies at the Masters level. In comparison, 52% of the Australian respondents had completed studies at the Postgraduate Diploma level and

36% at Masters. Consequently, there is a broader scope within the Australian group for enrolment in further studies which generally are widely available.

Membership of Professional Organisations. The results indicated differences between the two groups in memberships of professional organisations. Seventy seven per cent of the Australians belonged to at least one professional organisation, including State organisations such as State Science Teachers Associations. A number of Australian respondents are also members of national groups such as the Australian College of Education and international organisations such as the National Association of Research in Science Teaching (NARST).

Among the Indonesians, 70% belonged to a professional organisation but the significant difference compared to the Australians is that the opportunity to join a range of independent and autonomous organisations is limited. All organisations identified by the Indonesians are affiliated in some way with the central government. None belonged to organisations outside of Indonesia, probably due to the costs involved. Those organisations identified by the Indonesian respondents for which membership is automatic included PGRI (*Persatuan Guru Republik Indonesia*), KORPRI (*Korps Pegawai Republik Indonesia*), and MGMP (*Musyawarah Guru Mata Pelajaran*). PGRI is a professional organisation for all teachers from kindergarten level to university lecturers and includes educational administrators; KORPRI has wider membership that includes all government employees (B. Irianto, personal communication, November 9, 1998). The MGMP which is described in Chapter 2, is essentially an in-service teacher training initiative focusing on particular subject areas . In the absence of continued funding for the PKG project, it appears to be an attempt to sustain some of the PKG teacher in-service training initiatives.

How Respondents Became Enrolled in the SMEC Postgraduate Program. All Indonesian respondents indicated that their Government had nominated them for postgraduate studies at SMEC. As outlined in Chapter 1, this nomination was linked to their involvement as in-service teacher trainers in the PKG project. In contrast,

only one Australian indicated that they had been nominated for postgraduate study. This difference reflects the nature of many programs for students from developing countries, where external bi-lateral or multi-lateral funding is provided for institutional strengthening or specific skill upgrading of teachers. In these instances, Governments nominate personnel to attend specified programs using pre-determined selection criteria, as was the case for the Indonesian respondents in this study. In other instances, scholarships are made available and participants may self-select.

Time Spent on Teacher Development Activities. There were significant differences between the two groups in time spent on teacher development activities. Nineteen percent of Australians indicated involvements over the past 12 months of between six and 15 hours, and 35% indicated between 16 and 35 hours. In comparison, only 4% and 7% respectively of the Indonesians was involved with teacher development activities at these comparatively low levels. On the other hand, 81% of Indonesians indicated involvement of more than 35 hours, as compared to only 30% of Australian respondents. This significant level of teacher development reflects the involvement of Indonesian respondents with the PKG project and ongoing MGMP activities.

Support for Teacher Development Activities. The questionnaire data identified differences in the range of support for teacher development activities with 27% of Australian respondents indicated that they received no support at all, compared to only 15% of the Indonesians. From Table 8, which shows the different types and levels of support identified, the most significant difference between the two groups is the availability of professional development credits. This appears to be widespread within the Indonesian education system with 81% of Indonesians compared to only 17% of Australian respondents indicating this type of support. This result may also be a reflection of the centralised nature of the Indonesian education system, including national approaches to teacher professional development. In contrast, the education system in Australia is more autonomous, with responsibilities for teacher professional development being at the State level, and as outlined in Chapter 2, the approaches may vary between States.

Table 8
Support for Attending Teacher Development Activities for Australian and Indonesian Respondents

Type of support	% Australian respondents	% Indonesian respondents
None	27	15
Released time from teaching	54	33
Travel and/or per diems	43	41
Stipends	1	22
Professional development credits	17	81

4.2.4 *Part B: Introducing New Teaching Activities*

Participants were asked to indicate their level of agreement or disagreement with 19 statements associated with the introduction of new teaching activities into their classrooms. Exploratory factor analysis of the responses was attempted in order to examine any underlying processes (Tabachnick & Fidell, 1996) that might be supported by subsequent confirmatory factor analysis. This produced six scales using the 19 items, however the sub-groupings produced were not satisfactory in terms of giving meaning to these groupings. Establishing meaning for groupings of items identified by factor loadings is important in establishing validity with factor analysis, and these groupings should "make sense" (Tabachnick & Fidell, 1996, p. 636). Elaborating further on the interpretation of factors identified in a factor analysis, Tabachnick and Fidell (1996) suggest that it is necessary to ask:

> Is it trivial or is it a useful addition to scientific thinking in a research area? Where do the factors fit in the hierarchy of 'explanations' about a phenomenon? Are they complex enough to be intriguing without being so complex that they are uninterpretable?" (p. 677)

Additionally, the Cronbach alpha reliabilities produced by these sub-groupings suggested by the factor analysis were lower than the values shown in Table 5 above. Consequently, because of these considerations the 19 items were therefore

statistically analysed as one group (Appendix D, Tables 1 and 2) and are not included as a separate table in this section.

The analysis of responses indicated that there were no statistically significant differences between the opinions of the Indonesians and Australians on seven of the 19 questionnaire items (see Appendix D, Table 1). From these results, it can be concluded that for both groups, two prime considerations when introducing new teaching activities are the availability of resources and class time. Of least concern to both groups was that individuals may be the only teacher doing a particular activity. Similarly, when considering the introduction of new teaching activities, issues of student mis-behaviour, being unsure of the learning which is to occur, and the increased number of activities making it difficult for students to revise for examinations, were not considered as constraints by the Indonesian and Australian respondents.

Twelve questionnaire items showed statistically significant differences between the responses from the two groups (see Appendix D, Table 2), identifying a number of important concerns of Indonesian respondents. These concerns included the science curriculum, examinations, support from school management, discussion with other teachers, and knowing what will happen in class. Of lesser concern for some Indonesians, but still considered a constraint, were reduced student notetaking, having a different teaching style to other teachers, disadvantaging classes that do not complete the same activities, differing workbooks between classes, and responding to difficult questions from students. Low group means indicate that these were not constraints or concerns for the Australian respondents.

Both teacher groups registered disagreement on the items dealing with noisy students and loss of class control (see Appendix D, Table 2). However, while there were statistically significant differences in the responses from Indonesian and Australian teachers on these two items, the low group means suggest that these two issues

would not be a major constraint when considering the introduction of new teaching activities.

4.2.5 *Part C: Teachers' Beliefs about Science Teaching and Learning*

The 25-item Science Teacher Efficacy Belief Instrument (STEBI) consisted of two scales comparing Self Efficacy and Outcome Expectancy, to which teachers responded on a 5-point Likert scale of *strongly disagree*, to *strongly agree*. Scores for the two scales of the STEBI were computed by adding the items on the respective scales for each questionnaire respondent; the results for Indonesian and Australian science teachers are shown in Table 9. However, the Cronbach alpha reliabilities for the responses from Indonesian teachers to the STEBI scales are well below acceptable ranges, and therefore caution is required in drawing any conclusions from these data.

The analysis of responses to the Self-Efficacy scale for Australian teachers shown in Table 9 produced a mean score of 54 on a possible range from 13 to 65. This indicates that the Australian respondents have quite strong personal beliefs in their own efficacy as science teachers. A similar result is shown for the Indonesian respondents, and there are no statistically significant differences between the two groups.

Table 9
Descriptive Statistics for Self-Efficacy Scale (SE) and Outcome Expectancy Scale (OE) Scores for Indonesian and Australian Respondents

Scale	Group	N	Mean	SD	*t*	*p*	Alpha Reliability
Self-Efficacy	Indonesia	27	52.04	4.46	1.86	.067	.34
	Australian	79	54.34	7.95			.82
Outcome Expectancy	Indonesian	27	43.96	3.65	-6.70	*<.0001	.19
	Australian	79	36.51	7.66			.79

*Significant at $p < .05$

Analysis of the responses to the Outcome Expectancy scale, where possible scores can range from 10 to 50, suggest that the Australians had a reasonably high expectation of the outcomes of science teaching. However, the statistically significant higher scores of the Indonesian respondents on the Outcome Expectancy scale suggest that they had a higher expectation of the outcomes of science teaching than the Australians. In other words, the Indonesians had a higher expectation that good teaching will result in student learning.

4.2.6 *Part D: Teacher Development*

Participants were asked to indicate their level of agreement or disagreement with 22 statements identifying sources of teacher development. As shown in Table 5, analysis of the responses to these items produced Cronbach alpha reliabilities of .88 for the Indonesian teachers and .90 for the Australian teachers. Exploratory factor analysis was performed on the data in an attempt to identify any other underlying processes and this produced six scales using the 22 items. However, the sub-groupings produced were not satisfactory in terms of giving meaning to these groupings. Further, the groupings provided by the factor analysis did not provide reliability coefficients greater than the categories described below which were subsequently used to analyse the data as shown in Table 10. In deciding on these, the 14 items were examined using the criteria that the categories should "make sense" (Tabachnick & Fidell, 1996, p. 636), resulting in the three categories identified in Table 10 in addition to another eight items that could not easily be categorised.

The first category compared seven items dealing with collegiality and interaction with other teachers as a source of teacher development. The next group of items consisted of five sources of teacher development that are external to the day-to-day school environment and formal in nature including reading, lectures and courses. The third category considered two items involving students as a source of teacher development. Finally, eight items which did not fit into these categories were considered individually as sources of teacher development including items dealing

with analysis of test and examination results, having support from the school principal and writing a new teaching resource.

Analysis of the first three groups of items, shown in Table 10, indicated that there were statistically significant differences between Indonesian and Australian respondents in two areas, collegiality and sources of teacher development external to the school environment. In both cases, there were higher levels of agreement among Indonesian respondents for these groups of items.

Individual analysis of items dealing with collegiality and interaction with other teachers (see Appendix D, Table 3) shows that elements particularly important to the Indonesians were visiting other teacher's classrooms, feedback, watching others teach, and sharing problems. Here there were statistically significant differences and higher means for the responses from the Indonesians when compared to the Australians. Statistical analysis also indicated that there were similarly high levels of agreement amongst all respondents for the items covering talking with other teachers, sharing resources, and having the support of other teachers.

Table 10
Statistical Analysis of Responses from Indonesian and Australian Respondents for Part D of the Postal Questionnaire: Opinions on Teacher Development

Scale	Items	Group	Mean	SD	*t*	*p*	Alpha Reliability
Collegiality and interaction with other teachers	7	Indonesia Australian	4.48 4.07	0.39 0.58	-3.38	*.001	.75 .88
Sources external to the school environment	5	Indonesian Australian	4.32 3.55	0.44 0.59	-6.13	*<.0001	.65 .78
Student involvement in teacher development	2	Indonesian Australian	4.24 3.79	0.74 0.78	-1.55	.124	.74 .76

* Significant at $p < .05$

Means ≥ 4 indicate agreement
Means ≤ 2 indicate disagreement

Statistical analyses of items dealing with elements of teacher development that are external to the school environment are provided in Appendix D, Table 4. These results indicate statistically significant differences between the responses from the two groups on all five items. Activities such as reading, lectures, courses and keeping up to-date with science were considered more important by Indonesian respondents. There were no statistically significant differences between the Indonesians and Australians on the group of items dealing with student involvement in teacher development (see Appendix D, Table 5).

Sources of teacher development not included in the above three categories were analysed separately (see Appendix D, Table 6) with no significant differences indicated between the responses from both groups for the items trying new teaching activities, acquiring new teaching ideas and writing new resources. These results suggest that for all respondents these are important elements in teacher development. All other items in this category showed statistically significant differences between the opinions of the two groups. Thinking about what to do in class, evaluating the success of lessons and receiving feedback on changes made to teaching were seen by both groups as being important in teacher development. However, there were statistically significant higher levels of agreement among Indonesian respondents for these items. Of particular interest here is the high level of agreement among the Indonesians for items dealing with support from the school principal and analysis of examination results in comparison to the responses from the Australians.

4.2.7 *Part E: Teaching and Learning in Science*

Participants were asked to indicate their level of agreement or disagreement with 49 statements dealing with teaching and learning in science. Exploratory factor analysis was performed in order to investigate any underlying process that might be supported by subsequent confirmatory factor analysis. This produced two scales using the 49 items, however these were unsatisfactory in terms of providing meanings for these groupings. Additionally, the two subgroups indicated by the factor analysis did not

provide the opportunity to compare the beliefs of Indonesian and Australian respondents on student-centred teaching approaches and didactic approaches separately. For the purposes of analysis and discussion the items were therefore classified and grouped into six subgroups using the headings provided in Table 11. The Cronbach alpha reliabilities shown here are within the acceptable ranges discussed earlier in this chapter.

The results in Table 11 indicate that Indonesian and Australian respondents have high levels of agreement on the groups of items dealing with student-centred teaching approaches and constructivist viewpoints on student learning (see Appendix D, Tables 7 and 8 for analysis of individual items), with no statistically significant differences between the responses from the two groups. However, Table 11 shows statistically significant differences between the two groups on items dealing with didactic teaching approaches and non-constructivist viewpoints on student learning (see Appendix D, Tables 9 and 10 for analysis of individual items), with higher levels of agreement among Indonesian teachers for these two groups of items.

One particular item that attracted a high level of agreement from Indonesian respondents was syllabus coverage (see Appendix D, Table 9). This suggests that the Indonesians have particularly strong feelings about the need for classroom teachers to completely cover the required science syllabus. This requirement may therefore be a prominent factor in their choice of teaching approaches, where teachers may be reluctant to use time-consuming student-centred approaches and opt for the more direct didactic methodologies where they have more control over class time.

The statistical analysis of individual items in Appendix D, Table 10 dealing with non-constructivist viewpoints to student learning highlights a number of differences between the two groups. Here, there was agreement among the Indonesians of the importance of memorisation, notetaking, written exercises and examinations as a component of student learning. There were particularly high levels of agreement for the items dealing with the importance of written exercises from textbooks, sitting examinations, and the concept of teachers and textbooks being the source of new

knowledge for students. These elements of student learning attracted statistically significant lower levels of agreement from Australian respondents.

Table 11
Statistical Analysis of Responses from Indonesian and Australian Respondents for Part E of the Postal Questionnaire: Teaching and Learning in Science

Scale	Items	Group	Mean	SD	*t*	*p*	Alpha Reliability
Student-centred teaching approaches	8	Indonesian Australian	4.39 4.37	0.38 0.51	-0.20	.840	.77 .86
Didactic teaching approaches	5	Indonesian Australian	4.04 3.52	0.46 0.70	-3.62	*<.0001	.71 .81
Teachers opinions on other factors involved in teaching	9	Indonesian Australian	4.39 4.01	0.37 0.55	-3.34	*.001	.73 .83
Constructivist viewpoints on learning	12	Indonesian Australian	4.42 4.43	0.36 0.45	0.08	.939	.84 .89
Non-constructivist viewpoints on learning	7	Indonesian Australian	4.05 3.55	0.63 0.81	-2.91	*.004	.82 .93
Teacher opinions on other factors involved in student learning	8	Indonesian Australian	4.25 3.97	0.41 0.53	-2.50	*.014	.68 .80

* Significant at $p < .05$

Means ≥ 4 indicate agreement
Means ≤ 2 indicate disagreement

Opinions on a number of other elements involved in teaching science not included in the above categories also were considered (see Appendix D, Table 11). Here, significant differences between the responses from both groups suggest that having a good knowledge of science, knowing how science is done, student assessment, organising student groups and providing worksheets for students are more important components of teaching science in Indonesia than in Australia. There were high levels of agreement from both groups in other areas including planning lessons, being supportive of students, and providing resources to students.

Eight areas associated with student learning in science not included in the above categories received generally high levels of agreement from both groups (see Appendix D, Table 12), including teacher demonstrations, student enjoyment, confidence with new ideas, cooperation amongst students, motivation, and experiments. However, there were statistically significant differences between the two groups in the opinions on practicing examination questions. This item again illustrates the importance attached to examinations by the Indonesians. Similarly, there were statistically significant differences between the Indonesians and Australians in their responses to the item dealing with reading textbooks, with a higher level of agreement from the Indonesians.

4.2.8 *Part F: Classroom Practice*

Participants were asked to identify the frequency of 11 teaching practices occurring in their classrooms. Exploratory factor analysis was attempted in order to investigate any underlying processes that might support subsequent confirmatory factor analysis. This produced two scales using the 11 items; however these sub-groupings were not very satisfactory in terms of giving meaning to these groupings. Additionally, the Cronbach alpha reliabilities for the Indonesian responses to the two subgroups identified by the factor analyses were lower than the Cronbach alpha reliabilities shown in Table 5, where the items are considered as one group. Therefore, the following discussion considers the items as one group.

The results in Appendix D, Table 13 suggest a number of similarities in the classroom practices of Indonesian and Australian science teachers. The most frequently used teaching practices for both groups include teacher explanations, whole class discussions, and the use of activity sheets. Library research appears to be an infrequent activity for both groups. Statistically significant differences were identified on three items. These differences suggest that teacher initiated investigations and field trips occur more frequently in Australian classrooms, whereas small group discussions appear to be a more frequent occurrence in Indonesian classrooms.

4.2.9 *Part G: Frequency of Interactions Between Teachers*

This section of the postal questionnaire consisted of 19 statements describing the types of interactions that may occur between teachers. A factor analysis identified four scales (see Appendix D, Table 14). The first scale includes items dealing with sharing ideas about teaching, the second includes items on trying new ideas and giving advice on teaching, and the third covers items dealing with the observation of teaching. These three scales were satisfactory in providing meaning for the groupings of items. The fourth scale included a range of items that cannot be easily categorised, covering a diverse range areas such as borrowing equipment, formal teacher development, and social life. Each scale had acceptable ranges of Cronbach alpha reliability except for the Indonesian responses to the fourth category described above. The Cronbach alpha reliabilities for these four categories of items is not as high as when the items are considered as a single group as shown in Table 5, however the reliabilities are within acceptable ranges. Importantly, the four subgroups provide a meaningful basis on which to discuss the results as they isolate particular elements of teacher interaction such as sharing ideas and giving advice to other teachers.

The data for the first three categories of items identified above, presented in Table 12, show no statistically significant differences between responses from the Indonesians and Australians. For both groups, the sharing of ideas about teaching, trying new ideas, and giving advice about teaching generally occurs on a monthly basis. The least frequent interaction between teachers from both groups is the observation of teaching. The responses to individual items within these three categories are shown in Appendix D, Tables 15, 16 and 17. Of particular interest is the data in Appendix D, Table 17, which show that there were statistically significant differences between the two groups in attendance at teacher development activities. This result reflects the more structured and regular occurrence of teacher development activities provided in Indonesia by the PKG and MGMP initiatives (Thair, 1996a), of which the Indonesian respondents are participants, highlighting one of the essential differences between the two groups.

Table 12
Statistical Analysis of Responses from Indonesian and Australian Respondents for Part G of the Postal Questionnaire: The Types and Frequency of Interaction between Teachers

Scale	Items	Group	Mean	SD	*t*	*p*	Alpha Reliability
Sharing ideas about teaching	5	Indonesian Australian	3.73 3.85	0.61 0.68	0.77	.443	.78 .79
Trying new ideas and giving advice about teaching	4	Indonesian Australian	3.70 3.60	0.62 0.68	0.71	.478	.61 .77
Observation of teaching	4	Indonesian Australian	4.40 4.56	0.48 0.58	1.32	.191	.56 .63

Means ≥ 4 indicates monthly or rarely
Means ≤ 2 indicates daily or each lesson

The results for the questionnaire items in the fourth category show statistically significant differences in the responses from the two groups on five items (see Appendix D, Table 18). The borrowing and lending of materials appears to be a more frequent occurrence amongst Australians with this occurring on an approximately weekly basis. In comparison, Indonesian respondents indicated that this activity probably occurs on a monthly basis. Similarly, talking about their social life and asking informally what is being covered in other science classes occurs more frequently amongst Australian teachers. On the other hand, teaching other teachers in formal teacher development programs is a more frequent occurrence for Indonesian respondents occurring on a monthly basis. Again, this response is a reflection of the respondents' participation in PKG and MGMP activities.

4.2.10 *Part H: Places Where Interaction Between Teachers Occurs*

This section of the postal questionnaire required respondents to indicate the frequency of teacher interaction in eight locations. Exploratory factor analysis was

performed in an attempt to examine any underlying processes that might support subsequent confirmatory factor analysis. This analysis suggested two subgroups of items; however, these were not very satisfactory in terms of giving meanings to these groupings and the Cronbach alpha reliabilities were lower than when the items are considered as one group as shown in Table 5. Therefore, the following discussion will consider the items as one group (see Appendix D, Table 19).

There were no statistically significant differences between the responses from the two groups on items dealing with interactions in formal teacher meetings and staff development programs. However, statistically significant differences between the two groups indicated that the frequency of interaction between Australian teachers is higher when moving between classrooms, while in the staffroom, office or classroom, after school hours, and during lunchtime or other breaks when compared to the Indonesians. For Australian teachers, these interactions are generally occurring on a daily to weekly basis, whereas for Indonesian teachers the frequency is weekly to monthly.

4.3 Summary of Postal Questionnaire Results

4.3.1 *Introduction*

As outlined in Chapter 2, a number of advantages are provided in adopting a conceptual framework based on the Professional/Personal/Social Development approach to teacher professional development proposed by Bell and Gilbert (1996). The constructivist and sociocultural perspective of this approach have become a prominent theoretical position in science education research, with constructivism maintaining a dominant position in current approaches to science teacher professional development. The other approaches to teacher professional development reviewed in Chapter 2 did not provide a sufficiently broad conceptual framework specifically related to science teacher professional development, especially in terms of providing a focus on the broad institutional and classroom contexts of science teaching and learning. The following summary therefore considers the postal questionnaire results within the conceptual framework adopted for the study in terms

of professional, personal and social development, and the institutional influences of educational systems.

4.3.2 *Personal Development: Feelings about Being a Science Teacher, and Beliefs about Science Education*

In terms of personal feelings about being a science teacher, the Indonesian and Australian respondents demonstrated a strong personal belief in their own efficacy as science teachers and held high expectations about the outcomes of science teaching. However, due to low reliabilities for the Indonesian data, conclusions here must be treated with caution.

Indonesian and Australian respondents generally agreed with the use of student-centred teaching approaches and constructivist viewpoints on student learning in science. However, the results for the Indonesians were contradictory in that they also indicated agreement with a number of didactic approaches to teaching. Similarly, the Indonesians were generally in agreement with non-constructivist viewpoints on student learning. Coupled with these results, the data also highlight the Indonesian focus on examinations and the expectation that teachers should fully cover the science curriculum. Therefore, it would appear that the Indonesians support the notions of student-centred teaching approaches and constructivist viewpoints on student learning. However, in practice didactic approaches to teaching and student learning are adopted, probably due to expectations produced by the examinations system.

These results are supported by Mahady, Wardani, Irianto, Somerset, and Nielson, (1996) who report the findings of a survey carried out in 1995 involving 255 junior secondary and 348 senior secondary teachers across ten provinces in Indonesia. These findings indicated that teachers continued to dominate the classroom with little attention being paid to the development of learning skills. In another evaluation conducted over a three-week period involving the observation of 25 lessons, Mahady et al. (1996) reported similar findings. Because of these observations, the authors concluded that while the PKG project had established an impressive group of teacher

trainers, widespread and sustainable improvements in classroom teaching methodologies were not so apparent. However, these observations are in contrast to those reported by Treagust and Taylor (1989) who observed science lessons at various locations throughout Indonesia during 1989 and reported a high utilisation of student-centred approaches among those teachers observed. The timing of the observations may provide an explanation for these contradictory observations by Treagust and Taylor during 1989 and Mahady et al. During 1996. The original PKG model introduced in 1980 for science has evolved through a number of phases, and during 1993 was replaced by the MGMP model. Dillon (1993) suggests that this reflects the movement of the PKG project towards a phase of post-project sustainability. However, a limiting factor may be the availability of funding available at the local level to cover the costs of science teacher professional development not provided by the PKG project. Mahady et al. (1996) also raise concerns about the number of original trainers, as many as 7,000, returning to full-time teaching and the loss of this experience and skills base with the phasing out of the original PKG project. Therefore, the observations provided by Treagust and Taylor (1989) may reflect the situation during the fully-funded phase of the PKG project with a full complement of teacher trainers, whereas the conclusions made by Mahady, et al., (1996) may represent the situation when the project had been scaled back considerable to the MGMP model.

4.3.3 *Professional Development: Classroom Practices and the Introduction of New Teaching Activities*

Using the results of the questionnaire the author identified a number of similarities between the two groups in the frequency of a number of classroom teaching practices. However, there were a number of significant differences between the Indonesian and Australian respondents with, for example, library research, field trips and excursions occurring more frequently in Australian classrooms.

A number of significant constraints appear to influence the introduction of new teaching activities by Indonesian teachers. These include whether or not an activity is in the science curriculum, the nature of the examinations, discussion with other

teachers, and support from the school management. These results support those from other sections of the questionnaire highlighting the influence of examinations and the curriculum on the activities and beliefs of Indonesian teachers. In terms of teacher professional development initiatives, these are unlikely to be successful if this conflict between the introduction of new teaching activities and personal constraints is not resolved (Bell, 1993).

4.3.4 *Social Development: Relating to Other Teachers, and Notions of Teacher Development*

A number of differences in the patterns of interaction among Indonesian and Australian science teachers are identified in the results. Discussions concerning social and personal life are more frequent among Australian respondents, as is the practice of borrowing and lending materials. The results also indicate more frequent interactions between the Australian teachers in the staffroom, when moving between classrooms, and in classrooms. Additionally, interaction between teachers after school hours, during lunchtime or tea breaks occurred more frequently among Australian respondents.

Important differences between the two groups included opinions on collegiality and teacher interaction, which were viewed as being more important elements of teacher development by the Indonesian teachers. This therefore presents a contradiction, as the reported levels of teacher interaction were higher among Australian respondents. However, while the day-to-day levels of interaction between Australian teachers were reported to be higher, the Indonesians were involved in more regular in-service activities. This may account for the opinion that collegiality among this group is a more important element in teacher development than for the Australians. The Indonesian teachers also attached more importance to formal sources of teacher development, including lectures and reading. A further difference is the importance the Indonesians attached to support from the Principal and analysis of examination results as components of teacher development. Both groups saw students as being important in the process of teacher development and there were similar levels of

agreement on a number of other elements including trying out new activities and new teaching ideas, and writing resources.

4.3.5 *Influences of the Educational System*

The results from sections A, B and E of the postal questionnaire indicated that the Indonesians are operating in an educational system that is far more centralised than in Australia. This is evident in areas such as the need for Indonesian teachers to cover a centralised curriculum, their lack of involvement in curriculum development, and the focus on centralised examinations.

A number of differences between the two groups are a reflection of the selection processes used by the Indonesian Government in selecting PKG instructors to undertake postgraduate studies at SMEC. This process has provided a group of Indonesian participants that are reasonably homogeneous in a number of areas including age, years of teaching experience and the range of subjects taught. This is in contrast to the Australian participants who self-select to participate in postgraduate studies and as a group are more heterogenous.

4.4 Teacher Interviews

4.4.1 *Interviews with Indonesian Respondents*

Introduction. From the Indonesian respondents, seven were selected for interview during February and March 1999. These included two on the eastern Indonesian island of South Sulawesi, two in East Java, and one each in Central Java, West Java, and the island of Bali. This selection of interviewees represents a wide cross section of ethnic groups and cultures in Indonesia, including Sudanese, Javanese, Balinese, Bugis and Makassarese. The interviews, conducted in English, were based on the interview guide questions described in Chapter 3 and included in Appendix B. All of the quotes below are from field notes generated from the interview questions and additional unsolicited comments.

The Indonesian Educational system follows a 6-3-3 model; a six-year primary level beginning at ages six or seven; three years of junior secondary; and three years of

senior secondary level. The senior secondary system of education was originally based on the Dutch system where individual schools offer either an academic or a vocational stream. The academic schools provide a pathway to tertiary education, while the vocational schools provide the skilled, middle-level training directed at providing manpower for industry and commerce.

Of those interviewed, two were classroom teachers, two were school principals, one was an in-service science teacher trainer, and two were school inspectors. All are government employees and involved in their various capacities within the academic stream of the senior secondary level of schooling. Principals are expected to teach six periods a week within their area of subject expertise, in this case science. The school inspectors worked specifically with science teachers and their role included visiting schools and observing teachers in the classroom. Based on these visits, they provided feedback on teaching methodologies and these activities were generally associated with advancement of teachers through salary levels. The in-service science teacher trainer was employed at an institution providing regional in-service training programs (*Balai Pendidikan Guru* – BPG) for senior secondary teachers. Here, teachers attend training courses of between one and two weeks duration covering subject specific content material and teaching methodologies.

Considering the diverse ethnic groups and geographical areas covered in the interviews, the centralised nature of the Indonesian educational system was very evident to the researcher during school visits while conducting teacher interviews. Administrative structures in schools were similar, students wore the same uniforms in every school, curricula from Jakarta were rigorously implemented and even the front offices with their large noticeboard of school and staffing information was remarkably similar between schools.

It was this centralised nature of the educational system that provided the focus for unsolicited comment, suggesting that because the various regions were very different centralisation was not meeting the needs of students. A number of teachers felt that in the future particular regions might be given a certain degree of autonomy in

determining curriculum priorities. In the words of the in-service science teacher trainer located on an island outside of Java:

> The system here (in Indonesia) is controlled by Jakarta but the needs of all are not the same... the black students in Irian Jaya (the indigenous Melanesians) are not the same as the Javanese or Balinese but they have the same curriculum. Some students do very poorly in the national exams and this worries provincial governments.... Perhaps the curriculum is more relevant to the lives of students in Java than the poor eastern islands.

These sentiments also were expressed in Java, with one interviewee relating these to the changing political climate in Indonesia:

> Our government is changing; we are now free to express our opinions. The government in Jakarta has many problems and provincial governments in the future will take more responsibility. They (provincial governments) may have more responsibility for schools and in some ways may not have to follow Jakarta in everything they do.

These unsolicited comments stem from recent events in Indonesia which have seen dramatic changes in the political landscape producing an environment of open comment and questioning of government policy which in the past would not have been tolerated, especially from teachers and other public servants. The Indonesians referred to this period as *waktu reformasi*, which in English translates to a period of transformation and change.

Feelings about Science Teaching. All interviewees expressed positive feelings about science teaching; however, they identified a number of concerns. One school principal commented, "Since 1985 the curriculum has emphasised more process skills, however we have no laboratory assistants, therefore science teaching is a problem." Similarly, a chemistry teacher responded, "Chemistry is a nice subject to teach but it can be very theoretical." These comments were supported by a school inspector who felt that, "Science teaching focuses on factual information, not process skills." Another teacher indicated that "I like science teaching, but I am never satisfied with teaching... because of the lack of time to do a good job."

Feelings about Student Learning in Science. Generally, the interviewees expressed some concern about student learning in science, with one chemistry teacher suggesting that, "From primary school the students have developed poor learning habits which are difficult to correct (in senior secondary school)." Other interviewees highlighted the theoretical nature of the science subjects, "Science is too hard for students to understand, therefore they don't like science, this makes student learning difficult." Another commented, "Students are interested in learning science but generally it is too theoretical, students want to do something practical and useful." Generally, across all provinces, student performance in science examinations was poor and this was cause for concern. The prime cause identified by interviewees was the curriculum, in addition to the didactic and uninteresting teaching methodologies used by many science teachers. It was acknowledged that these methodologies are probably in response to the overloaded curriculum and lack of available time to develop new materials or teaching approaches.

Teachers Using Different Teaching Activities in a School. There were two categories of responses to this question, relating directly to the position of the interviewee. Those who were not classroom teachers, for example the teacher trainer and school inspector, indicated that teachers using different teaching approaches for a particular topic within a school should not be a problem. On the other hand, the two classroom teachers expressed concerns about this practice, about which one of them explained:

> Generally, teachers worry that if one teacher does something different it may create a situation where it is felt this gives this teacher an 'edge'....(many teachers) like to see all teachers doing exactly the same. I will ask students not to tell other teachers about my new activities (that I have done in class). If students like an activity that is not done by other teachers, they may ask other teachers to do the same activity.

One of the school principals commented:

> This creates problems as the exams are centrally set and this will disadvantage students if the teaching activities (in my school) are not the same for all of the science teachers. The MGMP program helps to standardise the teaching practices of science teachers.

Therefore, it would appear that teachers generally are more comfortable in a situation where all science teachers within a particular school do exactly the same activities. The MGMP activities attended by science teachers probably perpetuates this situation by standardising teaching approaches across the entire nation for particular topics. During MGMP sessions, teaching activities are discussed and particular teaching approaches and materials are covered in some detail. Again, it was suggested by the interviewees that the centralised curriculum is not appropriate to all provinces, and the interviewees felt that individual schools should be given the freedom to develop teaching activities that are more responsive to local student needs.

The Role of Student Assessment in Science. The Indonesian interviewees were unanimous in their opinion that the role of assessment was to measure student attainment of curriculum objectives and to allow selection of students for advancement to the next level of education. In terms of other potential roles for student assessment, a typical response was:

> I'd like to help students who are weak (by doing some assessment to identify weak students)....But my classes are very large with 50 students and I don't have time. Every week the class must make progress on the curriculum objectives and I must complete these. This is my duty as a teacher to complete the curriculum objectives.

Student Misbehaviour. Student misbehaviour was not seen as being a major problem. One teacher commented, "Large class sizes (around 50 students) may create situations where students become distracted and perhaps disruptive." Other interviewees commented on student abilities within classes, with one teacher commenting, "Heterogeneous classes make it difficult to cater for the different levels of student needs. This creates a situation where students become disruptive because they are bored." The types of student misbehaviour identified included not paying full attention to the teacher and talking to classmates. In large city schools, this may

extend to graffiti on student desks; however, it was suggested that this occurred very rarely.

The Importance of Covering the Science Curriculum. All interviewees indicated that it was extremely important for teachers to cover the entire curriculum. One of the school inspectors replied, "This is very important, this is the characteristic of a good teacher. A teacher is considered inadequate or poor if they cannot teach the full curriculum." Deviation from the current curriculum was not a consideration for any of the interviewees. A related issue is the examination system, and a common concern was expressed by the in-service science teacher trainer, "The curriculum is produced centrally and if it is not covered student assessment will be affected and marks will be low."

The Importance of Students Doing Well in Examinations. Good student performance in examinations was seen by all interviewees as being extremely important, as this determined student progress to the next grade level. The in-service science teacher trainer commented, "This is very important, if students do well it is good for the school, the teacher, and of course the students. Parents select schools on their performance in exams....Employers also look for good results."

The Influence of Examinations on Teaching Practice. The interviewees indicated that teaching was generally directed towards students passing examinations as opposed to developing a full understanding of curriculum content. A chemistry teacher described her approach as:

> I teach to pass the exams. Often exam items are not in the curriculum, therefore it is important to know these areas and ignore others that are not relevant to the exams. This is to make very ensure that my students do well in the examinations.

It was generally acknowledged that the memorisation of factual knowledge was important in examinations, and as a result, laboratory activities and process skills received little, if any, attention from teachers. The in-service science teacher trainer summed this up saying, "If exams focus on memorisation, then the teachers will

teach students to memorise facts. Many exams in Indonesia require student memorisation."

Barriers to Student Learning in Science. The interviewees were consistent in identifying a number of barriers to student learning in science. These included teacher-centred methodologies, a difficult curriculum, the focus on examinations as opposed to student understanding, and lack of available time. One school principal commented that, "The system does not provide a mechanism to remedy areas where students lack knowledge. If students fail, we must move on (in class)." None of the interviewees cited the problem of inadequate physical resources such as laboratories and science equipment, which from the observations of the researcher were generally under utilised. However, this is not surprising considering the apparent focus on theory and passing examinations as opposed to the development of process skills using appropriate laboratory activities.

Role in Providing Teacher Development Activities for Other Teachers. The two classroom teachers were involved as instructors in the MGMP program and in this role presented in-service activities in the areas of student assessment, lesson planning, and preparation of student worksheets. As all of the Indonesian graduates of SMEC were involved in the PKG project, if they were working as classroom teachers it would normally be expected that they would be involved in MGMP activities as instructors. For those promoted out of the classroom, to school principal or inspector for example, involvement in the MGMP was not expected. One of the key elements of the MGMP approach was the focus on classroom teaching methodologies and those not involved in teaching would be too far removed from the day-to-day curriculum requirements and programming to have a beneficial input.

Opportunities for Further Studies. Of the seven interviewees, one was currently enrolled in a three year PhD program in Indonesia. This interviewee was located in a city where a PhD program was available and was employed in a senior position within the Ministry of Education and Culture. Of the others, one indicated that he was too old (56 years) to consider further studies, and one female interviewee

indicated that as her husband was not well educated it would be difficult for her to consider a further upgrading of qualifications. The other four participants indicated that there were no opportunities available to undertake further study.

4.4.2 *Interviews with Australian Respondents*

Introduction. Six teachers were selected from the Australian respondents to the postal questionnaire and the interviews were conducted during April 1999. As the majority of respondents were Western Australian, the teachers interviewed were located in Perth, the capital city of this state, and the interviews were based on the interview guide questions described in Chapter 3 and included in Appendix B. All of the quotes below are from field notes generated from the interview questions and additional unsolicited comments.

In conducting the interviews, the researcher was struck by the level of autonomy and individual character of the schools visited. Each school had a very distinctive school uniform, and in one school, teachers had their own dress code clearly identifying the name of the school. Depending on location, certain areas in Perth have particular needs within the community, including for example high levels of ethnic minorities, Aboriginal populations, and high unemployment and dependence on social welfare. Schools appeared to be responding to these community needs, having implemented appropriate educational programs and curricula. Examples of these initiatives provided by interviewees included opportunities for participation in non-academic areas with a workplace focus and opportunities for work experience or subjects in various areas of Vocational Education and Training (VET).

The Western Australian school system follows a 7-5 model; a seven-year primary or junior level beginning at age five or six, followed by five years of secondary schooling. Of those interviewed, three were Head of Science in schools; two in secondary public schools and one in a private secondary school. These positions carried teaching duties within the particular areas of expertise of the teachers. One interviewee was a Deputy Principal in a public secondary school with no teaching duties, and another in a private school was the Head of the Junior School with

teaching duties. Finally, one interviewee was a classroom science teacher in a private school. This selection of Australian teachers reflects the diverse professional backgrounds of the Australian SMEC alumni.

Feelings about Science Teaching. All interviewees expressed positive feelings about science teaching and generally enjoyed the role they that were playing in the education system. However, interviewees in the public education system expressed concerns about science education and the education system generally. One Head of Science commented that "Political interference in education is of concern.... especially in areas of funding cuts and curriculum changes which I feel are not being adequately supported by the government." In terms of wider social issues, the Deputy Principal felt that:

> Increased retention rates of students in secondary schools due to the lack of employment opportunities is impacting on teaching. I recognise and accept that increased retention rates is government policy aimed at reducing unemployment, but this is creating classes where students are not interested in science.

These comments are supported by data showing that student retention to Year 12 in Western Australia rose from 34% of the cohort in 1980 to approximately 69% in 1993. Associated with this increase in student numbers is a broadening of the ability range of students which naturally includes those who are less academically able (Graham, 1998).

Feelings about Student Learning in Science. The public school interviewees were concerned about a number of aspects of student learning. Related to the increased retention rates, one Head of Science explained "Students have no vision....they don't see the big picture, and in particular they can't see the worth of science." Within other curriculum areas, it appeared easier to identify topics that related to areas of employment. Within this environment, the public school interviewees felt that student learning in science was out of context and not related to everyday life and employment aspirations, if any, of students. Additionally, they expressed concern about difficulties in catering for the diverse range of student needs in these classes.

These implications are supported by Beasley, Butler, and Satterthwait (1993) who stated that, "Accommodating the recent social forces attempting to make senior schooling more focused on work will require an energetic process of redesign of the syllabuses and in-service for teachers" (p. 12). Another concern was that many teachers are following traditional teacher-centred approaches. A science teacher in a private school suggested that, "This is being driven in Years 11 and 12 by the externally administered Tertiary Entrance Examination (TEE) which occurs at the end of Year 12."

Teachers Using Different Teaching Activities in a School. In Year 12, all teaching activities are open to external moderation in line with the very prescriptive science curricula. Consequently, teachers generally use the same teaching activities and apart from one interviewee, this was seen as being a problem.

In Years 8 to 10, in the absence of external examinations and moderation, teachers were free to choose their own teaching activities while following a common set of learning outcomes. The three Heads of Science indicated that within a particular school these learning outcomes are generally decided among the science teachers as a group, with reviews occurring on an annual basis. Most classes use a common set of assessment instruments developed within a particular school for Years 8 to 10. In practice then, the philosophy of curriculum implementation encourages the development and implementation of new teaching activities. However, the Deputy Principal pointed out that, "The mindset of teachers is to use the same teaching activities determined by the common assessment items in use within a particular school." For example, individual schools may have developed common mid-term and final student assessment instruments for each science subject.

An interview with the private classroom-based school teacher indicated that he worked in a different environment:

> The use of different teaching activities by science teachers is a big issue in my school. While I try to be an innovator, the overriding school philosophy is that every student is presented with the same learning opportunities. This

discourages teachers from using different activities. This situation remains unresolved, and is causing frustration, especially for those teachers interested in improving student learning and being more involved in professional development.

The Role of Student Assessment in Science. The responses of interviewees to this question fell into two categories - those covering science between Years 8 to 10 and for Years 11 and 12. A Head of Science responsible for Years 8 to 10 commented that, "Assessment requirements in lower school science are largely determined by individual schools and are not subject to external moderation or examinations. The prime purpose is to monitor student achievement." A teacher in a private school provided an added focus, "Staff are accountable to parents....My Year 8 assessments are used to sort student abilities, but importantly serve as an accountability mechanism to parents." Indeed, across all schools, student assessment was seen as a mechanism for providing feedback on student learning to teachers and parents. In some cases, assessment in lower school was seen as being useful in enabling the streaming of students into classes according to ability.

In both private and public schools, the role of student assessment in Years 11 and 12 was related to the TEE examination. Here, in addition to the final external examination grades, certain items of continual assessment are submitted by teachers as a component of the overall grade for each subject.

Student Misbehaviour. In private schools where parents pay tuition fees, student misbehaviour was not a problem. In government schools, the levels of student misbehaviour were related to the location of the school. Interviewees in two schools traditionally associated with areas of high unemployment and dependence on social welfare indicated that student misbehaviour was a concern. The Head of Science in one of these schools commented:

> Student misbehaviour ranges from relatively minor incidents of wearing hats in class, rocking on chairs, to abusive and threatening behaviour towards teachers. I have a lack of trust in students at this school; therefore, I consider

> very carefully the introduction of new teaching activities, especially if these involve dangerous chemicals or gas burners. In some cases, I segregate out the troublemakers so that these activities can proceed, and it is certainly a management problem.

The Deputy Principal in another public school indicated that while student misbehaviour was not a significant problem, it was something that teachers had to deal with, "Teachers occasionally contend with argumentative and abusive students.... these behaviours are essentially manifestations of problems in the wider community which include drugs, marriage breakdowns, and dysfunctional family units." The Head of Science in a government school in an area not associated with high unemployment and social welfare dependence indicated that student misbehaviour was not a major problem and that teachers commonly dealt with minor problems such as talking in class.

The Importance of Covering the Science Curriculum. For Years 11 and 12, all interviewees indicated that it was essential for teachers to follow the prescribed curriculum. The Head of Science in one school explained:

> All teaching activities in Year 12 are open to external moderation and selected teachers (providing a sample across the education system) provide moderators with assessment schedules, teaching programs, records of student marks, and examples of student work that the teacher has assessed.

In Years 8 to 10, teachers are essentially free to cover what they choose within a set of learning areas. In most schools, while the science teachers as a group identify the curriculum topics to be covered, there was no formal mechanism in place to ensure that individual teachers followed this selection of topics. In some cases, teachers indicated that they followed the interests of particular classes where possible, and were free to extend curriculum content if there was sufficient student interest. In the private schools, there appeared to be a stronger requirement to follow the curriculum topics adopted by the particular school.

The Importance of Students Doing Well in Examinations. Teachers in the private schools indicated that there was a lot of importance placed on student performance in examinations. The teacher in one private school indicated that students sit formal examinations for each subject from Year 8. Generally, in the public schools there are no examinations during Years 8 to 10. Consequently, not as much importance was placed on these continual assessment results as compared to those in Years 11 and 12, apart from being used to decide on which subjects students would enrol in during Year 11.

All interviewees indicated that the TEE results in Year 12 were extremely important. The Head of Science in one public school linked this to current changes in the education system, "The public school system is undergoing a process of devolution, newspapers are ranking public and private school based on TEE results.... it is becoming increasingly important for public schools to do well in these examinations."

The Influence of Examinations on Teaching Practice. All interviewees indicated that the TEE examination essentially dictated teaching practices for Year 12 and to a lesser extent Year 11, and that the primary focus is on students doing well in the TEE examinations. Generally, the pressure of examinations did not allow teachers to follow or develop areas of student interest.

Barriers to Student Learning in Science. All interviewees acknowledged the quality and abundance of the physical resources available in schools, indicating that this was not a barrier to student learning. However, most suggested that student attitudes towards science can become a significant barrier to student learning. The Head of Science in one public school summed up the feelings of most interviewees:

> Student attitudes towards science are the greatest barrier to learning. Many have no idea of what they want to do when they leave school. Consequently, science is not relevant. This influences the amount of time students are willing to devote to science subjects outside of class and produces a general lack of motivation. Parental attitudes do not help. Some parents don't see

science as being important, others see it as being difficult, probably based on their own school experience, which in turn influences student attitudes.

Role in Providing Teacher Development Activities for Other Teachers. Generally, the interviewees were not involved directly in providing teacher development activities. Within public and private schools these activities are usually conducted by external providers, for example the Education Department, the Science Teachers Association of Western Australia (STAWA), and individual experts or consultants. Examples of some of the activities provided by STAWA are provided in Section 2.2.3 of Chapter 2. Those interviewees in senior positions such as Head of Science play a role in facilitating the access of teachers to these activities and resources. Schools generally provided science departments with a small budget, and staff development days are provided in the school calender.

Opportunities for Further Studies. All interviewees indicated that there were plenty of opportunities available for further study, with one interviewee currently completing a PhD at SMEC. Generally, they saw no promotional or financial advantages in completing higher qualifications and indicated that study would generally be completed in their own time.

4.4.3 *Summary of Interviews of Indonesian and Australian Teachers*

The following summary considers the interviews with Indonesian and Australian teachers within the conceptual framework adopted for the study and described in Chapter 1. Primarily, the interview data can be considered within this teacher development framework in terms of professional development, personal development, and the influences from the educational system.

Personal Development: Feelings about Being a Science Teacher and Beliefs about Science Education. The interviews highlighted similar feelings and areas of concern among the Indonesian and Australian science teachers. The Indonesian teachers were concerned about the restrictive and very theoretical focus of the science curriculum and examination system. Consequently, they are contending with a lack of popularity

of science amongst students. Similarly, the TEE in Western Australia is equally restrictive; however, students have the option of non-TEE subjects, which may have a vocational orientation. Therefore, there was not the same level of concern about restrictive curricula among the Australian interviewees. The Australians expressed concern about the lack of student motivation and interest in science resulting from increasing numbers of students taking science in the last two years of schooling who otherwise would not have done so due to increased school retention rates. Clearly, the feelings and beliefs of both groups of teachers are influenced by having to deal with students who are not particularly interested or enthusiastic about science and the restrictions of prescribed curricula.

Professional Development: The Introduction of New Teaching Activities. Generally, the interviews indicated that for different reasons, the Indonesian and Australian teachers are generally more comfortable in a situation where all teachers within a school use the same teaching activities for a particular science topic. For the Indonesian teachers, this appears to be in response to the very prescriptive curriculum requirements and external examinations. The Australians are also teaching across two year levels – Years 11 and 12 - where examinations and curricula have an extensive influence on teaching practices. However, there are available non-TEE options for students during these two years. Across the other three year levels – Years 8 to 10 - the Australian teachers have a greater freedom of choice in the curriculum and in introducing new teaching activities. However, in practice, it would appear that these teachers generally prefer to use the same activities as their colleagues.

Influences of the Educational System. Perhaps the largest influence on Indonesian and Australian science teachers is the education system in which they operate. The highly centralised Indonesian education system caters to the needs of more than 200 million people divided into approximately 300 ethnic groups with about 14 main languages and 400 regional dialects (Turner, et al., 1995). During 1996, there was estimated to be approximately 40 million students enrolled in formal primary and secondary education in Indonesia (British Council, 1996). Administratively, the

centralised curriculum and examination system is provided from Jakarta across 27 provinces which include 246 districts, 55 municipalities, 3,592 sub-districts and 66,594 villages (Riyanto, 1991). Within this highly centralised and organised structure, there is little opportunity for teachers to break away and cater for localised educational needs.

In contrast, the Western Australian education system, which caters to a relatively small population of around 1.7 million people, has approximately 350,000 students in primary and secondary education with a projected enrolment of 357,991 for the Year 2000 (Australian Bureau of Statistics, 1998; Department of Employment Education and Training, 1991). Recently, schools in Western Australia have undergone a process of devolution with individual schools having a certain degree of autonomy. This process will be extended during the year 2000 in an Education Department initiated trial involving 30 Western Australian primary and secondary schools (Parents to manage schools, 1999). This plan aims to increase the levels of community involvement in schools and allow them to have inputs into the teaching and learning programs. This involvement in schools will include the areas of school expenditure, criteria for staff selection, class sizes and subjects, dress codes, school opening and closing times and reporting procedures to parents (Parents to manage schools, 1999).

While the postal questionnaire data suggest that student assessment is a more significant factor determining teacher feelings and beliefs amongst the Indonesian teachers, the contextual information provided by the interviews provides a broader perspective. The Indonesians teach across three years of senior secondary schooling with very rigorous curriculum and examination constraints. On the other hand, the Australian teachers generally teach across five years of secondary schooling, with the upper and lower years having very different curriculum and assessment parameters. In Years 11 and 12, teaching practices for the TEE subjects appear to be influenced by a very prescriptive curriculum and examination system in a similar manner as found among the Indonesian teachers. Therefore, while the Australian teachers are responding to the influences of this examination system on the one hand, they are

also teaching non-TEE subjects and in the other three year levels (Years 8 – 10) where they have an influence on assessment parameters.

These two vastly different systems are therefore creating quite different environments in which Indonesian and Australian teachers operate. While Indonesian teachers are attempting to cope with the rigid curriculum and examination requirements which they openly acknowledge is irrelevant to local needs and producing low student achievement levels, the Australians deal with a broader range of subject areas and are expected to cater for classes with a wide range of educational needs. Within this context, serious student behaviour problems in class are more prevalent in some government schools and almost non-existent in private schools, whereas they would appear to be almost non-existent in Indonesian classrooms.

4.5 Case Studies

4.5.1 *Indonesian Case Study*

Introduction. Of the Indonesian teachers interviewed, Ibu Anis (not her real name) was selected as the case study participant for a number of reasons in addition to her classroom teaching experience and long-standing involvement with science teacher professional development. Firstly, she displayed enthusiasm in opening her science classroom to outside scrutiny. Secondly, she was particularly interested in the researcher speaking privately with students in order to gauge their perceptions of science teaching and learning. Thirdly, Ibu Anis was very candid in her opinions, and was obviously committed to improving her own science teaching and that of other teachers in her role as an MGMP instructor.

Ibu Anis is over 45 years of age, has been involved in education for 25 years, completed her Masters at SMEC and teaches upper school chemistry with additional responsibilities in teacher development. She is representative of the Indonesian SMEC alumni in terms of age, years of experience, qualifications, and areas of specialisation as summarised in Section 4.2.3. Ibu Anis is an energetic chemistry teacher, and like many Indonesian female teachers, dresses in the modern Islamic

head scarf and long dress covering arms and legs. While typically Javanese in many ways, and therefore reserved and at pains to avoid conflict and disagreement, Ibu Anis at times was quite firm in her views, and within an Indonesian context, outspoken on issues she felt important to science teaching.

During the early 1980s she was selected as a PKG in-service instructor and completed a training program in Malaysia, as outlined in Chapter 2. This was followed by studies at both King's College, London and Curtin University, completing her Masters program at SMEC in 1993.

School Setting. Ibu Anis is a chemistry teacher at a large senior secondary school with approximately 1,000 students located in East Java. She has taught at this school for many years and with her Masters degree from SMEC is academically the highest qualified teacher in the school. Based on the researcher's extensive experience in the Indonesian education system as an in-service teacher trainer during 1993-95 and as a researcher (Thair, 1995; Thair, 1996a; Thair & Treagust, 1997; Thair & Treagust, 1998; Thair & Treagust, 1999), the school facilities were typical of the majority of senior high schools located in major cities across Indonesia.

The academic year in Indonesia runs from July to June. A typical week's program will have from between 37 to 45 periods distributed equally over six days of instruction, with each period being between 35 to 45 minutes depending on the time of classes. Generally, a full-time teacher has a teaching load of 24 periods per week, thus providing many opportunities to have a second and possibly third part-time teaching position. This is often necessary for teachers in order to supplement their very low government salaries. It would not be uncommon to find that with full and part-time positions combined, teachers may be carrying a total teaching load of between 40 and 50 periods per week, especially for teachers in subject areas where teacher shortages exist (van den Berg, 1993).

As a chemistry teacher, Ibu Anis only teaches this subject, and depending on timetabling this could be across one, two or all three years of the senior secondary

curriculum. The school week is six days, and on Saturday's Ibu Anis is provided with a time allowance in recognition of her role as an MGMP in-service instructor.

Classroom Observation. The observation was of a Year 3 senior secondary chemistry lesson, which is equivalent to Year 12 in Australia. The lesson was conducted in a general-purpose classroom, and this was where science lessons were usually conducted as confirmed during discussions with students after the class. As one student explained, "Our classes are always in that classroom. During the past nine months we have only visited the laboratory five times." This situation is not uncommon in developing countries where the large majority of schools are inadequately equipped for hands-on science activities, resulting in "textbook-orientated, theory-based, transmission teaching and rote learning" (Gray, 1999, p. 264).

There were no examples of student work posted on boards or walls, or any science related displays or posters. Essentially, the classroom walls were empty, apart from an Indonesian flag, a portrait of the President Habibie, a small chart listing the five principles of *Pancasila* (the philosophical and ideological foundation for developing the country, and therefore the educational system), and four colour pictures of Javanese heroes.

The classroom arrangement was typical for Indonesia, with Ibu Anis located at a front desk, and students seated in pairs at rows of desks. In this particular class, there were 51 students, which was considered normal. Students were arranged according to ability, the aim being to distribute high ability students evenly throughout the classroom. Prior to the class commencing, the student representative gave a short command, which resulted in all students placing their head on their desks for a short silent prayer. The class was concluded in a similar manner. This is the normal routine in Indonesian classrooms, where often the prayer is recited aloud and a class member may give a formal salutation to the teacher and request students to formally commence the class. Ibu Anis later explained that this period of prayer allowed students to clear their minds and focus on the lesson.

Before entering the classroom, Ibu Anis indicated that what was to be observed that day would not be a typical science lesson. She planned to use a number of student-centred teaching strategies including whole class discussion and small group activities, which under normal circumstances she would not use due to a lack of class time and the pressure to cover the curriculum. This situation is not unusual in Indonesia as reported by Na'im (1995) who, like Ibu Anis, had been involved in the supervision of teachers attending PKG teacher professional development programs in Indonesia since the 1980s. This author reported that while teachers undertook PKG training they usually employed student-centred teaching approaches; however, some teachers reverted to didactic approaches following the completion of this training. Contributing factors identified by Na'im (1995) included equipment shortages, lack of preparation time, curriculum overload, and poor national examination results which further encouraged teachers to take the safe approach of didactic methodologies. Commenting on the strong influence of examinations on teaching methodologies in Indonesia, Thair and Treagust (1999) reported "Teacher-centred methodologies focusing on drilling students on problem-solving exercises are seen by teachers as being appropriate for preparing students for these examinations" (p. 368).

It is therefore not surprising that Ibu Anis, while being aware of and proficient in the use of student-centred teaching approaches, indicated that she reverts to more didactic approaches because of the constraints she has identified. The reader is again reminded that in addition to her regular teaching duties, Ibu Anis is an in-service teacher trainer responsible for delivering science teacher professional development activities in the MGMP program, which further highlights the impact and pervasiveness of the constraints described above.

Ibu Anis also explained that the objective of the lesson was revision of important concepts associated with the transition elements. What was observed during the lesson, which spanned two 45-minute periods, was Ibu Anis leading the discussion initially, followed by whole class discussion, then an extended period of small group discussion. The final 15-20 minutes consisted of a whole class discussion. Ibu Anis

used a number of "props" initially to generate class discussion, before writing questions on the board to be discussed in small groups. It should be noted here that the language of instruction in Indonesian schools is Bahasa Indonesia, in which the researcher has a reasonable level of ability.

At times during the whole-class discussion Ibu Anis would add her comments, usually as points of clarification, and at other times she attempted to encourage the silent majority to join in. These attempts were generally unsuccessful. Based on previous teaching experience in Indonesian classrooms over a number of years, the researcher felt that this level of discussion and student participation, and the confident attitude of some students, would be quite intimidating to many Indonesian teachers, especially those who were not fully confident in the subject content.

While Ibu Anis had earlier indicated that this was not a typical class, students appeared to be comfortable with the student-centred methodologies used. During the periods of whole class discussion, those students who spoke were extremely confident in presenting their responses to the questions posed by Ibu Anis. Often, these responses were questioned and debated by other students in the class, with Ibu Anis remaining very much on the sidelines. At times, while very formal and controlled, the debate was spirited with students presenting quite strong arguments in support of their answers.

Discussions with the students after the class confirmed that this was not the usual approach adopted by Ibu Anis. One student commented, "Usually the teacher does all the talking. We have to write notes which we copy from the blackboard." The researcher had the impression that for the less able students, this may have been the preferred teaching methodology, and it was only the more capable students who preferred the student-centred approaches, especially whole class discussion. Similarly, in a case study of a chemistry teacher's questioning techniques in a senior secondary class in Indonesia, Wanti (1993) reported that whole class discussion usually only involved a small number of students, and that the lower ability students tended not to become involved. Tobin and Gallagher (1987) describe these

participating students in science classes who monopolised whole class discussions as "target students" (p. 61). They defined these students as those who were extensively involved in these discussions, usually by providing information, asking questions and responding to teacher questions. While the existence of target students may be widespread, some students prefer not to become involved due to the likelihood of responding incorrectly to a teacher question for example and losing face in front of other class-members and the teacher (Tobin, 1988).

While the lesson consisted of extended periods of whole class discussion and other student-centred activities, the classroom environment remained very controlled and formal. At all times, students asked Ibu Anis' permission before speaking and formal terms of addressing the teacher and other students were used. During the entire lesson the teacher and students were 100% on-task with Ibu Anis in full control of exactly how the lesson proceeded.

The researcher noted that the only resource available during the class was a government produced textbook and this was raised with Ibu Anis after the class. She had quite strong opinions on the textbook and indicated that:

> Textbooks are scarce and quite expensive. The government textbook we are using provides the students with many exercises and problems. However, this text is unpopular among many teachers because answers are not provided, and teachers have difficulty in answering the questions.

Several of the above observations were relayed to Ibu Anis during a discussion following the classroom observation. She acknowledged that in recent times students were becoming more demanding in terms of their learning needs and as a teacher these were difficult to meet due to a lack of time. This discussion led her into explaining more fully her feelings about students asking difficult questions:

> This does not happen often, but I can become angry or frustrated if the question is not related to the curriculum. This is because of the lack of time. With these questions, I prefer students to ask questions outside of class. Sometimes I am unable to answer the questions.

Related to these issues, Ibu Anis outlined an initiative undertaken by the school principal a few years ago:

> In response to the problem of catering to the needs of students with different abilities in our large classes, the principal decided to trial classes of students based on their ability. However, after one year the teachers in our school rejected this. One major problem was dealing with the student questions from classes of advanced level students, which often they couldn't answer.

These issues were certainly evident during the private discussions with students who indicated to the researcher that a number of science teachers were unable to meet their needs, especially in answering questions:

> Teachers can become angry if we ask questions that are not in the curriculum. Sometimes we are frustrated because we cannot find answers in the library. Sometimes teachers say they will provide answers or more information during the next class but often they do not.

The limited school library resources observed by the researcher in the schools visited supported the difficulties for both teachers and students to find additional sources of information.

4.5.2 *Australian Case Study*

Introduction. From the Australian teachers interviewed, Scott (not his real name) was selected as the case study participant for a number of reasons. Being over 45 years of age, involved in education for 27 years and with teaching experience across a broad range of science subjects at the lower and upper secondary levels, he was representative of the average Australian SMEC Alumni as outlined in Section 4.2.3. Additionally, Scott was willing to open his classroom to outside scrutiny.

Scott had been teaching for more than 20 years, and held the position as Head of Science at his current school for 11 years. Typical of most science teachers in Australia, he graduated with a science degree, followed by a postgraduate qualification in teaching (Chadbourne, 1997; Department of Employment Education

and Training, 1989), which then saw him placed in a non-city school as a classroom teacher for a number of years. On his return to the city, he secured his current position. He has completed the Masters program at SMEC, and is currently enrolled part-time in the PhD program. Scott is a very large man who appears very relaxed and informal. He had an easy-going rapport with staff under his control and students generally. His dress was casual, but neat.

School Setting. The school has approximately 750 students in Years 8 to 12, and is located in the northern suburbs of Perth. There would appear to be no special needs at this school in terms of catering for ethnic minorities, Aborigines, or families dependent on social welfare. The school itself is relatively new, being built about 12 years ago and generally appears to be very well maintained and equipped.

The academic year in Western Australia runs from late January to mid-December. The school week consists of five days of instruction between Monday and Friday. Within this framework, individual schools have a certain amount of freedom to set their daily schedule of teaching periods. In the case of Scott's school, each period is 80 minutes, with four periods scheduled each day. As Head of Department, Scott is expected to teach 13 periods each week and in addition is allocated four periods per week for administrative duties and another four periods for duties other than teaching (DOTT). Normal classroom teachers receive the DOTT allowance, with a teaching load of 17 periods. As is typical of many Heads of Department, Scott teaches a range of subjects including Year 9 and 10 Science, Year 11 and 12 Senior Science (a non-TEE subject), and Year 12 TEE Human Biology.

Scott has a range of duties as Head of Science including making recommendations to the school administration for timetabling teachers into appropriate classes, decisions on resourcing issues related to science, the maintenance and management of equipment and materials budgets, and being responsible for a teacher development budget. In addition, he is also required to handle inquiries from parents and prospective students relating to science as well as any other general administrative tasks associated with the science area.

Classroom Observation. The observation was of a Year 12 TEE Human Biology class conducted in a biology laboratory that is the usual location for these classes. The laboratory was very well resourced and there were more than 30 posters of various sizes on the walls of the laboratory from the Bureau of Meteorology, the Australian Academy of Science, Department of Conservation and Land Management, Perth Zoo, and various other sources. There were also a number of posters prepared by students, in addition to samples of student work including practical reports. A number of biology experiments and aquariums were set up around the laboratory. The science preparation area adjacent to the laboratory housed a very large shelving system that contained individual trays of equipment prepared for classes by the technical support staff. The researcher examined other laboratories in the school and these appeared to be similar.

Students remained outside the laboratory until Scott unlocked the door, and on entering the laboratory students went directly to their seats. The classroom arrangement was informal, with students seated in small groups or clusters around a number of moveable benches and not all students were seated so as they were facing the front of the class. Some students elected to be seated alone at benches. Scott positioned himself initially at a fixed bench near the whiteboard and overhead projector. The class size was small, with 14 students in attendance and Scott explained later that three students were absent that day. He indicated that the average class size for science subjects was between 18 and 20 students, with Government regulations stipulating a maximum class size of 25.

There were no greetings or formalities between Scott and the students at the commencement of the lesson and he immediately announced the topic to be covered that day. Scott explained that the lesson would cover water balance in the human body and the functioning of the Antidiuretic Hormone (ADH), he added that this was background to a practical lesson planned for the following week.

The lesson consisted of one 80-minute period, with the first 20 minutes consisting of an explanation by Scott of water balance using a diagram on the overhead projector. Students were then directed to make a copy of the diagram in their notebooks, and to complete a number of activities from their textbook. Essentially, following the initial input from Scott, this ended his formal contribution to the lesson and students worked by themselves for the remaining 60 minutes.

Generally, the classroom atmosphere was relaxed and informal, with Scott having the role of a facilitator rather than of a traditional classroom teacher. During the student bookwork, Scott left the laboratory and had discussions in the science preparation area with the technical support staff and other science teachers. This went unnoticed by students and the researcher also left the classroom and observed other classes completing bookwork while being unattended by teachers for short periods.

There were two or three brief questions raised informally by students, which Scott answered adequately for their needs. Towards the end of the lesson there was a reasonable level of off-topic chatting amongst the students and on a number of occasions Scott engaged in general chatting with students as he moved around the classroom. Scott concluded the lesson by outlining his expectations for the next lesson which included the completion of the assigned bookwork commenced during the lesson and a reminder to students that the following week they would be participating in a practical activity related to water balance in the human body.

After the departure of students from the laboratory, the researcher commented to Scott that it had been a very relaxed and informal lesson. Scott acknowledged this, adding:

> What you observed was a typical lesson. Students largely are doing more for themselves and taking responsibility for their own learning. However, a concern of mine is the general lack of motivation amongst students, which produces undemanding students who were easy going and relaxed in the classroom.

Another observation made by the researcher was the extremely well equipped science facilities. In response Scott explained:

> We employ two technical staff, both of whom have science degrees. Their major responsibility is to prepare materials for laboratory lessons and generally maintain the chemicals and equipment. However, I find it extremely challenging to maintain this level of facilities. There are a number of frustrations with the school administration that made this task very difficult. Apart from budget constraints, the administrators have little understanding of the needs of a science department. For example, they are quite happy to allocate the same budget to run the maths department, which requires very little in the way of resources and equipment. They have also reduced the number of teaching periods for some science subjects, they don't understand the time required for lab classes.

The problems cited by Scott are manifestations of the process of devolution and autonomy that currently is occurring in Western Australian schools. Here, the government essentially provides a budget allocation to run the school and the school administration decides on how to allocate the budget between the various departments. Within this environment, schools are free to make many decisions, and it places a large responsibility on administrators, especially in science, to ensure that they are allocated adequate resources.

4.5.3 *Summary of Case Studies of Indonesian and Australian Teachers*

The case studies provide a very rich contextual background of what is happening in Indonesian and Australian science classrooms. There are obviously vast differences in the levels of science equipment resourcing between the two countries. In addition, the teaching demands on Indonesia teachers fall within very narrow subject disciplines, whereas the Australian teachers are expected to teach across a diverse range of science areas.

The case studies also point to differences in teaching styles. In Australia, this style is relaxed and informal, and student-centred in that students to a large extent take responsibility for their own learning in very well resourced school facilities. In contrast, what was observed in Indonesia was a very formal classroom, with the teacher taking control and responsibility for student learning. However, the Indonesian teacher and students have made a very poignant statement during the classroom observation that was freely acknowledged as not being a typical science lesson. The teacher and students appeared to be very comfortable with certain student-centred teaching methodologies. This suggests that the experiences gained during exposure to the PKG project and the SMEC postgraduate program have provided the teacher with skills to implement student-centred teaching methodologies. However, what was clear, is that under normal circumstances these methodologies are discarded in order to produce a more traditional teaching role in response to constraints imposed by curriculum overload, lack of class time, and the strong influence of examinations which rely heavily on rote memorisation and student recall. Additionally, it also would appear that these more traditional approaches are favoured by those teachers whose subject knowledge in science is weak.

4.6 Interviews with SMEC Staff

4.6.1 *Introduction*

Separate interviews were conducted with three staff involved with postgraduate programs at SMEC. Professor David Treagust, Professor of Science Education at SMEC, participated in the initial discussions with Indonesian government officials before the decision was made where to send the PKG in-service trainers for postgraduate studies. He has subsequently taught all of the Indonesian groups between 1988 and 1995. Therefore, the interview questions directed towards Professor Treagust were quite broad, covering the historical context of how the Indonesian program became established at SMEC and the overall goals and structure of the program. Questions that are more specific were included in separate interviews with Professor John Malone, Professor of Mathematics, and Dr. Peter Taylor, a

Senior Lecturer and Course Coordinator at SMEC. These questions focussed on the differences and similarities between Indonesian and Australian participants in terms of their classroom practices, the education systems in which they operated and constraints limiting the introduction of new teaching practices.

4.6.2 *The Historical Context for Indonesian Involvement with SMEC*

The Indonesian participants were PKG in-service teacher-trainers as described in Chapter 2. Initially in 1979, the Indonesian government identified 12 teachers as PKG in-service trainers and they attended a 12-week training program covering subject content, practical activities, classroom methodologies, and approaches to teacher training in Malaysia at the Regional Centre for Science and Mathematics Education (RECSAM) (Somerset, 1988). On their return to Indonesia, these in-service trainers had the task of inducting other teachers into the PKG approach; following these induction programs a number of PKG instructors were selected for postgraduate studies at SMEC and King's College in London (Thair, 1996a).

Before the decision was made by the Indonesian government where to send these PKG instructors for postgraduate studies, a number of universities were visited and their suitability determined within the context of the PKG project. Professor Treagust described the initial approach to SMEC:

> Before this program got underway, Gordon Aylward who was the consultant who formerly taught chemistry at Macquarie (Macquarie University, New South Wales, Australia)...came to Australia with officials from the government (of Indonesia), from the education department.... So they came to see what we did, basically they interviewed us, they asked us what we do, how we teach, what we taught, what our expectations were with these students.... So we met with the hierarchy before any students came here.... So that's how the whole program got going.

As a result of these discussions, 51 Indonesian science and mathematics PKG in-service instructors attended SMEC between 1988 and 1995. As these Indonesians were all PKG teacher-trainers, this process highlights the selection process that

occurred for both the institutions providing the programs and the participants. In contrast, Australian participants in SMEC postgraduate programs were self-selecting and could be expected to be a more heterogenous group with widely varying backgrounds and experience.

4.6.3 *Program Goals and Structure*

As outlined in Chapter 1, SMEC offers a range of postgraduate studies in science, mathematics and technology education. In addition to the doctoral programs are the Master of Science in Science Education or Mathematics Education by thesis or by coursework and project, and the Postgraduate Diploma in Science, Mathematics, or Technology Education. The Indonesian participants generally completed the Postgraduate Diploma in one-year of full-time study before completing the Master of Science program by coursework and project the following year. Typically, Australian participants complete these studies on a part-time basis. Essentially, the broad aims of these programs are the development of participant's critical self-awareness of their roles in science or mathematics education (SMEC, 1997).

In describing the goals of the postgraduate programs more fully, Professor Treagust indicated that these were the same for both local and overseas students and in referring to the Indonesians:

> They were required to give presentations, write assignments, and they were treated just the same as any other student.... In a very general sense, to learn more about education, of science and mathematics, to learn about teaching a subject, to learn about curriculum decision making, curriculum design, curriculum evaluation.... Our goal was that when they finished the program they could be more effective teachers in their classrooms....They had a very rigorous program, there was not a program for the Indonesians and a program for the Australians from the point of view of the level of expectations.

Outlining some of the earlier negotiations and contact with the Indonesian Ministry of Education and Culture, Professor Treagust described a number of factors that shaped the structure and management of the program:

> It was made clear to us that this was not to be a weaker program for these overseas students, they wanted high academic credentials....it (was) very clear that they didn't want "coconut science", they wanted real science. So I think this gave us the framework.

The reference to "coconut science" identifies a very serious constraint in designing and offering programs to participants from developing countries. This is highlighted by Gray (1999) when he suggests that, "The struggle is against a mind-set that believes that science is only real and authentic if it takes place in a laboratory with sophisticated First World equipment" (p. 264). The discussions described by Professor Treagust also highlight the Indonesian government's concern about the rigour of the program. At the same time, SMEC staff were aware of the different educational environment in Indonesia and therefore the requirement to tailor the program to meet these needs. However, Professor Treagust outlined some frustration in determining more precisely what these needs were:

> We didn't know what (the participants – the teachers) wanted, because they would never tell us, it was like a mystery, so we worked out what to do and I think it came about by people like Peter and myself, John Malone, talking about...what we were actually trying to achieve here, because they were not forthcoming.

These comments indicate that the Indonesian postgraduate students, within their cultural context, may have had difficulties in delineating important educational issues relevant to science education in Indonesia, or alternatively these concerns may have been expressed but not fully understood by SMEC staff. Even if the Indonesians had been partly successful in communicating these concerns, considering the limited coverage in the academic literature at that time, and even currently, of science education issues in developing countries, coupled with the limited exposure of SMEC staff to classroom teaching in these environments, it is not surprising that these frustrations arose.

Associated with the issue of meeting the particular needs of the Indonesians was the decision whether to integrate the Indonesian participants with Australian students.

Professor Treagust indicated that the Indonesian government clearly articulated that they wanted the Indonesians taught as a separate group. He suggested that this requirement might have stemmed from previous experience in sending teachers to other countries where the Indonesians had integrated with home-country students, resulting in poor performance. Professor Treagust suggested that, "One of the reasons was because they were in large groups ...with many students, and of course they've got deficiencies in language and maybe nuances and understanding." There were also a number of logistical problems at SMEC that further dictated that the Indonesians be treated as a separate group. As outlined by Professor Treagust:

> It wasn't possible (integrated classes) because in those days, we didn't have any full time Australian students, all the students were part timers and used to come in the evening, and daytime was for teaching the Indonesian students. So it was evening teaching Australians and daytime teaching Indonesians. The program used to be very much that way....The great idea to have this combined group together just didn't work out, physically it was impossible. That's a real down side in a sense to the program.

Therefore, with the Indonesians as a separate group, a number of things were done differently from the evening groups of Australian students. Professor Treagust indicated that these included group work allowing the Indonesians to speak in their own language, computers supplied by Curtin University that could be set up and used in living quarters and funding provided by the Indonesian government for English tutors. These tutors assisted the Indonesians on one-to-one basis with writing and correcting of assignments.

4.6.4 *Differences and Similarities Between the Classroom Practices Generally of Indonesian and Australian Science Teachers*

A number of more specific questions in separate interviews were directed towards Professor Malone who was involved in the teaching two groups of Indonesian students between 1991 and 1993 and Dr. Taylor who had very extensive teaching duties with all of the Indonesian groups between 1988 and 1995. Both interviewees

described differences in the classroom practices of Indonesian and Australian science teachers. Indicative of these were the comments made by Dr. Taylor:

> Hugely large classes around fiftyish....Teaching to a rigorous, rigid timetable, a national timetable with national examination systems, so teachers, working, in lock-step fashion ensuring that the syllabus was covered to the best of their ability. Pretty much the transmission mode.

Professor Malone and Dr. Taylor were unable to identify many similarities between the classroom practices of Indonesian and Australian science teachers. However, in commenting on the widespread didactic approaches in Indonesian classrooms, Dr. Taylor commented:

> You can find those people in Australia too, but I'm just more aware that in Australia there are more curriculum possibilities for a more student-centred enquiry-based approach to teaching. The teachers whom I work with here who are students of this Centre by and large do make those sorts of attempts in their own teaching practices.

The classroom observation reported in Section 4.5.2 and the interview with the Australian teacher support this viewpoint compared to the classroom observation and interview with the Indonesian teacher.

4.6.5 *Differences Between Indonesia and Australia in Terms of the Structure of the Education System and School Management*

Both interviewees commented on the centralised and top-down education system in Indonesia and Dr. Taylor contrasted this to the decentralisation occurring in Western Australia. In commenting on the limitations of this centralisation in Indonesia he added, "(it) is very restraining in terms of adapting curricula to local contexts and local needs and circumstances." In relating this to what was happening in Indonesian science classrooms, Dr. Taylor added, "It was pretty much locking teachers into a content delivery state of mind...and despite their intentions for a more student-centred approach, I think they were very restrained. Exceedingly restrained." These comments were supported by a very poignant example provided during the interview with Professor Treagust:

> I was taken to a school in Solo (Central Java) and this one teacher was teaching in a very innovative manner with groups working on different experiments, but ... the hierarchy in the school didn't like what he was doing because his students weren't in step with the other teachers. So he would have been an exceptional teacher in any system, but the structure...didn't allow this to continue to happen.

These responses therefore indicate that SMEC staff were aware of the environment in Indonesia which did not openly encourage or support the introduction of new ideas from individual teachers. Generally, this points to a system where innovations are not introduced until they have the approval of the management structure that subsequently allows institutionalisation of new initiatives.

4.6.6 *Steps Taken to Ensure that the Experiences and Theoretical Frameworks the Indonesian Participants Were Exposed to at SMEC Were Compatible With the Beliefs, Value Systems and Sociological Environment of Indonesia*

A number of structural constraints operating within the Indonesian education system were acknowledged by Dr. Taylor and Professor Malone. A recurring theme during the interviews with Professor Malone and Dr. Taylor was that the Indonesian participants generally understood and agreed with student-centred teaching approaches and constructivism, however they repeatedly indicated that these were difficult to introduce into their classrooms. Unless the content and experiences gained at SMEC were compatible with these constraints, in addition to the beliefs and value systems operating in Indonesia, the participants on their return home could therefore be placed in the unenviable position of realising the benefits of the learning frameworks presented at SMEC but being unable to implement them. If this was the case, the effect may have been in effect, to deskill these participants.

However, as mentioned previously, student-centred teaching practices underpinned the PKG project and therefore these approaches were applicable within the context of this project. Dr. Taylor outlined the realisation at SMEC that the PKG project, with

its very strong focus on promoting student-centred teaching approaches, was itself out of step with the broad educational environment in Indonesia. Coupled with this was the further realisation of the massive inertia involved with educational reform in Indonesia, which Dr. Taylor summed up by saying:

> Huge constraints ... face educational reform, macro-educational reform and micro educational reform and...the impossibility in many respects of the PKG Program to make huge steps, to achieve the goals it had set itself, because of the way it was only one stakeholder in the entire reform process.

Within the context of this realisation, Dr. Taylor highlighted the problem of determining exactly what the Indonesians were hoping to get out of the program and, in determining more precisely the beliefs, value systems and the sociological and political imperatives operating in Indonesia at that time. In describing these difficulties Dr. Taylor commented, "We had ... a mind set here that we wanted to deliver something to these guys that was relevant to their interests and needs. We couldn't get them to articulate it, apart from telling us about the PKG Program. They didn't seem to arrive with an agenda."

A number of attempts were made by SMEC staff to determine more clearly these needs from the education authorities in Indonesia, including visits to Indonesia; however, these proved unfruitful in expanding on what their particular requirements were. As a result of these visits and continuing discussions, Dr. Taylor concluded, "So the impression I got was, well we're (the Indonesian government) sending these people to you and you should know what they need because you are the academics in the universities." From this, Dr. Taylor indicated that a broad constructivist pedagogical approach to the Indonesian postgraduate program involving a cooperative partnership incorporating the needs of the Indonesian educational system was difficult to implement. As the program evolved over the years, Dr. Taylor suggested that the program progressed towards providing the Indonesian participants with increased opportunities for expressing their own ideas and to "help them become more self-determined and independent and autonomous in their own thinking in the context of their own local circumstances." During this process, SMEC

staff were also able to learn more about the Indonesians. One particular example provided by Dr. Taylor was where he had the students, "Write a little introductory personal experience profile on who you are, where you fit into your PKG system, and what values you're bringing into this research project that you hope can be met."

Another influence alluded to by Dr. Taylor, and Professor Treagust, was that when completing their research projects the Indonesian participants had a strong desire to demonstrate the superiority of the student-centred PKG approach. This is clearly supported by an examination of the research projects completed at SMEC by the Indonesian students between 1988 and 1995. Generally, these projects used quasi-experimental research approaches or surveys, with a limited number of ethnographic/qualitative type projects, and a focus on one or a combination of areas including the effectiveness of practical activities, constraints on the use of practical activities, student attitudes and achievement, or enhanced pedagogical skills (Thair, 1996a). As stated by Dr. Taylor, the approach of the Indonesians was, "A mind set of we want to do pre-test, post-test measures of the change of attitude of the teachers or students as a result of this new teaching innovation to prove how good the PKG is."

Considering these concerns and the other constraints associated with the introduction of student-centred teaching methodologies in Indonesian classrooms, the Indonesians were steered away from demonstrating the superiority of the PKG approach, especially in the choice of projects completed as part of their Masters program. As described by Dr. Taylor, the move was towards an, "interpretive approach, to understanding more deeply the learning processes that are going on and particularly their professional roles as facilitators of change." During the interview, Dr. Taylor made the point that this process with the Indonesian teachers studying at SMEC began more than 10 years ago when these approaches where in their infancy and "lacking legitimation in science and maths education." In effect, in the process of these approaches becoming more widely accepted in the broader science education community, they were concurrently being introduced to the Indonesian and Australian participants at SMEC.

4.6.7 *Particular Skills and Theoretical Frameworks that the Indonesians Took from SMEC That Would be Directly Applicable to Secondary School Settings in Indonesia*

As described above, the postgraduate program for both Indonesian and Australian participants over the years evolved towards a more interpretive approach, with an increasing focus on understanding the processes associated with student learning in science. Again, this was acknowledged and highlighted by Professor Malone and Dr. Taylor. In describing this process in relation to the Indonesian students, Dr. Taylor explained:

> I think one really practical thing was David's (David Treagust) two tiered diagnostic test approach and that was seized on with great relish (by the Indonesians) ...and I think they are potentially a very powerful diagnostic tool for alerting teachers to students' conceptual activity.

Another example provided by Dr. Taylor was action research, which he saw as being helpful in enabling teachers to become more reflective. Similarly, Professor Malone described his involvement with a teacher training institution in Indonesia interested in introducing the notion of action research. Within this context, Dr. Taylor highlighted the suitability of the PKG project in facilitating teacher reflection:

> They had actually an ideal model of in-service professional development. The in-service/pre-service mix of things where the teachers would come out of the system for a two week period ... then go back in, then meet on a regular basis on Saturday mornings ... that is just fantastic for facilitating action research, reflective practice and all those sorts of things.

In making this observation, Dr. Taylor acknowledged that this model had influenced his conceptualisation and approaches to teacher professional development over the years, and that he had come to value these elements of the PKG approach in terms of what occurs within the Australian context of science teacher professional development.

4.6.8 *Constraints Operating in Indonesia That Limit the Introduction of New Classroom Skills*

Both Professor Malone and Dr. Taylor identified the rigid science curricula in Indonesia and the influences of the centralised examination system as the major constraints limiting the introduction of new teaching practices. Dr. Taylor described this as, "the metaphor of the curriculum as a container and knowledge as content to be transmitted by the teacher." He went on to explain that this "metaphor" was established and maintained by individuals outside of the PKG project, and as a result the initiatives embedded within the project were unable to impact on science curricula or the examination system.

Professor Malone highlighted the traditional role of teachers and identified some further differences in respect to resources which in his opinion, "were very traditional with short explanations and heaps and heaps of exercises to be done with very little other sorts of explanation."

4.6.9 *Strategies Developed by the Indonesian Participants in Order to Overcome the Constraints Limiting the Introduction of New Teaching Practices*

As constructivist theory was introduced to the Indonesians during the SMEC program, Dr. Taylor gave the example of group practical activities as a strategy overcoming some of the constraints operating in science classrooms. At the same time, Dr. Taylor suggested that the Indonesians were building a strong philosophical and educational foundation for this type of student-centred teaching methodology. However, Dr. Taylor qualified the statement from a philosophical standpoint saying, "I myself personally never tell a teacher what they should do in a classroom in terms of practical teaching strategies." Rather, he saw his role more as encouraging reflection among teachers - "What I try to do is get teachers to be reflective about the assumptions...the values that underpin these strategies (for introducing new classroom practices), the way they are shaped by curriculum forces and other expectations."

Considering the prominence of constraints operating in Indonesian science classrooms, and the obvious impact this was having on the introduction of new teaching approaches, Dr. Taylor was asked if a cooperative approach involving SMEC academics and the Indonesian participants was ever considered in overcoming these constraints. In responding, Dr. Taylor acknowledged that this had not occurred at SMEC to any large extent and was one of the limitations of the program. He then went on to highlight the recent reconceptualisation of the linkages between teaching, research and curriculum, and related these to the program at SMEC. He described what he saw in those days as a, "downplaying of the value of curriculum development and an overvaluing of research as a separate activity from curriculum development." Dr. Taylor further emphasised that many of these notions had not become firmly established in the literature or in the minds of SMEC staff at that time.

In discussing these notions, both interviewees again emphasised the difficulties in determining the thoughts and feelings of the Indonesian participants in working cooperatively towards developing strategies to overcome classroom constraints. Dr. Taylor observed, "I guess this is possibly to do with the authority relationship between teachers (the SMEC staff) and students (the Indonesian participants)." In summing up, Dr. Taylor emphasised that if the program for the Indonesians was to be conducted again, it would probably be done differently, citing the increasing awareness and sensitivity, both among SMEC staff and in the literature, of cross cultural issues in science education and teacher professional development

4.6.10 *Classroom Teaching Experience of SMEC Staff in Indonesia or Other Developing Countries*

The interviews revealed that none of the SMEC staff had taught in science classrooms in Indonesia or any another developing country. Professor Treagust has had extensive experience in presenting science teacher professional development activities in developing countries and consultancies associated with the PKG project in Indonesia. Similarly, Professor Malone has been involved in various teacher professional development activities in the region. Dr. Taylor has made visits to

Indonesia associated with the PKG project and when asked if he had any teaching experience in a developing country was able to draw some parallels with his experience in teaching indigenous Australian Aborigines.

4.6.11 *Summary of Interviews with SMEC Staff and Conclusions*

In summary, the interviews with SMEC staff indicated that the program had similar expectations and rigour for both Indonesian and Australian participants; however, the Indonesian students were taught as a separate group. A recurring theme in all interviews was the frustration in determining exactly what the Indonesian participants were hoping to gain from their experience at SMEC. While familiar with broad differences between classroom practices in Indonesia and Australia and the structure of the two education systems, none of the SMEC staff had taught secondary science in a developing country. Consequently, they may not have fully understood the complexity of the educational environment and culture in Indonesia, and the culture that extends beyond the classroom. Therefore, it is conceivable that the Indonesians may have attempted to communicate some of these educational expectations within their own cultural context, and that the SMEC staff may not have understood this.

Notwithstanding these frustrations and limitations, the interviews indicated that over a period of time the program moved towards an approach that promoted an understanding of learning processes and opportunities which encouraged the Indonesian participants to express their own ideas. It was pointed out that this was occurring during a period when these processes and notions were becoming increasingly accepted within the science education community.

The interviews identified the very important realisation at SMEC that the student-centred PKG approach, while acceptable within an Australian context, was in effect out of step with the broad educational environment in Indonesia. Consequently, there was not broad support within the Indonesian education system for the sharing of new skills and ideas outside of the PKG project. While it is widespread in Indonesia, to-date the PKG initiative has not become institutionalised and there are a number of

reasons for this. The expenditures on a number of parallel teacher development programs in Indonesia for primary and secondary teachers across most curriculum areas totals an estimated US$100 million annually (Asian Development Bank, 1996). As with the PKG initiative, external priorities and individual project design parameters have often dictated the structure and content of these programs and coordination of these inputs across the education system is ad hoc (Asian Development Bank, 1996). Furthermore, with around 203,000 teachers in senior secondary schools, these teacher development programs have trained too few teachers in each school to have any significant and sustainable impacts on classroom teaching practice. Unfortunately, it is now widely acknowledged in Indonesia that returning teachers rarely apply in the classroom what they have learned (Asian Development Bank, 1996). The reason identified was that they were returning to a system that generally was unable to provide system-wide political and employer support in day-to-day teaching for any skills obtained externally to the system.

4.7 Summary of Results

The research adopted a social constructivist approach to evaluating the responsiveness of a science education postgraduate program to the needs of participants from the host nation and a developing country. In response to recent research trends in the field of teacher professional development, the research methodology combined both quantitative and qualitative data collection methods including a postal questionnaire, interviews, classroom observations and case studies. The participants included Indonesian and Australian alumni of SMEC in addition to SMEC academic staff involved in the teaching of postgraduate programs. The results from the various sources of data were summarised within the conceptual framework adopted for the study that included professional, personal, and social development, in addition to the institutional influences of education systems.

The triangulation of data from the various data collection instruments identified a number of clear results. While Indonesian and Australian participants agreed with the use of student-centred teaching approaches and constructivist viewpoints on student

learning in science, clearly the Indonesian teachers mostly used teacher-centred approaches in their classrooms. The overriding reason for this approach was concern about examinations, which appear to rely heavily on memorisation, and the need to fully cover the curriculum. In contrast, the Australians tended to adopt more student-centred approaches, although in Years 11 and 12 they were constrained by a prescriptive curriculum. Additionally, Australian schools were implementing a range of teaching styles and subjects to meet local needs and demand.

These approaches stem from differences in the structure of the education systems, which in Indonesia is very centralised whereas in Australia there is a reasonably high level of autonomy and therefore an environment that is more conducive to implementing new activities in classrooms and meeting local interests and needs. The interviews with SMEC staff indicated that they understood the differences and constraints operating in Indonesian and Australian science classrooms and that in effect student-centred teaching approaches were out of step with what occurs generally in Indonesian classrooms. An overriding theme emerging from the results was that the culture in Indonesia is generally authoritarian and within this environment students are encouraged to respect authority. Consequently, this makes it difficult for both students and teachers to encourage questioning and to move away from the role of having students as passive recipients of knowledge. As shown in the results, large class sizes and lack of resources perpetuate this environment. In contrast, the Australian schools were extremely well resourced and had relatively low class sizes in which students to a large extent have responsibility for their own learning.

Chapter 5 provides responses to the four research questions identified in the first chapter. From these responses a number of conclusions are made concerning the responsiveness of a science education postgraduate program conducted in Australia and the influences of differences between Australian and developing country science teachers in terms of their professional, personal and social development. A discussion of the conclusions follows, and Chapter 5 concludes with a consideration of the limitations of the study and recommendations for future research.

Chapter 5

Responses to Research Questions, Conclusions, Limitations and Recommendations for Future Research

5.1 Introduction

Many developing countries do not have in place high quality science education postgraduate programs; consequently teachers from these countries are enrolling in programs in developed countries such as Australia, the United Kingdom and the United States. Within this context, a number of authors have raised concerns that these programs are not responsive to the professional development needs of developing country teachers, suggesting that participants remain unaffected by their overseas experiences (Kerrison, 1992; Lunetta & van den Berg, 1995; Morris, 1996).

In response, this thesis examined the ability of a science education postgraduate program conducted in Australia to respond to the specific needs of participants from developing countries and in particular, the differences between Australian and Indonesian science teachers in terms of their professional, personal and social development. The assumption being that programs in developed countries are largely orientated towards the needs of home-country students. The conceptual framework for the thesis is a recent approach to science teacher professional development proposed by Bell and Gilbert (1996) that provides a holistic perspective on science teacher professional development, focusing not only on individual teachers but also on the educational environment in which they operate. This perspective incorporates a number of elements of effective teacher development identified by Sprinthall et al. (1996) and Coble and Koballa (1996), including the acknowledgment of the complexities of school environments; consideration of teachers' beliefs and feelings; and the need for professional development programs to consider schools in their entirety, not just individual teachers.

The research focuses on participants from Australia and Indonesia who have completed a science education postgraduate program in Western Australia at the Science and Mathematics Education Centre (SMEC) located at Curtin University of Technology in Western Australia. These two groups were chosen because between 1988 and 1995 they were the predominant nationalities participating in SMEC programs. The research methodology and use of quantitative and qualitative research instruments was in keeping with the holistic conceptual framework adopted for the study and follows recent trends in teacher professional development research which have seen a broadening of research methodologies. The instruments used included a postal questionnaire, classroom observation schedule and structured interviews.

The study results identified factors that can enhance the responsiveness of science teacher professional development programs conducted in developed countries to the needs of teachers from developing countries. The following sections examine the responses to the research questions from which a number of conclusions are drawn and then discussed. The chapter concludes with an examination of the study's limitations and recommendations are made for future research.

5.2 Response to Research Questions

Research Question One: What differences and similarities exist between Australian and Indonesian graduates in terms of personal development with respect to their feelings about being a science teacher, and beliefs about science education?

While teachers from both groups indicated that they felt generally satisfied with their role as science teachers, they had to contend with students who were generally unenthusiastic about science. In Indonesia, this was seen to stem from the very theoretical focus of the science examinations with which the Indonesians expressed feelings of dissatisfaction. The Indonesian science teachers acknowledged that the curriculum over the years had made some progress in emphasising science process skills; however, the lack of laboratory technical support was probably perpetuating this continued focus on theory and factual recall in examinations. In Australia, the increasing school retention rates were producing classes with greater numbers of less academically able students and the current curricula were not catering to the needs

and interests of these students. The Australian science teachers in government schools felt that they increasingly had to deal with social issues in classrooms including drug-related problems and family breakdowns. These feelings were compounded by concerns about student discipline in schools located in areas of high unemployment and reliance on the social welfare system. The Australians in private schools appeared to be sheltered from these concerns as the schools were selective in their student intake and with parents paying school fees they were not catering for students from predominantly low socioeconomic backgrounds as were some of the government schools. These teachers were more focussed on enhanced student academic outcomes and less concerned with the social issues identified by their government school counterparts.

Both groups of respondents had strong beliefs in support of student-centred teaching approaches and constructivist viewpoints on student learning in science. However, in contrast to the Australian teachers, the Indonesians also had strong beliefs in the use of didactic classroom teaching approaches and non-constructivist approaches to student learning. The belief held by the Indonesians was that teacher-centred approaches were very necessary because of the limited time available to cover the science curriculum and the existence of centralised examinations that largely required recall of knowledge and application of standard formula by students. The Australians also were preparing Year 12 classes for examinations driven by a very prescriptive curriculum. While these were administered at the state level, the examination questions were traditionally targeted at a range of cognitive levels and process skills thereby avoiding the exclusive focus on factual recall as identified by the Indonesians. In preparing students for these examinations, the Australian teachers employed a range of teacher-centred and student-centred teaching methodologies that included a prescribed number of practical activities. A moderation program was in place ensuring that the required number of practical activities and appropriate range of student assessment methods were employed by teachers. These approaches therefore reinforced the beliefs held by the Australian teachers concerning the utilisation of student-centred teaching approaches. This same type of reinforcement and support for teachers' beliefs associated with the same range of teaching and assessment methodologies was not apparent within the Indonesian context. As

outlined above, the mechanisms and constraints in operation which included large class sizes and examinations requiring factual recall perpetuated the use of didactic approaches and encouragement of rote memorisation.

Research Question Two: What differences and similarities in professional development in terms of classroom practices generally, and the introduction of new teaching activities, exist between Australian and Indonesian graduates?

While the results identified a number of general similarities in classroom practice in the areas of whole class discussion and use of activity sheets for example, there were a number of very significant differences between the Indonesian and Australian graduates. In support of the very strong beliefs about the use of didactic teaching approaches expressed in the postal questionnaire responses, the classroom observation and interviews in Indonesia confirmed the very formal teacher-centred approaches adopted by the Indonesians. These were in contrast to the less formal student-centred classroom practices used in Australia as shown in the data produced from the interviews and classroom observation. These observations confirmed the findings produced by the postal questionnaire indicating that the Australians held beliefs that strongly supported student-centred teaching approaches, as did the Indonesians; however, the Indonesians were also strongly in favour of didactic teaching approaches whereas the Australian beliefs did not support these approaches. Therefore, the results indicated that the classroom teaching practices of the Indonesian participants were very formal and teacher-centred, whereas for the Australians these were less formal and involved more student-centred approaches.

In terms of the introduction of new teaching activities, both groups were generally more comfortable in an environment where all teachers within a school used the same teaching activities for a particular science topic. However, there were differences between the two groups as to why this was the preferred situation. The Indonesians indicated that this was in response to the constraints imposed by a very prescriptive curriculum, external examinations and the overriding culture that expects conformity, both within the education system and society generally. The education system was described as being very centralised and authoritarian in nature and within this environment there was neither the encouragement of individualism

nor the introduction of new teaching activities. In contrast, while the same constraints may apply for Tertiary Entrance Examination (TEE) subjects, the Australian teachers delivered a wider range of subjects between Years 8 to 12 with various assessment requirements that generally allowed greater freedom in introducing new teaching activities. Groups of teachers within a particular school, or individuals themselves, had the freedom to design and implement new teaching activities and assessment approaches appropriate to their students. However, for reasons of convenience, the results indicated that the Australian participants generally preferred to use similar teaching activities as their colleagues do. This generally followed a process where teachers in a particular school reached a consensus on the particular teaching activities and assessment approaches to be adopted.

Research Question Three: What differences and similarities in social development in terms of their ways of relating to other teachers, and notions of teacher development exist between Australian and Indonesian graduates?

The results suggest a number of significant differences in the way Indonesian and Australian teachers relate to their colleagues. Generally, the Australians reported more frequent interaction with their fellow teachers across a range of locations within schools generally, their classrooms and outside of school. However, while occurring less frequently, the Indonesians rated these interactions as being more important than the Australians in terms of teacher development. This appears to be related to their more frequent involvement when compared to the Australians with in-service activities, which for the Indonesians generally occurred every three weeks in the MGMP (*Musyawarah Guru Mata Pelajaran*) program. These in-service activities were entirely focussed on responding to the science curriculum and student evaluation requirements of the current teaching program. All of the Indonesian participants in the study were either current in-service trainers on the MGMP program or had significant involvement in the past. Additionally, while Australian teachers are normally expected to be in attendance at school, for example between 8:30AM and 3:30PM, in Indonesia teachers often hold multiple teaching positions in different schools (van den Berg, 1993) and therefore are less likely to have the opportunity to engage with other teachers in one particular school. In effect, the only

opportunity for this to occur is during the regular MGMP in-service sessions and consequently this engagement is likely to be formal in nature as evidenced by the questionnaire responses from the Indonesians. This is in contrast to the ad hoc and spontaneous interactions that were reported to frequently occur among Australian teachers out of school and as they moved between classes.

The notion of teacher professional development for the Indonesians was very academic in nature and with significant importance being attached to formal sources of teacher development such as reading and lectures. Additionally, other elements including student examination results and support from the school principal were considered as being important by the Indonesians. Again, this highlights the very formal and centralised nature of the Indonesian education system and these notions are probably reinforced by the MGMP program which is compulsory and appears to have as its focus the standardisation of teaching approaches related specifically to the science curriculum and expectations produced by the examination system. In contrast, the notion of teacher professional development held by the Australians was less formal and less structured, as evidenced by the types of activities available and the voluntary participation. These activities ranged from hands-on type activities, for example data logging with graphics calculators, to broader personal enrichment type activities including for example visits to scientific establishments. Consequently, the general notion of teacher professional development among the Australians was broader, more eclectic in content and with a focus on broad personal development as opposed to the narrow focus on curricula and student learning outcomes evident among the Indonesians.

Research Question Four: What are the influences of the structure of the educational system, school management, and availability of teacher development programs on Indonesian and Australian graduates?

The results indicate that a large impact on Indonesian and Australian science teachers is the education system in which they operate. In Indonesia, the system is highly centralised, dominated by the national science curricula and examinations and does not cater specifically to local student needs. In contrast, the relatively high degree of autonomy seen in Western Australian schools allows responses to local needs.

Consequently, teachers in Australian schools have the capacity to undertake significant decision making within the broad frameworks provided by state education authorities.

The site visits and interviews with teachers highlighted the vast differences between the fiscal resources and facilities of science departments in these two countries. Schools in Indonesia have much larger classes, with 45 to 50 students being the norm, and there is no availability of a wide selection of student textbooks as in Australian science classrooms. In contrast to Australia, the role and availability of school science laboratories in Indonesia is very limited.

The education system in Australia requires science teachers to respond to a range of curriculum and assessment models, ranging from externally examined and moderated TEE science subjects to internally evaluated science subjects. Within broad guidelines, teachers have the freedom to determine what is taught in the internally evaluated subjects. Additionally, Australian teachers generally have a wide repertoire of subject skills across five secondary year levels. In contrast, the Indonesian teachers cover a narrow range of subjects and year levels, all with very similar curriculum and assessment models.

As mentioned above, the only widely available ongoing teacher development activities for Indonesian teachers are the centralised MGMP initiatives and teacher development activities conducted by the government. In contrast, the Australian teachers have the choice of attending a wide range of formal university-based teacher development programs, activities conducted in their schools by outside providers, or programs developed by commercial organisations.

The involvement of the Indonesians in the MGMP program and other government initiated professional development activities also highlighted a common characteristic of developing country participants in that often they are selected to attend overseas programs as part of a wider national initiative as was the case for example in the project described by Kerrison (1992) for chemistry teachers from the Philippines. In the current study, the Indonesian participants were involved in the

PKG project that later evolved into the MGMP initiative, which produced a homogenous group in terms of experience and background. On completing overseas studies the Indonesian participants continued as PKG Instructors or were promoted within the education system as a result of their additional academic qualifications. In contrast, Australian participants in SMEC programs are self-selecting, producing a more heterogenous group of participants and it was acknowledged by the Australians that participation in postgraduate studies had little, if any, impact on their career advancement.

The combined effect of these influences significantly impacts on teaching practices. In Indonesia, these effects appear to promote didactic and uniform teaching approaches across a centralised education system with little encouragement for trying new activities or implementing individual initiatives in classrooms. Importantly, there appears to be very little, if any, outside influence on teaching practices. The outcome is a very high level of conformity in teaching practices and opinions across the education system. Among the Australian teachers there was a more divergent range of influences and teachers implemented a range of teaching styles to meet local needs and demands in a system that encouraged autonomy within schools.

5.3 Conclusions

The conceptual framework for the study, the Professional/Personal/Social Development approach to science teacher development proposed by Bell and Gilbert (1996), is conceptualised from a social constructivist perspective, where teacher development is seen as taking place within the broad social contexts of schools and the wider society. The responses to the research questions, which are based on the conceptual framework, indicate very clearly that the Indonesians have different needs to their Australian counterparts in terms of their professional, personal and social development. These differences were demonstrated in;

(a) the differences in terms of the Indonesians' extensive beliefs in and use of didactic and formal teaching methodologies,

(b) limitations on the introduction of new teaching activities into Indonesian classrooms,

(c) the more frequent and extensive informal teacher interaction among Australian teachers,

(d) a more centralised and formal education system in Indonesia in contrast to the increasing autonomy seen in Australia, and

(e) a more flexible and less formal teacher professional development approach in Australia focussing on personal development as opposed to the curriculum and assessment focus seen in Indonesia.

In addition, there are vast differences between the Indonesian and Australian education systems in which these teachers operate and these differences are impacting on classroom teaching practices and teacher beliefs about science education, with the effect of reinforcing many of the different beliefs outlined above between the Indonesian and Australian participants. Further, the Indonesian participants were nominated and financially supported by their government to attend the SMEC postgraduate program as part of a broader national teacher professional development project. On their return home, the Indonesians were expected to participate in this national teacher professional development initiative which was perceived as a positive factor in career enhancement. In contrast, the Australians self-selected to attend SMEC with the knowledge that the postgraduate qualification would have little direct impact on their career.

Within the context of teachers' professional, personal and social development therefore, the findings demonstrate that in terms of day-to-day teaching practices the Indonesian participants have remained largely unaffected by their SMEC experience. Demonstrating this point, the Indonesian case study provided in Chapter 4 documents the "demonstration" of a student-centred lesson in which the teacher openly acknowledged that under normal circumstances this approach was not sustainable due to the very prescriptive curriculum and demands from external examinations, a situation which is common in Indonesia (Mahady, Wardani, Irianto, Somerset, & Nielson, 1996; Na'im, 1995). Similarly, the postal questionnaire results and teacher interviews showed that while Indonesian teachers generally understood and agreed with student-centred teaching approaches and constructivism, in practice they adopted more didactic methods, again in response to curriculum constraints and

external examinations. These teachers are therefore in the very unenviable situation of realising the cognitive benefits of student-centred teaching practices, but at the same time under pressure to have students perform well in national examinations that require factual recall and routine calculations. Their response is to put into practice the didactic teaching approaches and rote learning that they used prior to postgraduate studies. From the teachers' perspective, this is a sensible approach as these more prescriptive and top-down classroom methodologies are seen as being a lot less time consuming than student-centred approaches in classes of around 50 students. Additionally, from a cultural perspective, some teachers and students may feel uncomfortable or threatened by the dynamics and demands of student-centred activities. In effect then, the day-to-day teaching practices of these Indonesian teachers largely remain unaffected by their teacher development experiences at SMEC.

In contrast, the Australians operate within a system that is conducive to student-centred teaching approaches and more in line with the theoretical frameworks presented as components of the postgraduate program at SMEC. These theoretical frameworks were supported by academic literature that is primarily based on research done in developed country classrooms, including Australia. This is not the case for developing country participants and Gray (1999) suggests that work done in developing countries may not be reported widely in the academic literature as this may not always be aligned with the acceptance criteria established by editorial boards. However, there are some exceptions, with several publications having a developing country focus, including, for example the *Journal of Science and Mathematics Education in Southeast Asia* and the *South Pacific Journal of Teacher Education*. However, more significant is that within the educational environment described in the data for the Australian participants there is the capacity to experiment with and implement any new teaching practices and theoretical frameworks gained from their experience at SMEC.

The results therefore support the conclusion that the ability of a science education postgraduate program conducted in Australia to meet the needs of all participants will be influenced by differences between Australian and developing country science

teachers in terms of their professional, personal and social development. The findings support the concerns raised by various authors (Kerrison, 1992; Lunetta & van den Berg, 1995; Morris, 1996) that these types of programs may not be responsive to the professional development needs of developing country teachers and that essentially participants remain unaffected by their experience overseas. While the above conclusions focus on the differences between Indonesian and Australian teachers, and while acknowledging that these differences are important, it is not intended that the above conclusions present science teachers from developing countries as being deficient in any way. As discussed below, in recognising that these differences are a program strength, the challenge for science education postgraduate program providers is to enrich the overall delivery of programs to meet the needs of both developed and developing country participants.

5.4 Discussion and Recommendations for Teacher Development

Even though convenient for the university, it is therefore evident on the basis of the above conclusions that a predetermined science education postgraduate program structure that is expected to meets the need of all participants is unsuitable. While largely meeting the needs of Australian participants, the conclusions above indicate that this was not the case for the Indonesians. Therefore, an approach is required that allows the negotiation and tailoring of programs to meet individual and country needs. This emphasises the need for cultural specificity when considering program design, and the need to take into account the worldviews and experiences of participants from developing countries.

The above conclusions point very strongly to the need for science education postgraduate program providers to adopt a constructivist pedagogical perspective in program planning and design. Here, program implementation becomes a cooperative partnership incorporating individual needs and the needs of the home-country education system. As pointed out in Chapter 1, this approach avoids the inherent danger of reinforcing cultural imperialism and arrogance due to the projected supposition that programs originating from developed country institutions are somehow superior.

In adopting a constructivist philosophy towards program planning, participants from developing countries on their return home should be better equipped to analyse the context of their own education system, and to identify the strengths and constraints operating within their classrooms and the education system itself. However, while this assumption is based on the premise that teachers, as professionals, are expected to display initiative and that this could be expected to occur in a supportive environment, Shaeffer (1993) suggests that these expectations and environment may not exist in many developed countries. The research results presented in Chapter 4 suggest that the Australian participants were experiencing the type of environment described by Shaeffer (1993). In contrast, the results indicate that the study participants from Indonesia returned to an education system that generally does not encourage and support the sharing of new skills and ideas.

Interviews with SMEC staff members highlighted this aspect and combined with participant interviews, demonstrated that the science teacher in-service project in which the Indonesians were involved in Indonesia was itself out of step with the general classroom environment in Indonesia The main reason for this was that the PKG project had never become fully institutionalised and was one of many projects, each with external priorities and individual project design parameters, that was administered in an *ad hoc* approach to teacher professional development in Indonesia. SMEC academic staff involved in delivering the postgraduate program were well aware of this situation; a recurrent theme throughout their interviews were the difficulties involved in having the Indonesians explain clearly what their needs were within this complex environment.

In attempting to address these needs, the SMEC staff, as have a number of authors (Jegede, 1995; Ogawa, 1986; Shaeffer, 1993), recognised that science education theories and practice are culture-bound and context-dependent. Consequently, the general exposure of developing country participants to theoretical frameworks may have had some benefit in enhancing the understanding of new approaches to teaching. Maximum benefit could only be obtained if the central focus, as reasonably as was practicable, was the home-country education system. Here, program content

would be compatible with the beliefs, value system, and sociocultural environment from which developing country students originate. The challenges presented to participants would therefore be realistic and viable in their own cultural context, and not only in the culture of the institution providing the program. Considering the program presented to the Australian participants, all of the above criteria relating to home-country education system, beliefs, value systems and socioeconomic environments would have been met during by their experiences at SMEC.

However, as identified above, the situation for the Indonesians was different and the interviews with SMEC staff indicated that despite repeated attempts and obvious frustrations, it was difficult for the Indonesians to delineate areas of need that they felt were important in their classrooms. Even if they had, with the limited coverage in the academic literature of science teacher professional development in developing countries, literature searches and reviews would not have supported these concerns. Gray (1999) highlights a very serious constraint on academic literature that is exercised by editors, and this may conceivably extend to academic staff in institutions providing science education postgraduate programs. Gray (1999) suggests that:

> Value judgements are exercised by editors and editorial boards about what is acceptable for publication or not and it is conceivable that valuable work done in developing world contexts may not always fit their criteria and will not be published. (p. 266)

Consequently, there may not be available the theoretical frameworks within which academic staff are comfortable to work within when presenting academic programs in science education. Within this environment, it appears that the Indonesians remained focussed on demonstrating the benefits of the PKG student-centred teaching methodologies, which were underpinned by student-centred teaching approaches, and which were therefore compatible with the theoretical frameworks presented by SMEC. However, as mentioned previously, the focus of the PKG on student-centred classroom methodologies was out of step with the wider educational environment in Indonesia. Within these constraints, it is therefore difficult to facilitate a holistic focus on needs, especially in those areas of need imposed by the contextual conditions identified by the research data which included the examination

system, large class sizes and overloaded curriculum, all of which are common constraints in many developing countries. As suggested by Shaeffer (1993), the needs and problems of these developing country participants should not have been impacted on by such constraints. The findings further highlight the need for a participatory approach facilitating a process whereby program participants can identify issues directly relevant to the day-to-day realities of their classroom.

However, even if some of these needs had been recognised, further constraints are introduced where academic staff are not familiar with the culture, school environment and language of the student's country. This makes validation of needs difficult and the production of suitable content material extremely difficult. Again, these needs may not be adequately supported by the academic literature. Consequently, these constraints and concerns probably steer students and academic staff towards areas that are less culturally sensitive and more familiar to the academic staff and prevalent in the science education literature of developed countries. The research data presented above, and especially the interviews with SMEC staff, suggests that this is exactly what occurred. At no point was a collaborative approach taken with the academic staff and Indonesians working together to develop additional or more appropriate new teaching methodologies designed to overcome some of the constraints identified by the research data. However, the SMEC staff acknowledged that this would have been a desirable approach if it could have been facilitated, but the Indonesian participants tended to defer to the experience and authority of the SMEC staff.

In practical terms, addressing some of the above issues and implementing a constructivist philosophy in program planning can only be addressed by insisting that at least some of the academic staff involved have extensive experience in both developed and developing countries. This experience should be "hands-on" and not simply restricted to brief visits or one-of workshops. These short visits do not provide the required comprehensiveness in understanding the complexity of educational environments, which often extends beyond the classroom. A practical solution suggested by George (1996) is the establishment of close links between faculties in developed and developing countries. This could be extended to staff

exchanges, especially placements in centres such as SMEC of developing country academics that have completed a PhD and are currently working as change agents in their home country. On the one hand, this would certainly provide developed country institutions with an up-to-date perspective on science teacher development imperatives in developing countries. On the other hand, it would have the additional benefit of facilitating the implementation of a postgraduate program that was truly planned and implemented from a constructivist pedagogical perspective. This approach would be in keeping with the concept of collaborative action research, which Feldman (1995) has suggested is an effective approach for developing countries. The essential elements are the recognition of other teachers as useful resources in teacher professional development, but more importantly, the facilitation of outsider knowledge into the context of teaching practices in day-to-day classrooms.

However, even if some of the above approaches are adopted, there remains the problem of how developed country institutions can allow developing country students to conceptualise their needs and then incorporate these into a structured program. The challenge is that the needs identified may be outside the current models of science teaching and research, which predominantly originate from developed countries. Even if these needs are acknowledged, there is the further challenge for these institutions in providing for a flexible, but no less rigorous postgraduate program, that is comparable in standards to the program provided for home-country students.

The conclusions outlined above highlight the limitations of expecting that the science education content of postgraduate science education programs can be easily transferred to developing country participants. Further, in overcoming these limitations it is not simply a matter of providing a range of minor interventions or modifications in program design or content. In summary, the study has identified a number of differences and similarities in the needs of developing and developed country participants. These can be translated into a number of key indicators pointing to the level of responsiveness of science education postgraduate programs to the needs of developing country participants.

Therefore it is recommended that:

- host institutions enrolling science teachers from developing countries be fully conversant with the classroom and social contexts of societies to which the program participants will return.

- host institutions accept that in some cases the approaches used in developed countries may be inappropriate to developing countries.

- science education postgraduate program design, planning and implementation be based on a constructivist pedagogical approach involving a cooperative partnership between developing country participants and program providers.

- if programs are to be designed and implemented from a constructivist perspective to meet the needs of developing country participants, the negotiation and conceptualisation of these needs be enhanced by the involvement of academic staff with extensive experience in developing countries and academic staff from the developing country involved be attached to the institution in the developed country providing the program.

- host institutions to developing country participants have in place strategies enabling the incorporation into postgraduate programs of educational notions and frameworks originating from the developing country. These notions and frameworks are outside the science teaching and research models currently adopted in developed countries, and based on these, postgraduate programs should be designed and implemented that are as rigorous as those provided for home-country participants.

5.5 Limitations to the Study

The data gathering and analysis were carefully designed and implemented using recognised approaches for quantitative and qualitative research methods identified in

the literature. However, this type of study is subject to a range of methodological problems. Of particular concern is that the research instruments used were generally devised for developed country research, and their validity and reliability were not determined independently for developing country contexts. Further, there was not the opportunity to trial the research instruments with the target overseas group. However, the quantitative methodologies generally provided adequate reliabilities, apart from the Science Teachers Efficacy Belief Instrument (STEBI) results for the Indonesian participants.

It could also be expected that the qualitative methodologies employed were dependent on the influences of language and culture in their interpretation. For example, in many Asian cultures it is usual to offer responses that are perceived to be what the researcher would like to hear, and what is culturally or socially acceptable and it may be impolite to disclose problems to individuals outside of a particular school community (Lewin, 1990a). Political contexts also may be expected to impact on the responses given to researchers. However, given these limitations, it was found that the triangulation of data from the various instruments provided consistent findings for the Indonesian and Australian participants. The author's knowledge of Indonesian language and culture coupled with extensive in-country experience may have reduced some of the research limitations associated with the interpretation of interview responses and classroom observations identified above. Further, at the time during which interviews and observations were conducted in Indonesia, the country was experiencing major changes politically which had created a particularly open environment and as reported in the data the interviewees felt more comfortable in speaking out and being critical than they would have in the past. Therefore, it could be concluded that perhaps the limitations identified here did not have a severely detrimental effect on the quality of findings reported.

A limitation on the interpretation of teacher interviews and classroom observations was the use of a convenient sample, which for both Indonesia and Australia included teachers located in major cities. While a reasonable coverage of cities was achieved in Indonesia, the data was limited to only Perth in Western Australia. Consequently, this limitation does not allow for a wide spectrum of generalisability (Shavelson,

Webb, & Rowley, 1989) to include, for example, teachers from rural communities. Another limitation is the uniqueness of the PKG project in Indonesia and the involvement of all Indonesian participants in the study as teacher-trainers on this project. As discussed in Chapter 4, student-centred teaching approaches underpinned the PKG approach and these where a focus of the postgraduate studies at SMEC. Notwithstanding the acknowledgment by SMEC staff and the Indonesian participants that these teaching approaches were difficult to implement outside of the PKG project in Indonesia, the study findings did not include teachers from a developing country who have not had previous exposure to student-centred teaching methodologies in their own country. Consequently, caution is required in extending the research findings to teachers in other developing countries.

A limitation highlighted by Vulliamy (1990b) is the concern that the research in Indonesia was undertaken from the perspective of an expatriate researcher sponsored and legitimated by a developed country university. Within this context there is the danger of fostering "academic colonialism" (Vulliamy, 1990b, p. 233). For example, it is difficult for educators in developing countries to access the data and results of such studies, as generally these only become available through the conventional channels of academic publishing. Generally, international journals are simply not available to teachers in most developing countries. A partial solution suggested by Gray (1999) is that international journals create a special section allowing for the publication of abstracts dealing with research and development occurring in developing countries. Notwithstanding this suggestion, this does place some responsibility on the authors of journal articles for facilitating the availability of research results to researchers, educational authorities and teachers in developing countries.

5.6 Recommendations for Future Research

The research literature provides a very limited focus on science teacher professional development in developing countries. This therefore presents a very wide scope for future research. Perhaps the most compelling area for research is in the area of appropriate models of science teacher development, both within developing countries

and science education postgraduate programs offered in developed countries. Within this context, the Professional/Personal/Social Development approach proposed by Bell and Gilbert (1996) appears particularly attractive as it is conceptualised from a social constructivist perspective, recognising the significant influences on science teacher professional development of the education system and a range of elements including for example school management and the nature of teaching.

Lunetta and van den Berg (1995) provide a wide-ranging overview of problems associated with postgraduate science education programs offered to developing country participants, and these authors highlight a number of inadequacies of these programs. However, the position presented by these authors is not supported by data, or even the opinions of developing country teachers. Notwithstanding these limitations, it was a significant and worthwhile contribution to the debate and has evoked a large number of responses in the literature (Cobern, 1996). Considering the issues raised by these authors, future research efforts should involve the collection of qualitative and quantitative data from developing country participants in postgraduate science education programs. This section identifies a number of potential areas for future research.

1. Of particular concern to the author, probably resulting from personal experience in developing country classrooms, are a number of cultural issues. The major thrust of the SMEC postgraduate science education program is an emphasis on active student learning, with the focus being on student-centred teaching. This approach is diametrically opposed to the well-entrenched didactic teaching styles commonly found in many developing country classrooms. Therefore, a broad research focus is needed in the area of the pedagogical and psychological implications in these classrooms of this pedagogical shift.

2. When developing country teachers come to a foreign campus to do post-postgraduate studies they are exposed to upgrades in subject content knowledge, new teaching practices, a body of literature, and the research interests and background of academic staff. These elements will set the

parameters in which postgraduate science education participants select and conduct research projects. Within this environment, a participant who, for example, feels threatened by the concept of being asked questions by students, as could be anticipated in student-centred teaching approaches, may find little support in the literature for these concerns. This is generally not an issue in classrooms in developed countries and may not be a research interest of academic staff or a topic in science education postgraduate subjects. Additionally, it would be difficult for academics in a developed country to relate to this concern if they do not have in-depth knowledge and experience of developing country classrooms. Such issues will probably be ignored by these developing country participants in favour of more conventional and accessible topics of research, which may have little application in their home countries. Therefore, there appears to be a need for research in the area of the cultural differences and dynamics of relationships between academic staff in developed country institutions and the developing country participants in postgraduate science education programs.

3. Another area of concern is a mis-match between student-centred pedagogical approaches and the requirements of national examinations. Here, it may be useful to examine strategies that can be implemented by teachers in order to increase student achievement in examinations requiring factual recall, while at the same time developing student process skills. One possible approach is use of diagnostic testing as outlined by Paulus and Treagust (1991) and Treagust (1988) in identifying student alternative conceptions. By effectively identifying student conceptual weaknesses, teachers may be better able to plan their teaching within the time-constraints, and implement other strategies to improve student performance on national examinations.

4. There is a need to develop and validate a wide range of basic research instruments for use in developing countries. These instruments would need to be sensitive to local cultures, and should include classroom observation schedules, classroom environment questionnaires, and instruments dealing with teacher beliefs.

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Appendices

Appendix A

Postal Questionnaire

Science and Mathematics Education Centre (SMEC)
Director: Professor Barry J Fraser FAAAS FIAE FASSA FACE

curtin
University of Technology
Western Australia

GPO Box U 1987
Perth 6845
Western Australia

Kent Street
Bentley 6102
Western Australia

Date

Respondent address

Dear *(respondents name)*

I am writing to seek your cooperation in completing a questionnaire which is part of a study to evaluate the responsiveness of SMEC's science education postgraduate program to the needs of science educators in Australia and overseas. As a past graduate of SMEC you are in a position to make a significant contribution to this evaluation. The results of the evaluation may provide information to enhance the quality of science education postgraduate programs provided for teachers from both developed and developing countries.

Your response to this questionnaire will be treated confidentially. You have been assigned a code number, and once the questionnaire data have been recorded this identification coding system will be destroyed.

Space has been provided at the end of the questionnaire for any additional comments that you may care to make.

I look forward to receiving your completed questionnaire, and thank you for taking the effort and time in assisting with this project. Completed questionnaires can be returned to me using the pre-paid envelope enclosed

Yours sincerely,

Mike Thair

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Identification Label

Columns 1-6

Curtin University of Technology

Science and Mathematics Education Centre (SMEC)

Science Education Graduate Questionnaire

This questionnaire is part of a study to evaluate the responsiveness of SMEC's science education graduate program to the needs of science educators in Australia and overseas. Results of the study will be used to address concerns that science teachers from developing countries have profiles of knowledge, skills, and experiences which are different from teachers in developed countries. Increased knowledge of the differences and similarities between teachers in developed and developing countries may enhance the responsiveness of science education graduate programs conducted in developed countries.

This questionnaire consists of questions about your background, your beliefs about science teaching and learning, teacher development, classroom practice, and interaction with other teachers.

The information contained in this questionnaire will be treated confidentially. The use of code numbers will guarantee anonymity, and once questionnaire data have been recorded, identification codes and names will be destroyed.

THANK YOU FOR COMPLETING THIS QUESTIONNAIRE.
YOUR ASSISTANCE AND COOPERATION IS HIGHLY VALUED.

Mike Thair
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PART A BACKGROUND

1. Are you male or female? Male ❒ 1 Female ❒ 2 7

2. How old are you? under 30 ❒ 1 between 30-45 ❒ 2 over 45 ❒ 3 8

3. How many years have you been employed in education? _____ 9-10

4. What is the highest qualification that you hold? (Please only tick your highest qualification, and add the year of graduation) 11-13

Post Graduate Diploma	❒ 1
Masters Degree	❒ 2
PhD	❒ 3

Year of graduation 19_____

5. What do you consider yourself a specialist in? (tick a maximum of six) 14-25

Primary School	❒ 01	Lower Secondary School	❒ 08
General Science	❒ 02	Upper Secondary School	❒ 09
Mathematics	❒ 03	Chemistry	❒ 10
Physics	❒ 04	Biology	❒ 11
Administration	❒ 05	Curriculum	❒ 12
Teacher Development	❒ 06	Resource Development	❒ 13
Policy & Planning	❒ 07	Instructional Design	❒ 14
		Other (please specify below)	❒ 15

_____

6. Are you currently enrolled in a course for further qualifications? (Please give details)

_____ 26

7. What professional organisations do you belong to? _____ 27

8. How did you become enrolled in the SMEC Postgraduate program? (tick one)

Nominated by my government/department ❒ 1 My own decision to enrol ❒ 2 28

9. During the **last twelve (12) months** what is the **total** amount of time you have spent on in- service training? (Include for example attendance at professional meetings, workshops, and conferences, but do **not** include formal courses for which you received university credit.)

	(tick one)
None	❒ 1
Less than 6 hours	❒ 2
6 - 15 hours	❒ 3
16 - 35 hours	❒ 4
More than 35 hours	❒ 5

29

10. What type(s) of support have you received when attending in-service training?

	(tick all that apply)
None	❒ 1
Released time from teaching	❒ 2
Travel and/or per diem expenses	❒ 3
Stipends	❒ 4
Professional development credits	❒ 5
Others (please specify below)	❒ 6

30-35

_____

The following sections of the questionnaire require you to indicate your level of agreement or disagreement with a number of statements. There are no 'right' or 'wrong' answers. Your opinion is what is wanted.
Draw a circle around your response, 1, 2, 3, 4 or 5.

1	if you ***strongly disagree*** with the statement,
2	if you ***disagree*** with the statement,
3	if you ***neither agree or disagree*** with the statement, or are unsure
4	if you ***agree*** with the statement,,
5	if you ***strongly agree*** with the statement

PART B: INTRODUCING NEW TEACHING ACTIVITIES

When introducing new teaching activities it is important to consider if:

		Strongly Disagree				Strongly Agree
1.	The activity is in the science curriculum.	1	2	3	4	5
2.	The necessary resources are available.	1	2	3	4	5
3.	The activity is related to the exams.	1	2	3	4	5
4.	Students may become noisy.	1	2	3	4	5
5.	There is enough time in class.	1	2	3	4	5
6.	I am the only teacher doing the activity.	1	2	3	4	5
7.	If the timetable will allow it.	1	2	3	4	5
8.	The school management is supportive.	1	2	3	4	5
9	I can discuss it with another teacher.	1	2	3	4	5
10.	Students will mis-behave.	1	2	3	4	5
11.	I know what will happen in class.	1	2	3	4	5
12.	Students may write less notes.	1	2	3	4	5
13.	I will be different from other teachers.	1	2	3	4	5
14.	Students will be disadvantaged in a test if all classes do not do the same activity.	1	2	3	4	5
15.	Student workbooks in my class will be different to other classes.	1	2	3	4	5
16.	Students will ask difficult questions.	1	2	3	4	5
17.	I am unsure about the learning which is going to occur.	1	2	3	4	5
18.	I may lose control of the class.	1	2	3	4	5
19.	Too many new activities may make it difficult for students to revise for examinations.	1	2	3	4	5

Columns 7-25

PART C: TEACHERS' BELIEFS ABOUT SCIENCE TEACHING AND LEARNING

		Strongly Disagree				Strongly Agree
1	When a student does better than usual in science, it is often because the teacher exerted a little extra effort.	1	2	3	4	5
2	I am continually finding better ways to teach science.	1	2	3	4	5
3	Even when I try very hard, I do not teach science well.	1	2	3	4	5
4	When the science grades of students improve, it is often due to a more effective teaching approach by their teacher.	1	2	3	4	5
5	I know the steps to teach science concepts effectively.	1	2	3	4	5
6	I am not very effective in monitoring science experiments.	1	2	3	4	5
7	If students are underachieving in science, it is most likely due to ineffective science teaching.	1	2	3	4	5
8	I generally teach science ineffectively.	1	2	3	4	5
9	The inadequacy of a student's science background can be overcome by good teaching.	1	2	3	4	5
10	The low science achievement of some students cannot be blamed on their teachers.	1	2	3	4	5
11	When a low-achieving child progresses in science, it is usually due to extra attention given by the teacher.	1	2	3	4	5
12	I understand science concepts well enough to be effective in teaching science.	1	2	3	4	5
13	Increased effort in science teaching produces little change in some students' science achievement.	1	2	3	4	5
14	The teacher is generally responsible for student achievement	1	2	3	4	5
15	Students' achievement is directly related to their teacher's effectiveness in science teaching.	1	2	3	4	5
16	If parents feel that their child is showing more interest in science, it is probably due to the performance of the teacher.	1	2	3	4	5
17	I find it difficult to explain to students why experiments work.	1	2	3	4	5
18	I am typically able to answer students' science questions.	1	2	3	4	5
19	I wonder if I have the necessary skills to teach science.	1	2	3	4	5
20	Effectiveness in science teaching has little influence on the achievement of students with low motivation.	1	2	3	4	5
21	I would not invite the principal to evaluate my teaching.	1	2	3	4	5
22	When a student has difficulty understanding science, I usually cannot help the student understand better.	1	2	3	4	5
23	When teaching science, I usually welcome student questions.	1	2	3	4	5
24	I do not know what to do to motivate students to learn science.	1	2	3	4	5
25	Even teachers with good science teaching abilities cannot help some students to learn science.	1	2	3	4	5

Columns 7-31

PART D: TEACHER DEVELOPMENT

In my opinion, the best teacher development occurs when:

		Strongly Disagree				Strongly Agree
1.	Talking with other teachers.	1	2	3	4	5
2.	Reading education material.	1	2	3	4	5
3.	Reading scientific material.	1	2	3	4	5
4.	Listening to a lecture.	1	2	3	4	5
5.	Trying out new teaching activities.	1	2	3	4	5
6.	Acquiring new ideas for teaching.	1	2	3	4	5
7.	Sharing teaching resources with others.	1	2	3	4	5
8.	Having the support of other teachers.	1	2	3	4	5
9.	Attending a course.	1	2	3	4	5
10.	Thinking about what I will do in class.	1	2	3	4	5
11.	Keeping up-to-date with science.	1	2	3	4	5
12.	Visiting another teachers' classroom.	1	2	3	4	5
13.	Having the support of the Principal.	1	2	3	4	5
14.	Talking with students.	1	2	3	4	5
15.	Having students willingly participate.	1	2	3	4	5
16.	Evaluating the success of my lessons.	1	2	3	4	5
17.	Getting feedback from other teachers.	1	2	3	4	5
18.	Writing a new resource or unit of work.	1	2	3	4	5
19.	Watching another teacher teach.	1	2	3	4	5
20.	Sharing problems with other teachers.	1	2	3	4	5
21.	Analysing test and examination results.	1	2	3	4	5
22.	Getting feedback on changes I have made to my teaching.	1	2	3	4	5

Columns 7-28

PART E TEACHING AND LEARNING IN SCIENCE

Teaching science involves:

		Strongly Disagree				Strongly Agree
1.	Having a good knowledge of science.	1	2	3	4	5
2.	Knowing how science is done.	1	2	3	4	5
3.	Planning lessons.	1	2	3	4	5
4.	Covering the syllabus.	1	2	3	4	5
5.	Being supportive of students.	1	2	3	4	5
6.	Providing resources for students.	1	2	3	4	5
7.	Giving instructions.	1	2	3	4	5
8.	Giving knowledge to students.	1	2	3	4	5
9.	Determining the direction of lessons.	1	2	3	4	5
10.	Giving notes to students.	1	2	3	4	5
11.	Assessing students' work.	1	2	3	4	5
12.	Finding out what students are thinking.	1	2	3	4	5
13.	Helping the students to think for themselves.	1	2	3	4	5
14.	Helping students change their ideas.	1	2	3	4	5
15.	Promoting discussion by students.	1	2	3	4	5
16.	Accepting student ideas.	1	2	3	4	5
17.	Organising the groupings of students.	1	2	3	4	5
18.	Making science relevant and interesting for students.	1	2	3	4	5
19.	Listening to student ideas.	1	2	3	4	5
20.	Using student ideas in class.	1	2	3	4	5
21.	Providing worksheets for students.	1	2	3	4	5
22.	Helping students pass examinations and tests.	1	2	3	4	5

Columns 7-28

For students, learning science involves:

		Strongly Disagree				Strongly Agree
23.	Linking new ideas to existing ideas.	1	2	3	4	5
24.	Weighing up the value of a new idea.	1	2	3	4	5
25.	Practicing a skill.	1	2	3	4	5
26.	Watching a teacher demonstration.	1	2	3	4	5
27.	Thinking for themselves.	1	2	3	4	5
28.	Being involved in activities.	1	2	3	4	5
29.	Enjoying themselves.	1	2	3	4	5
30.	Memorising facts and knowledge.	1	2	3	4	5
31.	Following directions.	1	2	3	4	5
32.	Clarifying ideas.	1	2	3	4	5
33.	Being interested in what they are learning.	1	2	3	4	5
34.	Constructing new ideas.	1	2	3	4	5
35.	Using new ideas and skills with confidence.	1	2	3	4	5
36.	Co-operating with other students.	1	2	3	4	5
37.	Finding out things for themselves.	1	2	3	4	5
38.	Being motivated.	1	2	3	4	5
39.	Changing their ideas.	1	2	3	4	5
40.	Obtaining new knowledge from the teacher or book.	1	2	3	4	5
41.	Learning how-to-learn.	1	2	3	4	5
42.	Doing experiments.	1	2	3	4	5
43.	Listening to teacher explanation.	1	2	3	4	5
44.	Taking good notes for revision.	1	2	3	4	5
45.	Practicing examination questions.	1	2	3	4	5
46.	Reading textbooks.	1	2	3	4	5
47.	Doing written exercises from textbooks or activity sheets.	1	2	3	4	5
48.	Reflecting on their own ideas.	1	2	3	4	5
49.	Sitting tests and examinations.	1	2	3	4	5

Columns 29-55

The following sections of the questionnaire ask how often certain practices occur in your school. There are no 'right' or 'wrong' answers. Your opinion is what is wanted.

Draw a circle around:

1	if the practice takes place ***each lesson,***
2	if the practice takes place ***daily,***
3	if the practice takes place ***weekly***
4	if the practice takes place ***monthly,***
5	if the practice takes place ***rarely.***

PART F CLASSROOM PRACTICE

This section of the questionnaire contains statements about **practices which may take place in your classroom.**

Teaching science in my classroom involves:

		each lesson	daily	weekly	monthly	rarely
1.	Teacher demonstration.	1	2	3	4	5
2.	Teacher explanation.	1	2	3	4	5
3.	Use of media (video, film, etc).	1	2	3	4	5
4.	Students doing teacher-initiated investigations.	1	2	3	4	5
5.	Students doing self-initiated investigations.	1	2	3	4	5
6.	Small group discussions.	1	2	3	4	5
7.	Whole class discussions.	1	2	3	4	5
8.	Students doing written work (activity sheets).	1	2	3	4	5
9.	Students copying notes from the blackboard.	1	2	3	4	5
10.	Students doing library research.	1	2	3	4	5
11.	Field trips and visits.	1	2	3	4	5

Columns 7-17

PART G: FREQUENCY OF INTERACTION BETWEEN TEACHERS

From your experience, how often do the following types of interaction between teachers take place:

		each lesson	daily	weekly	monthly	rarely
1.	Borrow materials from other teachers.	1	2	3	4	5
2.	Ask my colleagues for ideas about teaching.	1	2	3	4	5
3.	Persuade others to try a new idea or approach to teaching.	1	2	3	4	5
4.	Lend materials to other teachers.	1	2	3	4	5
5.	Describe to other teachers my attempt at trying something new in the classroom.	1	2	3	4	5
6.	Design and prepare materials with other teachers.	1	2	3	4	5
7.	Ask my colleagues for help with teaching problems.	1	2	3	4	5
8.	Agree with others in my school to try a new idea in the classroom.	1	2	3	4	5
9.	Invite other teachers to observe my teaching.	1	2	3	4	5
10.	Observe other teachers in the classroom.	1	2	3	4	5
11.	Teach other teachers in formal inservice programs.	1	2	3	4	5
12.	Teach other teachers informally.	1	2	3	4	5
13.	Attend teacher inservice programs with other teachers from my school.	1	2	3	4	5
14.	Talk about my social and personal life.	1	2	3	4	5
15.	Have coffee/tea or a meal with my colleagues outside school hours.	1	2	3	4	5
16.	Ask informally what is being covered in other science classes.	1	2	3	4	5
17.	Team teach.	1	2	3	4	5
18.	Review and discuss lesson plans with other teachers.	1	2	3	4	5
19.	Give advice to other teachers.	1	2	3	4	5

Columns 7-25

PART H: PLACES WHERE INTERACTION BETWEEN TEACHERS OCCURS

From my experience, interaction with other teachers occurs:

		each lesson	daily	weekly	monthly	rarely
1.	When moving between classrooms.	1	2	3	4	5
2.	During formal teacher meetings.	1	2	3	4	5
3.	In the staffroom.	1	2	3	4	5
4.	In the office.	1	2	3	4	5
5.	In the classroom.	1	2	3	4	5
6.	After school hours.	1	2	3	4	5
7.	During staff development programs.	1	2	3	4	5
8.	At lunch time or during morning and/or afternoon tea breaks.	1	2	3	4	5

Columns 7-14

Comments

Appendix B

Teacher Interview Guide Questions

Teacher Interview Guide Questions

Name: _____

School: _____

Subjects taught: _____

Date: _____

1. What are your general feelings about **science teaching**?
2. What are your general feelings about **student learning in science**?
3. When introducing a new teaching activity, are you concerned if other teachers in your school are not using the same activity? Explain?
4. In your opinion, what is the role of student assessment in science teaching?
5. In your opinion, what are some common examples of student misbehaviour that may limit the ability of teachers to introduce new teaching activities?
6. How important is it for you to cover the science curriculum? Explain
7. Is it important for students to do well in examinations? Explain.
8. What influence do examinations have on your teaching?
9. How do you feel about students asking difficult questions? Explain, provide examples.
10. In your opinion, what are the major barriers in your school to student learning in science?

11. What role, if any, do you have in providing teacher development activities for other teachers?

12. What opportunities are available for you to pursue further studies?

Appendix C

Classroom Observation Checklist

Classroom Observation

Teacher: _____ School: _____

Class: _____ No. of students: _____

Date: _____

1. Overall classroom ethos

1.1. Does the class start on time?

1.2. Are examples of student work posted on walls, boards etc?

1.3. Are there any tables/displays/posters of science topics in the classroom?

1.4. Are these displays produced by the teacher or students?

1.5. What is the predominant strategy of student organisation: whole group teaching, small groups, independent-individualised instruction?

1.6. What are the seating arrangements in the classroom for students and teacher?

1.7. Are any rituals conducted (prayers, greetings etc) before lesson commenced?

1.8. At conclusion of lesson?

2. Teaching and learning

2.1. What is the lesson activity and teacher's strategy in opening the lesson?

2.2. What appeared to be the objective of the lesson?

2.3.	**How does the teacher facilitate learning?**	Most of time	Half of time	Minimal time	Not observed
2.3.1.	teacher led discussion	1	2	3	4
2.3.2.	teacher demonstration	1	2	3	4
2.3.3.	teacher explanation	1	2	3	4
2.3.4.	use of media (video, film, etc)	1	2	3	4
2.3. 5.	teacher-initiated investigations	1	2	3	4
2.3. 6.	students doing self-initiated investigations	1	2	3	4
2.3. 7.	tinkering	1	2	3	4
2.3. 8.	small group discussions	1	2	3	4
2.3. 9.	student explanation to the whole class	1	2	3	4
2.3.10	students discussing as a class	1	2	3	4
2.3.11	students doing written work from textbook or activity sheets	1	2	3	4
2.3.12	students copying notes from the blackboard	1	2	3	4
2.3.14	students writing their own words	1	2	3	4
2.3.15	reading textbooks	1	2	3	4
2.3.16	carrying out practicals following the instructions provided	1	2	3	4
2.3.17	students asking questions	1	2	3	4
2.3.18	students testing their own ideas	1	2	3	4
2.3.19	students solving puzzles and problems	1	2	3	4
2.3.20	students reflecting on their own ideas	1	2	3	4
2.3.21	students evaluating what they have learnt	1	2	3	4
2.3.22	teacher praises or encourages student action or behaviour	1	2	3	4

2.3.	**How does the teacher facilitate learning**?	Most of time	Half of time	Minimal time	Not observed
2.3.23	teacher accepts or uses ideas of students	1	2	3	4
2.3.24	teacher asks questions about content or procedure with the intent that a student answer	1	2	3	4
2.3.25	teacher asks rhetorical questions	1	2	3	4
2.3.26	teacher often selects students who volunteer to answer questions	1	2	3	4
2.3.26	teacher uses choral responses	1	2	3	4
2.3.27	teacher interacts with individual students	1	2	3	4
2.3.28	teacher uses a pattern for selecting students to respond to questions	1	2	3	4
2.3.29	teacher questions a student about a previous response made by another student	1	2	3	4
2.3.30	teacher directs questions to those who do not volunteer	1	2	3	4

2.4.1. Does the teacher have a lesson plan, which includes objectives and activities?

2.4.2. How rigidly was the lesson plan followed?

2.4.3. If lesson implementation varied from lesson plan, what reasons were given by the teacher for this variation?

2.5. What is the general classroom climate: authoritarian, democratic, chaotic, friendly, tense, busy, rushed, easy-going etc?

2.6. Generally, did the teacher make any attempt to evaluate learning through questioning, pupil work, etc?

2.7. Briefly, describe overall student participation in the lesson.

2.8 How was the lesson terminated?

3. General

3.1. Did the students react to the presence of an observer? How?

3.2. Did the teacher evaluate his or her own performance? How? What comments were made by the teacher regarding this evaluation?

3.3. What impression is there that the lesson observed was a "typical" science lesson? Reasons?

4. Additional comments/observations

Appendix D

Analysis of Questionnaire Responses by Individual Items

Table 1

Items Showing No Statistically Significant Differences* Between Responses from Indonesian and Australian Teachers to Part B of the Postal Questionnaire: Introducing New Teaching Activities

Item	Group	Mean	SD	*t*	*p*
2. The necessary resources are available.	Indonesian	4.33	0.88		
	Australian	4.24	.91	-0.46	.645
5. There is enough time in class.	Indonesian	4.00	0.88		
	Australian	3.71	1.05	-1.29	.199
6. I am the only teacher doing the activity.	Indonesian	2.15	1.01		
	Australian	1.78	0.84	-1.84	.068
7. If the timetable will allow it.	Indonesian	3.41	1.01		
	Australian	3.25	1.10	-0.69	.489
10. Students will mis-behave.	Indonesian	2.74	1.13		
	Australian	2.87	1.17	0.51	.609
17. I am unsure about the learning which is going to occur.	Indonesian	2.67	0.92		
	Australian	2.99	1.18	1.28	.202
19. Too many new activities may make it difficult for students to revise for examinations.	Indonesian	3.07	1.11		
	Australian	2.63	1.09	-1.82	.072

*Not significant at $p > .05$

Means ≥ 4 indicate agreement
Means ≤ 2 indicate disagreement

Table 2
Items Showing Statistically Significant Differences in Responses from Indonesian and Australian Teachers to Part B of the Postal Questionnaire: Introducing New Teaching Activities

Item	Group	Mean	SD	*t*	*p*
1. The activity is in the science curriculum.	Indonesia Australian	4.15 3.14	1.20 1.16	-3.86	*<.0001
3. The activity is related to the exams.	Indonesian Australian	4.00 2.38	0.88 1.03	-7.92	*<.0001
4. Students may become noisy.	Indonesian Australian	2.78 2.26	0.85 1.07	-2.25	*.026
8. The school management is supportive.	Indonesian Australian	4.33 3.04	0.62 1.14	-7.40	*<.0001
9. I can discuss it with another teacher.	Indonesian Australian	4.11 2.96	0.89 1.17	-4.65	*<.0001
11. I know what will happen in class.	Indonesian Australian	4.15 2.83	0.72 1.04	-7.24	*<.0001
12. Students may write less notes.	Indonesian Australian	3.23 2.08	1.07 0.98	-5.09	*<.0001
13. I will be different from other teachers.	Indonesian Australian	3.15 1.73	1.17 0.78	-7.11	*<.0001
14. Students will be disadvantaged in a test if all classes do not do the same activity.	Indonesian Australian	3.30 2.49	1.17 1.22	-2.98	*.004
15. Student workbooks in my class will be different to other classes.	Indonesian Australian	3.18 1.90	0.92 0.96	-6.09	*<.0001
16. Students will ask difficult questions.	Indonesian Australian	3.41 1.84	1.15 1.11	-6.24	*<.0001
18. I may lose control of the class.	Indonesian Australian	2.11 2.82	1.01 1.25	2.96	*.004

*Significant at $p < .05$

Means ≥ 4 indicate agreement
Means ≤ 2 indicate disagreement

Table 3

Statistical Analysis of Indonesian and Australian Responses to Statements from Part D of the Postal Questionnaire: Sources of Teacher Development, Collegiality and Interaction with Other Teachers.

Item	Group	Mean	SD	*t*	*p*
1. Talking with other teachers.	Indonesian	4.59	0.50	-1.69	.094
	Australian	4.38	0.58		
7. Sharing teaching resources with others.	Indonesian	4.59	0.57	-1.95	.054
	Australian	4.28	0.77		
8. Having the support of other teachers.	Indonesian	4.26	0.71	-0.41	.686
	Australian	4.19	0.79		
12. Visiting another teachers' classroom.	Indonesian	4.33	0.78	-2.99	*.004
	Australian	3.81	0.79		
17. Getting feedback from other teachers.	Indonesian	4.55	0.64	-3.72	*<.0001
	Australian	3.92	0.80		
19. Watching another teacher teach.	Indonesian	4.37	0.56	-3.26	*.002
	Australian	3.78	0.87		
20. Sharing problems with other teachers.	Indonesian	4.67	0.48	-3.68	*<.0001
	Australian	4.15	0.67		

* Significant at $p < .05$

Means ≥ 4 indicate agreement
Means ≤ 2 indicate disagreement

Table 4
Statistical Analysis of Indonesian and Australian Responses to Part D of the Postal Questionnaire: Sources of Teacher Development External to the School Environment.

Item	Group	Mean	SD	*t*	*p*
2. Reading education material.	Indonesian	4.55	0.58	-5.20	*<.0001
	Australian	3.76	0.72		
3. Reading scientific material.	Indonesian	4.37	0.79	-4.20	*<.0001
	Australian	3.62	0.80		
4. Listening to a lecture.	Indonesian	3.85	0.82	-4.23	*<.0001
	Australian	3.01	0.91		
9. Attending a course.	Indonesian	4.22	0.70	-4.30	*<.0001
	Australian	3.47	0.81		
11. Keeping up-to-date with science.	Indonesian	4.59	0.50	-4.13	*<.0001
	Australian	3.91	0.80		

* Significant at $p < .05$ Means ≥ 4 indicate agreement
Means ≤ 2 indicate disagreement

Table 5
Statistical Analysis of Indonesian and Australian Responses to Statements from Part D of the Postal Questionnaire: Student Involvement in Teacher Development.

Item	Group	Mean	SD	*t*	*p*
14. Talking with students.	Indonesian	4.22	0.80	-1.70	.092
	Australian	3.90	0.87		
15. Having students willingly participate	Indonesian	4.26	0.86	-1.02	.311
	Australian	4.06	0.86		

Means ≥ 4 indicate agreement
Means ≤ 2 indicate disagreement

Table 6

Statistical Analysis of Indonesian and Australian Responses to Statements from Part D of the Postal Questionnaire: Other Sources of Teacher Development.

Item	Group	Mean	SD	*t*	*p*
5. Trying out new teaching activities.	Indonesian	4.52	0.58	-1.40	.164
	Australian	4.33	0.61		
6. Acquiring new ideas for teaching.	Indonesian	4.48	0.58	-1.59	.116
	Australian	4.26	0.65		
10. Thinking about what I will do in class.	Indonesian	4.63	0.56	-2.41	*.018
	Australian	4.26	0.71		
13. Having the support of the Principal.	Indonesian	4.37	0.63	-6.02	*<.0001
	Australian	3.38	0.99		
16. Evaluating the success of my lessons.	Indonesian	4.69	0.47	-3.68	*<.0001
	Australian	4.24	0.72		
18. Writing a new resource or unit of work.	Indonesian	4.00	0.83	-0.80	.425
	Australian	3.84	0.87		
21. Analysing test and examination results.	Indonesian	4.63	0.49	-9.01	*<.0001
	Australian	3.35	0.93		
22. Getting feedback on changes I have made to my teaching.	Indonesian	4.70	0.46	-3.49	*.001
	Australian	4.21	0.67		

* Significant at $p < .05$

Means ≥ 4 indicate agreement
Means ≤ 2 indicate disagreement

Table 7

Statistical Analysis of Indonesian and Australian Responses to Statements from Part E of the Postal Questionnaire: Student-centred Teaching Approaches

Item	Group	Mean	SD	*t*	*p*
12. Finding out what students are thinking.	Indonesian	4.44	0.58	-0.06	.951
	Australian	4.43	0.64		
13. Helping the students to think for themselves.	Indonesian	4.33	0.83	2.18	*.036
	Australian	4.70	0.51		
14. Helping students change their ideas.	Indonesian	4.18	0.62	-0.17	.869
	Australian	4.15	0.84		
15. Promoting discussion by students.	Indonesian	4.59	0.50	-1.59	.115
	Australian	4.38	0.78		
16. Accepting student ideas.	Indonesian	4.15	0.72	-0.04	.968
	Australian	4.14	0.83		
18. Making science relevant and interesting for students.	Indonesian	4.74	0.45	-1.73	.088
	Australian	4.55	0.59		
19. Listening to student ideas.	Indonesian	4.52	0.51	-0.95	.345
	Australian	4.38	0.67		
20. Using student ideas in class.	Indonesian	4.18	0.56	0.24	.812
	Australian	4.22	0.75		

* Significant at $p < .05$

Means ≥ 4 indicate agreement
Means ≤ 2 indicate disagreement

Table 8

Statistical Analysis of Indonesian and Australian Responses to Statements from Part E of the Postal Questionnaire: Constructivist Viewpoints on Student Learning

Item	Group	Mean	SD	*t*	*p*
23. Linking new ideas to existing ideas.	Indonesia	4.74	0.45	-0.45	.654
	Australian	4.69	0.54		
24. Weighing up the value of a new idea.	Indonesian	4.08	0.69	1.26	.209
	Australian	4.28	0.74		
25. Practicing a skill.	Indonesian	4.52	0.51	-2.34	*.021
	Australian	4.13	0.81		
27. Thinking for themselves.	Indonesian	4.07	0.83	4.08	*<.0001
	Australian	4.64	0.53		
28. Being involved in activities.	Indonesian	4.63	0.49	-0.79	.433
	Australian	4.54	0.53		
32. Clarifying ideas.	Indonesian	4.26	0.45	1.89	.063
	Australian	4.47	0.66		
33. Being interested in what they are learning.	Indonesian	4.48	0.58	-0.89	.377
	Australian	4.35	0.68		
34. Constructing new ideas	Indonesian	4.74	0.53	-1.27	.206
	Australian	4.58	0.59		
37. Finding out things for themselves.	Indonesian	4.48	0.58	-0.14	.886
	Australian	4.46	0.64		
39. Changing their ideas.	Indonesian	4.22	0.64	-0.48	.629
	Australian	4.14	0.78		
41. Learning how-to-learn.	Indonesian	4.52	0.64	-0.35	.726
	Australian	4.46	0.75		
48. Reflecting on their own ideas.	Indonesian	4.33	0.68	1.05	.297
	Australian	4.47	0.57		

* Significant at $p < .05$

Means ≥ 4 indicate agreement

Means ≤ 2 indicate disagreement

Table 9

Statistical Analysis of Indonesian and Australian Responses to Statements from Part E of the Postal Questionnaire: Didactic Teaching Approaches

Item	Group	Mean	SD	*t*	*p*
4. Covering the syllabus.	Indonesian	4.48	0.51	-7.07	*<.0001
	Australian	3.42	1.00		
7. Giving instructions.	Indonesian	4.11	0.70	-1.12	.265
	Australian	3.92	0.77		
8. Giving knowledge to students.	Indonesian	4.04	0.76	-2.82	*.006
	Australian	3.51	1.00		
9. Determining the direction of lessons.	Indonesian	4.26	0.53	-3.97	*<.0001
	Australian	3.72	0.77		
10. Giving notes to students.	Indonesian	3.33	0.83	-1.52	.133
	Australian	3.00	1.03		

* Significant at $p < .05$

Means ≥ 4 indicate agreement
Means ≤ 2 indicate disagreement

Table 10

Statistical Analysis of Indonesian and Australian Responses to Statements from Part E of the Postal Questionnaire: Non-constructivist Viewpoints on Student Learning

Item	Group	Mean	SD	*t*	*p*
30. Memorising facts and knowledge.	Indonesia	3.92	1.03	-2.48	*.015
	Australian	3.36	1.02		
31. Following directions.	Indonesian	3.74	0.94	-0.17	.863
	Australian	3.70	0.91		
40. Obtaining new knowledge from the teacher or book.	Indonesian	4.15	0.82	-2.10	*.038
	Australian	3.76	0.84		
43. Listening to teacher explanation.	Indonesian	3.85	0.86	0.61	.542
	Australian	3.73	0.89		
44. Taking good notes for revision.	Indonesian	4.04	0.81	-2.95	*.005
	Australian	3.47	0.98		
47. Doing written exercises from textbooks or activity sheets.	Indonesian	4.48	0.64	-4.49	*<.0001
	Australian	3.58	0.97		
49. Sitting tests and examinations.	Indonesian	4.23	0.81	-4.17	*<.0001
	Australian	3.27	1.08		

* Significant at $p < .05$ Means ≥ 4 indicate agreement
Means ≤ 2 indicate disagreement

Table 11

Statistical Analysis of Indonesian and Australian Responses to Statements from Part E of the Postal Questionnaire: Other Factors Involved in Teaching Science

Item	Group	Mean	SD	*t*	*p*
1. Having a good knowledge of science.	Indonesia Australian	4.74 4.50	0.45 0.66	2.11	*.038
2. Knowing how science is done.	Indonesian Australian	4.78 4.35	0.42 0.62	-3.95	*<.0001
3. Planning lessons.	Indonesian Australian	4.59 4.35	0.50 0.68	-1.72	.088
5. Being supportive of students.	Indonesian Australian	4.33 4.55	0.55 0.59	1.67	.098
6. Providing resources to students.	Indonesian Australian	4.15 4. 33	0.66 0.6 4	1.29	.2 01
11. Assessing students work.	Indonesian Australian	4.70 3.85	0.46 0.88	-4.81	*<.0001
17. Organising the groupings of students.	Indonesian Australian	4.33 3.36	0.62 1.07	-5.73	*<.0001
21. Providing worksheets for students.	Indonesian Australian	4.18 3.32	0.74 1.04	-4.70	*<.0001
22. Helping students pass examinations and tests.	Indonesian Australian	3.74 3.51	1.06 1.15	-0.91	.367

* Significant at $p < .05$

Means ≥ 4 indicate agreement

Means ≤ 2 indicate disagreement

Table 12
Statistical Analysis of Indonesian and Australian Teachers Opinions on Other Factors Involved in Student Learning of Science

Item	Group	Mean	SD	*t*	*p*
26. Watching a teacher demonstration.	Indonesia	3.78	0.85	-1.90	.060
	Australian	3.39	0.93		
29. Enjoying themselves.	Indonesian	4.18	1.00	0.26	.799
	Australian	4.23	0.72		
35. Using new ideas and skills with confidence.	Indonesian	4.55	0.58	-0.31	.754
	Australian	4.51	0.62		
36. Co-operating with other students.	Indonesian	4.44	0.58	-0.90	.368
	Australian	4.31	0.71		
38. Being motivated.	Indonesian	4.48	0.51	-1.03	.307
	Australian	4.34	0.66		
42. Doing experiments	Indonesian	4.44	0.70	-1.55	.125
	Australian	4.20	0.69		
45. Practicing examination questions.	Indonesian	3.96	0.85	-3.09	*.003
	Australian	3.32	1.12		
46. Reading textbooks.	Indonesian	4.18	0.83	-3.49	*.001
	Australian	3.47	0.94		

* Significant at $p < .05$ Means ≥ 4 indicate agreement
Means ≤ 2 indicate disagreement

Table 13
Statistical Analysis of Indonesian and Australian Teachers Responses to Postal Questionnaire Items on Frequency of Teaching Practices

Item	Group	Mean	SD	*t*	*p*
1. Teacher demonstration.	Indonesia	3.04	1.16	0.16	.874
	Australian	3.08	1.11		
2. Teacher explanation.	Indonesian	1.70	0.77	-0.28	.783
	Australian	1.65	0.82		
3. Use of media (video, film, etc).	Indonesian	3.55	1.40	-0.27	.792
	Australian	3.48	0.75		
4. Students doing teacher-initiated investigations.	Indonesian	3.31	1.29	-2.20	*.035
	Australian	2.72	0.79		
5. Students doing self-initiated investigations.	Indonesian	3.85	1.57	-0.43	.672
	Australian	3.70	1.06		
6. Small group discussions.	Indonesian	2.26	1.06	2.30	*.023
	Australian	2.82	1.10		
7. Whole class discussions.	Indonesian	2.11	1.22	1.10	.273
	Australian	2.40	1.14		
8. Students doing written work (activity sheets).	Indonesian	2.33	1.07	1.58	.117
	Australian	2.68	0.95		
9. Students copying notes from blackboard.	Indonesian	2.54	1.58	1.97	.057
	Australian	3.21	1.23		
10. Students doing library research.	Indonesian	4.18	1.04	-1.05	.301
	Australian	3.96	0.66		
11. Field trips and visits.	Indonesian	4.92	0.38	-3.58	*.001
	Australian	4.55	0.64		

* Significant at $p < .05$ Means ≥ 4 indicates monthly or rarely
Means ≤ 2 indicates daily or each lesson

Table 14

Rotated Factor Matrix: Responses from Indonesian and Australian Teachers to Part G of the Postal Questionnaire (Frequency of Interactions Between Teachers))

Item No	Item Statement	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Alpha Reliability
2	Ask my colleagues for ideas about teaching.	0.63					
6	Design and prepare materials with other teachers.	0.71					
7	Ask my colleagues for help with teaching problems.	0.76					
8	Agree with others in my school to try a new idea in the classroom.	0.49					
18	Review and discuss lesson plans with other teachers.	0.67					
							Indo .78
							Aust .79
1	Borrow materials from other teachers.		0.81				
4	Lend materials to other teachers.		0.67				
11	Teach other teachers in formal inservice programs.		0.60				
14	Talk about my social and personal life		0.64				
16	Ask informally what is being covered in other science classes.		0.64				
							Indo .47
							Aust .64
3	Persuade others to try a new idea or approach to teaching.			0.52			
5	Describe to other teachers my attempt at trying something new in the classroom.			0.49			
12	Teach other teachers informally.			0.83			
19	Give advice to other teachers.			0.65			
							Indo .61
							Aust .77
9	Invite other teachers to observe my teaching.				0.74		
10	Observe other teachers in the classroom.				0.70		
13	Attend teacher inservice programs with other teachers from my school.				0.40		
17	Team teach.				0.65		
							Indo .56
							Aust .63

n= 102

Only factor loadings greater than 0.40 are recorded.

Table 15
Statistical Analysis of Responses from Indonesian and Australian Teachers for Part G of the Postal Questionnaire: Sharing Ideas About Teaching

Item	Group	Mean	SD	*t*	*p*
2. Ask my colleagues for ideas about teaching.	Indonesia Australian	3.63 3.33	0.84 0.98	-1.41	0.162
6. Design and prepare materials with other teachers.	Indonesian Australian	3.74 3.92	0.81 0.95	0.89	.376
7. Ask my colleagues for help with teaching problems.	Indonesian Australian	3.81 3.92	0.92 0.89	0.54	.592
8. Agree with others in my school to try a new idea in the classroom	Indonesian Australian	3.85 4.13	0.91 0.80	1.50	.137
18. Review and discuss lesson plans with other teachers.	Indonesian Australian	3.63 3.94	0.69 0.98	1.56	.121

Means $\geq$ 4 indicates monthly or rarely
Means $\leq$ 2 indicates daily or each lesson

Table 16
Statistical Analysis of Responses from Indonesian and Australian Teachers for Part G of the Postal Questionnaire: Trying New Ideas and Giving Advice about Teaching

Item	Group	Mean	SD	*t*	*p*
3. Persuade others to try a new idea or approach to teaching.	Indonesia Australian	3.74 3.81	0.98 0.82	0.35	.730
5. Describe to other teachers my attempt at trying something new in the classroom	Indonesian Australian	3.74 3.61	0.76 0.78	-0.73	.470
12. Teach other teachers informally.	Indonesian Australian	3.89 3.73	0.93 0.95	-0.75	.455
19. Give advice to other teachers in the classroom	Indonesian Australian	3.44 3.25	0.85 0.93	-0.97	.335

Means $\geq$ 4 indicates monthly or rarely
Means $\leq$ 2 indicates daily or each lesson

Table 17
Statistical Analysis of Responses from Indonesian and Australian Teachers for Part G of the Postal Questionnaire: Observation of Teaching

Item	Group	Mean	SD	*t*	*p*
9. Invite other teachers to observe my teaching.	Indonesia Australian	4.55 4.70	0.64 0.86	0.81	.423
10. Observe other teachers in the classroom.	Indonesian Australian	4.30 4.40	0.67 0.94	0.51	.609
13. Attend teacher inservice programs with other teachers from my school.	Indonesian Australian	4.22 4.67	0.89 0.55	2.43	*.020
17. Team teach	Indonesian Australian	4.52 4.50	0.80 0.98	-0.09	.930

* Significant at $p < .05$

Means ≥ 4 indicates monthly or rarely
Means ≤ 2 indicates daily or each lesson

Table 18
Statistical Analysis of Responses from Indonesian and Australian Teachers for Part G of the Postal Questionnaire: General Items Covering Interaction Between Teachers

Item	Group	Mean	SD	*t*	*p*
1. Borrow materials from other teachers.	Indonesia	4.52	0.64	-7.10	*<.0001
	Australian	3.35	0.96		
4. Lend materials to other teachers.	Indonesia	4.23	0.81	-5.48	*<.0001
	Australian	3.22	0.82		
11. Teach other teachers in formal inservice programs.	Indonesian	4.07	0.98	2.86	*.007
	Australian	4.65	0.58		
14. Talk about my social and personal life.	Indonesian	4.15	1.17	-3.76	*<.0001
	Australian	3.19	1.13		
15. Have coffee/tea or a meal with my colleagues outside school hours.	Indonesian	4.15	1.13	0.35	.727
	Australian	4.23	0.77		
16. Ask informally what is being covered in other science classes.	Indonesian	3.69	0.88	-2.41	*.018
	Australian	3.22	0.86		

* Significant at $p < .05$

Means ≥ 4 indicates monthly or rarely
Means ≤ 2 indicates daily or each lesson

Table 19

Statistical Analysis of Indonesian and Australian Teachers Responses to Postal Questionnaire Items on Places Where Interaction Between Teachers Occurs

Item	Group	Mean	SD	*t*	*p*
1. When moving between classrooms.	Indonesia	3.85	1.54	-2.94	*.004
	Australian	2.93	1.34		
2. During formal teacher meetings.	Indonesian	3.52	0.64	-0.71	.477
	Australian	3. 41	0.69		
3. In the staffroom.	Indonesian	2.70	1.17	-2.05	*.048
	Australian	2.22	0.64		
4. In the office.	Indonesian	3.63	1.21	-2.26	*.026
	Australian	2.97	1.32		
5. In the classroom.	Indonesian	4.41	0.84	-2.66	*.010
	Australian	3.84	1.19		
6. After school hours.	Indonesian	3.85	1.23	-2.65	*.012
	Australian	3.15	1.00		
7. During staff development programs.	Indonesian	3.85	0.91	1.73	.093
	Australian	4.18	0.66		
8. At lunch time or during morning and/or afternoon tea breaks	Indonesian	3.15	1.46	-3.07	*.005
	Australian	2.24	0.69		

* Significant at $p < .05$

Means ≥ 4 indicates monthly or rarely
Means ≤ 2 indicates daily or each lesson