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Exploring the potential for an alternative teacher education programme for pre-service teacher education in the Environmental Related Activities Curriculum in Sri Lanka through the Problem Based Learning approach used in one university in New Zealand

A thesis presented in fulfilment of the requirement for the Degree  
of  
Doctor of Education  
at  
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2011

## Declaration

I certify that this thesis does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any university; and to the best of my knowledge and belief it does not contain material previously published or written by another person except where due reference is made in the text.

.....

Signature

## **Abstract**

The researcher's aim was to explore the potential for an alternative teacher education programme for the Environment Related Activities Primary Pre-service Teacher Education curriculum on the basis of the Problem Based Learning approach as used in the Integrated Curriculum: Science and Technology course conducted by one University in New Zealand.

In this study, three methods of data collection were used in order to understand the main features of the Problem Based Learning approach used in the above course. Semi-structured interviews helped to capture the ideas from teacher educators involved in this particular course. To triangulate the data, a questionnaire was used to obtain the students' views on the Problem Based Learning approach and how it helped them in preparing to be quality teachers in the integrated primary school curriculum in New Zealand. Further, the researcher carried out a document analysis on several curriculum materials found in New Zealand and Sri Lanka.

From this study, the researcher found that the Problem Based Learning approach used in this particular primary teacher education course is a curriculum model based on the principles of constructive learning theories. The Problem Based Learning approach used problems as a context for students to acquire knowledge, and the students were actively engaged in learning which is authentic to the environment as all problem scenarios are from real life contexts.

The Environment Related Activities primary curriculum in Sri Lanka consists of major themes and learning activities focus on learning through the environment. All themes are related to the everyday life of the children. Similarly, in New Zealand, the primary school curriculum is based on an integrated approach. From this study, the researcher found that the Problem Based Learning approach used at one university in New Zealand, suits the integrated nature of the primary school curriculum in New Zealand. Therefore, the researcher highlights the main features of Problem Based Learning approach and explores the potential for an alternative teacher education programme for the Environmental Related Activities Primary Pre-Service teacher education curriculum in Sri Lanka.

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# **Exploring the potential for an alternative teacher education programme for pre-service teacher education in the Environmental Related Activities (ERA) Curriculum in Sri Lanka through the Problem Based Learning approach used in a New Zealand University College of Education**

## **Chapter 1.0- Introduction**

### **1.1 Background**

Teachers are one of the key elements in effective education systems and teacher education plays a vital role in preparing student teachers who are competent in the face of the challenges and complexities of teaching. Quality education is a top priority for most countries and many countries around the world seeking ways of reforming teacher education by improving teacher education programmes to empower student teachers with the necessary competencies (Gunawardana, 1996). However the literature reveals that in some instances teacher education is not as coherent as expected (Darling-Hammond, 2005; Korthagen & Kessels, 1999). Indeed, teacher education programmes have recently been criticized for failing to connect theory and practice (Darling-Hammond, 2005; Korthagen, Loughran, & Lunenberg, 2005; Korthagen, Loughran, & Russell, 2006). During the last decades this theory and practice gap has been widely discussed. Many student teachers experience problems about the relationship between theory and practice in teacher education and find theories irrelevant to the development of teacher competencies (Gunawardana, 1996; Wickramasinghe, 2004)). It is important that teacher education programmes are designed so that theory and practice are integrated in ways that will effectively prepare beginning teachers to cope with the realities of the classroom.

The researcher is a Sri Lankan Teacher educator who was previously attached to the National Institute of Education, Sri Lanka. As a teacher educator engaged in teacher education activities, she was aware of the above problems and has herself experienced

how most of the student teachers were facing problems in applying theories they learnt in the theoretical component of the teacher education programme. In other words, they lacked the knowledge and skills to deal with problems in actual classroom settings even though they had received a theoretical foundation through their teacher education programme. If student teachers could obtain this knowledge and skills by articulating problems from their own perspective and construct new knowledge that made sense to them, novice teachers would be able to face the challenges in the actual classroom more confidently. Through an extensive literature review, research and investigation the researcher learned that Problem Based Learning (PBL) is an approach that contributes to a reduction in the gap between theory and practice in teacher education (Gorden et al., 2001; Keppell, 2006; Torp & Sage, 1998). This approach uses real life problems to motivate students to identify the problems, to research information and to work collaboratively, thus creating a successful learning environment for both students and teachers (Pratt, 2007; Savin-Baden, 2000; Stepien et al., 1993). This study investigates ways to integrate theory and practice through a PBL approach. It explores the potential for an alternative teacher education programme for Sri Lanka by undertaking a critical review and analysis of the PBL approach as used at one university in New Zealand. In this introductory chapter, the researcher provides a brief overview of the research focus and the structure of the thesis.

## **1.2 Motivation for the research and current teacher education innovations in New Zealand**

Currently, in Sri Lanka, and elsewhere, many teacher educators are seeking ways to reform teacher education (Gunawardana, 1996). It would also seem evident that change in schools cannot occur without also thinking about how student teachers are prepared for their teaching roles. As a teacher educator, the researcher was involved in carrying out research in the area of teacher education and seeking ways to reduce the gap between theory and practice in teacher education.

In her previous work the researcher developed a professional development model aimed at improving teaching practice. In this model she was able to implement two techniques, peer coaching and self evaluation, as a way of developing teaching skills and providing feedback to a group of student teachers in their teaching practicum during the Post

Graduate Diploma in Education Course conducted by the National Institute of Education, Sri Lanka. She developed criteria for both self evaluation and peer evaluation to be used by student teachers who took part in the study. The two techniques of peer coaching and self evaluation worked effectively in helping the teachers make the transition from the traditional practices. Through self evaluation teachers were able to rethink the methods and practices they used in their teaching. Self evaluation encouraged the student teachers to not only reflect on their teaching but also to develop their own teaching style. This inquiry found that peer coaching and self evaluation were very effective strategies for developing the practice teaching component of the course. The two techniques were demonstrated to be very effective in overcoming the issues in the existing programme and helped to reduce the gap between theory and practice of teacher education (Wijayawardana, 2000). The successful implementation of that programme encouraged the researcher to undertake further research in the area of teacher education.

While studying the theoretical component of a Doctor of Education (Ed.D) programme at one New Zealand University the researcher's intention was to design an alternative teacher education programme for Sri Lanka using her existing knowledge of teacher education and to improve the model implemented earlier. During the block course for Advanced Professional Education at Massey University the researcher was required to give a presentation on new trends in teacher education. She therefore studied the New Zealand Education system and realised that curriculum integration had been introduced in schools and teacher training institutes in New Zealand in a similar manner to the Sri Lankan primary education system. The New Zealand curriculum specifies eight grouped skills, attitudes and values that are quite similar to the competencies described in the Sri Lankan curriculum. The skills, attitudes and values in the New Zealand curriculum and the competencies in the Sri Lankan curriculum are covered in different contexts across the curriculum. Integration is more prominent in the primary curriculum in both countries. Further, New Zealand has developed a new curriculum framework with new initiatives that would suit the needs of the children in the classroom that is quite similar to the current curriculum reforms in Sri Lanka. A description of these similarities is discussed in Chapter 2 under the literature review.

When the researcher studied the advanced directed study paper, she undertook an analysis of current literature in teacher education. Then she found that the current research in teacher education identifies a gap between what teachers are taught during their pre-service teacher education and what they are expected to do in the real classrooms in their career (Cole & Knowles, 2000; Ramsay, 2000; Sorin, 2004). In response to the perception that theory is often irrelevant to practice, various studies point out that there is a need to integrate the various component of pre-service teacher education (Leinhardt, et al., 1995, Korthagen, 2001). According to them an integrated approach is advocated to enable pre-service teachers to gain a better understanding of theory practice links. Then the researcher found that Integrated Curriculum: Science and Technology course in the primary teacher education programme conducted by one university in New Zealand has a component that is also a part of Environmental Related Activities (ERA) in Sri Lanka. This particular course focused mainly on the PBL approach and integration. Keppell (2006) writes of the benefits of PBL for teacher education and suggests that the approach is a useful means of bridging the gap between theory and practice for pre-service teachers.

The researcher was the team leader of the Environment Related Activities (ERA) curriculum for pre-service primary teacher education in Sri Lanka and she found how student teachers were facing problems in preparing themselves to teach ERA in Primary schools. Therefore she suggests PBL would be a very effective approach, as ERA, is an integrated subject across several subject disciplines and is similar to Fogarty's (1991) webbed model of integration. In the PBL approach all problem scenarios are from the real world and the researcher envisages that PBL could help in preparing student teachers to be successful in different classroom settings and geographical regions as it provides an authentic learning environment. Edwards and Hammer (2007) point out PBL is an ideal way to integrate theory and practice.

“PBL is an approach to learning that emphasizes the relationship between theory and practice ....PBL offers the potential to support the learning and developmental needs of pre-service teachers by providing a realistic and empowering learning experiences... As an approach PBL draws on many of the fundamental principles associated with constructivist and social – constructivist philosophies of learning.” (p. 15)

Therefore, the researcher studied more about the PBL approach used in the Integrated Curriculum: Science and Technology course as it is both curriculum organisation and instructional strategy that creates a learning environment in which students are active learners and teachers are coaches of student thinking and inquiry and facilitate higher levels of understanding. Further, PBL allows student teachers to become authentic stakeholders in the learning and provides them with opportunities to develop as professionals (Keppell, 2006).

Another factor that is a very important aspect of this particular programme is that Information Communication Technology (ICT) is embedded in the course. Sri Lanka is a developing country and developing ICT knowledge at the teacher college level will be beneficial to the country's education system. Under the national policy on ICT education in Sri Lanka, the Ministry of Education's vision statement is: "A new generation of Sri Lankans empowered with Information and Communication Technology facilitating the planning and implementation and sustenance of ICT in schools to enhance students learning and quality of learning" (ICT education policy, Ministry of Education, 2002). There is a six year plan under the reforms in Sri Lanka aimed at providing ICT literacy to all government teachers. The Sri Lankan Ministry of Education (MOE) has a long term objective to integrate ICT into teacher education as a tool, as a subject and as an education resource (World Bank GEP2, 1999). Therefore, an alternative teacher education programme would contribute to the integration of ICT in teacher education.

### **1.3 Focus of the study**

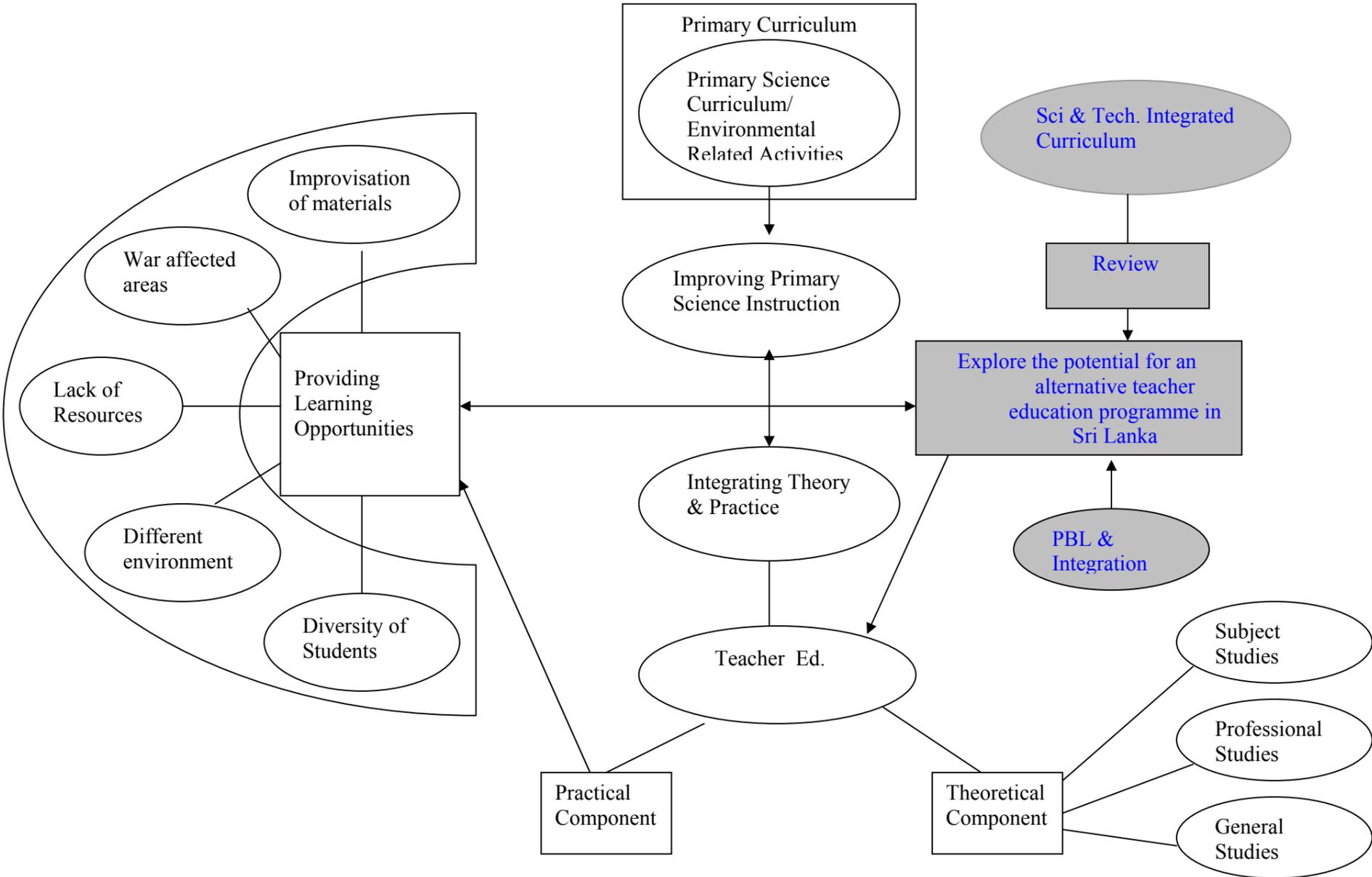
This research focused on the following research questions:

1. a) What are the main objectives of the Integrated Curriculum: Science and Technology course in Pre-service Primary Teacher Education programme conducted by one university in New Zealand?
  
- b) What are the major teaching approaches used in this integrated course?

- c) What are the student teacher expectations from taking the Integrated Curriculum: Science and Technology course?
2. What are the benefits of using the Problem Based Learning approach in teacher education?
3.
  - a) How could Problem Based Learning fulfil the objectives stated in the National Primary School Science Curriculum in New Zealand?
  - b) What are the key features that would match the primary school curricula in Sri Lanka and in New Zealand?
4. How could the Problem Based Learning approach be transferred to Pre-service Primary Teacher education in Sri Lanka?

The research structure is shown in the following diagram with the focus of the study shown in grey:

Figure1: Integrating Theory and Practice into Primary Teacher Education



To address the research questions the researcher reviewed and synthesised the literature about using a PBL approach for teacher education. The literature review provided a conceptual framework to guide the collection and analysis of data. From the data analysis, the researcher identified the main features of curriculum integration showed how the PBL approach would be beneficial to the development of teacher education. It is necessary to understand the education system and teacher education in Sri Lanka and the education and teacher education in New Zealand in order to compare and contrast both systems. Therefore, a brief overview of education in Sri Lanka and New Zealand is described in this introductory chapter.

#### **1.4 Education system in Sri Lanka**

The education system of ancient Sri Lanka was designed by the Buddhist temples and the curriculum focused mainly on improving literacy through Buddhist literature. In 1505, Sri Lanka was captured by the Portuguese and subsequently by the Dutch and British. Sri Lanka became a colony and during the colonisation period under the Dutch and British the education system of Sri Lanka was developed in a systematic way according to their requirements. In 1948 when Sri Lanka became an independent country it had an education infrastructure developed from the influence of the British Education system, which had introduced free education for large number of unprivileged children in Sri Lanka.

Systematic curriculum development commenced in the 1960s with the establishment of the curriculum development centre and several curriculum changes occurred in 1971 and 1981. Later, when the National Institute of Education (NIE) was established in 1986, curriculum development was handled by the NIE.

In 1991, the National Education Commission was formed to make recommendations about the quality of education and construct a national education policy. Major education reforms were introduced in 1997 and implemented in 1999 under the recommendations of the National Education Commission and the Presidential Task Force. The main objectives of the reforms are:

- a. extending education opportunities
- b. improving the quality of education.

In fulfilment of these main objectives, a set of basic competencies was introduced with the ultimate goal of character and nation building and to address the key issues in the existing system of education as well as the ethnic problems of the country.

### **1.5 Primary education in Sri Lanka**

Primary Education comprises three stages as follows:

Key stage 1 - Grade 1 and Grade 2

Key stage 2 - Grade 3 and Grade 4

Key stage 3 - Grade 5

The integrated nature is more prominent in the present curriculum than it was in the past due to the introduction of Environment Related Activities (ERA) that comprises the disciplines needed for the total development of the child. Primary education has been given a special emphasis in the National Education Reforms in Sri Lanka. The current primary curriculum is based on an integrated approach with emphasis on Environment-Related Activities (Education Reforms, Ministry of Education, Sri Lanka, 1999).

Key Stage 1		Key Stage 2		Key Stage 3	
Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	
First language (5 hours)	←	First Language (5 hours) English (3 hours) Second National Language (1 hour)	←	First Language (5 hours) English (3.30 hours) Second National Language (1 hour)	←
Mathematics (3.30 hours)	←	Mathematics (5 hours)	←	Mathematics (5 hours)	←
Religion (1.15 hours)	←	Religion (2 hours)	←	Religion (2 hours)	←
<b>Environmental Related Activities</b> (6 hours)	→	<b>Environmental Related Activities</b> (6 hours)	→	<b>Environmental Related Activities</b> (7.30 hours)	→

**Figure2: Primary curriculum framework and time allocation for primary grades (per week)**

ERA is a major subject in the primary curriculum. The ERA curriculum consists of major themes and all learning activities focus mainly on “learning through the environment.” The themes relate to the everyday life of the children. The philosophy that underpins this approach is that children learn more effectively when new ideas are introduced in their natural settings and surroundings. The children then construct new knowledge and develop new skills on the foundations of their past experiences in real life contexts.

### **1.6 Teacher education in Sri Lanka and in New Zealand**

Through reading and presentations at block courses the researcher realised that there are similarities in teacher education between New Zealand and Sri Lanka. Consequently, through in depth discussions with her colleagues she discovered that there are some special teacher education programmes available in New Zealand that might also be suitable for Sri Lanka. Redefining teacher education is also a main aspect of education reforms in Sri Lanka and the researcher tried to understand new trends of teacher education in order to explore the particular aspects that would be suitable for Sri Lanka.

The main purpose of teacher education in Sri Lanka and New Zealand, as elsewhere, is that of preparing effective teachers for the school system. The term teacher education is broader than teacher training and the two terms are described in the research report on initial teacher education in New Zealand (Cameron & Baker, 2004) as follows:

“Teacher training is defined as the learning of a set of skills and management techniques for teaching. Teacher education, while it may contain some aspects of training, is educative in that teachers are developed as professionals who are equipped to make sound decisions about their practice in the best interests of all students.” (p. 3)

The beginning of institutionalised teacher training in Sri Lanka occurred in 1747 under the Dutch government and it was known as “Normal Schools”. In the British period a similar school was set up by the British Rulers in Sri Lanka to train teachers. However, the first government teacher training college was set up in 1903. In 1949 Post -Graduate level teacher training was started by the University of Ceylon. The long history of teacher training in Sri Lanka consists of a variety of teacher training programmes. By the mid-1970s there were six categories of teacher training programmes including formal institutionalized, non institutionalized, non formal and continuing education in Post Graduate, Graduate and Certificate levels. The teacher education network in Sri Lanka today consists of the National Institute of Education, four Universities, 17 National Colleges of Education and four teacher education centres which are responsible for providing in-service and pre-service teacher education and the other continuing teacher education programmes.

Even though provision of in-service teacher education was available from 1747, systematic pre-service teacher education Sri Lanka did not begin until 1986 with the establishment of Colleges of Education under Parliament Act No. 30. At the beginning, six colleges were set up in 1986. The National Colleges of Education functions under the direct control of the Ministry of Education and Higher Education Sri Lanka and with the collaboration of the National Institute of Education, Sri Lanka. The establishment of Colleges of Education enables capable young people who have passed General Certificate of Examination, Advanced Level (G.C.E.) examination to be attracted to the teaching profession. This initial teacher education qualification is the National Diploma

in Teaching and it is the only pre-service institutionalised teacher education programme available in Sri Lanka. The National Diploma in Teaching consists of a two year institutional period and a one year internship period and it is offered only from the National Colleges of Education.

The aims and the objectives of the pre-service teacher education course are:

- A commitment to the rigorous training of prospective teachers for the school system
- The recognition that prospective primary and secondary teachers need to acquire a firm basis of knowledge, understanding and skill to support the effective planning, teaching and assessment of National Curriculum subjects.
- A belief in the value of developing reflective teachers, able to adopt and modify approaches in the light of changing needs and demands, and able to deliver high quality education
- A recognition of the need to address cross-curricular themes, provide preparation for national integration peaceful, co-existence, protection of environment and awareness of Human Rights and promote equality of opportunity through teaching in school.

This pre-service teacher education course is structured around four main interrelated components which develop the aspects of the profession of teaching. These components are:

- Professional component
- General component
- Specialisation component
- Extra- curricula component

The specialisation component is concerned with the development of the pre-service teacher in relation to the subject area in the school curriculum such as Primary, Science, English, and Agriculture etc. Currently, there are 20 specialisation areas available and Primary Teacher education is one of the above specialised areas. This particular research focused on exploring potential for the Environment Related activities teacher education curriculum which is a component of National Diploma in Primary Teaching offered by five of the National Colleges of Education.

The changing role of the teacher from transmission and transaction to transformation is a key aspect of any teacher education curriculum. However, several attempts had made to redefine the teacher education curriculum as a major requirement of the changing needs of the society. Environment related activities in the primary school curriculum in Sri Lanka form an integrated subject with several subject disciplines. Preparing teachers for teaching that particular subject area in primary classrooms is a challenge for National Colleges of Education in Sri Lanka. This particular study focuses on exploring potential for the above area of teacher education with special attention to the Problem Based Learning Approach used in a primary science pre-service teacher education course offered at a New Zealand University College of Education.

According to New Zealand's teacher education literature initial teacher education includes both pre-service teacher education and the two years provisional registration. Until the 1990s initial teacher education in New Zealand was limited to a small number of specialist education institutes. From 1990 onwards there was significant growth in the number of new providers and qualifications through the introduction of new funding policies and the deregulation of teacher education. At present, there are 31 providers and 156 different programmes for initial teacher education in New Zealand. Approximately 75 programmes are offered for primary school teaching and 32 for secondary teaching (Cameron & Baker, 2004). Similarly, initial teacher education in New Zealand policy and practice final report (Kane et al., 2005) provides details as follows:

“Initial teacher education in New Zealand is characterised by a range of providers (universities, colleges of education, polytechnics, private training establishments and Wananga) offering qualifications through internal face to face and alternative modes of delivery. In spite of the number of providers, universities and colleges of education prepare most teachers in New Zealand.” (p. xii)

According to Cameron and Baker (2004) there have been numerous new approaches to becoming a teacher and some programmes are heavily school-based and other programmes are external, web-based-and/or based on satellite campuses with minimal teacher educator visits.

Since 1996, both countries have worked towards improving the quality of teacher education. Further, the New Zealand Ministry of Education and the New Zealand Teachers' Council paid more attention to teaching quality and the variability of initial teacher education because of the large number of providers and their different programmes.

However, the main purpose of primary pre-service teacher education in Sri Lanka, or the initial primary teacher education in New Zealand, is to prepare effective primary teachers for teaching in primary schools in order to implement the national primary education curriculum. In both countries the primary school curriculum is based on an integrated approach, which is different from the subject oriented approach in secondary schools. The primary class teacher is required to teach all subjects in the primary education curriculum. In this regard, primary education teachers need to have a high level of competency in the basic teaching skills associated with each of the subjects and know how to integrate them in the classroom for the all around development of primary school children.

The researcher's aim was to explore the potential for an alternative teacher education programme in the ERA curriculum for pre-service primary teacher education in Sri Lanka by analysing curriculum integration and reviewing the integrated teacher education programme as taught by a New Zealand University College of Education.

### **1.7 Limitations of the study**

This particular research explores the potential for an integrated teacher education programme for the ERA curriculum which is a component of Pre-Service Primary Teacher education in Sri Lanka. Even though the ERA curriculum covers several subject areas, the research analysis focuses mainly on science with special attention to the Integrated Curriculum: Science and Technology primary teacher education programme, conducted by a New Zealand University College of Education.

## **1.8 Thesis organisation**

This thesis is organised into six chapters. This introductory chapter, Chapter 1, provides a brief overview of the research. The rationale for the study is described in this chapter as well as the background and motivation for the research and the focus of the study. A brief outline of current teacher education innovations and the integrated primary teacher education programme taught by a New Zealand University College of Education and the background of Sri Lankan education and pre-service teacher education is included. How New Zealand teacher education innovations and the new Sri Lankan teacher education programme relate to each other is also described.

Chapter 2 examines the literature on the development of teacher education, science teacher education and issues related to science teaching. The Sri Lankan primary school curriculum and primary teacher education programme and the New Zealand primary school curriculum and primary teacher education programme are discussed in order to compare and contrast these education systems. In this study the main purpose was to explore the potential for an alternative teacher education programme for the ERA curriculum in Sri Lanka using PBL. Therefore, the literature review analyses the purposes of curriculum integration and the PBL approach internationally and in New Zealand. This involves different views, definitions and models of integration and PBL.

Chapter 3 describes the research methods and processes including the research design, research procedures, data collection techniques, data analysis procedures and methods of validating the accuracy of data and ethical considerations.

To achieve the objectives of the research the researcher paid attention to the New Zealand curriculum and how it related to Sri Lanka. In order to obtain ideas about the specific type of integration that would be useful for Sri Lanka, the main features of the PBL approach used in one university in New Zealand are described in the Chapter 4, along with an analysis of the responses of the teacher educators and students of the Integrated Curriculum: Science and Technology primary teacher education course taught in New Zealand.

Chapter 5 describes the research findings and explains how and why PBL would fit the alternative teacher education programme for Sri Lanka by highlighting the key features. This chapter begins with the main features of the PBL approach that would be suitable for Sri Lanka. Addressing the research questions of how these approaches could be transferred to Sri Lanka is the most important aspect of this study and it is described with special reference to the features of the ERA curriculum. An overview and links with other curriculum areas are described later. Potential for an alternative teacher education programme including the roles of the facilitator and the student teacher are described. Student teachers' individual and group assessment procedures and criteria, with examples, are also included in Appendix XI, referring to Chapter 5.

Chapter 6 consists of conclusions, improvements, recommendations and suggestions for further research.

## **Chapter 2.0 - Literature Review**

### **2.1 Introduction**

In this chapter a review of the relevant literature provides the background information and pathway to the current study. The purpose of a literature review is to situate research ideas into the existing field and determine where the current study will add to existing knowledge (Gay & Airasian, 2003). Neuman (2000) states that a literature review integrates and summarises what is known and provides information about prior research and establishes the credibility of the researcher.

This research is mainly focused on exploring the potential for an alternative teacher education programme in the Environment Related Activities Curriculum (ERA) for pre-service teacher education in Sri Lanka by undertaking a critical review on curriculum integration using PBL as taught at a New Zealand University College of Education.

This chapter is organised around the following topics:

- Development of teacher education and the changing role of the teacher.
- Gaps between the Theory and Practice of teacher education.
- National education policy and curriculum development in Sri Lanka.
- Curriculum development in New Zealand.
- Comparing and contrasting the primary curriculum and teacher education in New Zealand and Sri Lanka.
- Effective approaches to teacher education.
- Models of integration and some different approaches to integration.
- Problem Based Learning.

This review begins with a brief overview of the development of teacher education and the necessity for the changing role of the teacher. As shown in the diagram, the researcher explains how the education reforms and curriculum development in Sri Lanka, as well as curriculum and teacher education in New Zealand, connect with the new trends in teacher education. Then the role teacher education has to play in preparing teachers according to the needs of the society is discussed including where the gaps are and how to reduce these gaps. A several models of Integration is described next and how the integrated curriculum aligns with the current trends in teacher education is discussed. Issues in science teaching and how PBL would mitigate the issues arising in science teaching and learning are also discussed. Next the special features of PBL are highlighted that make it suitable for teaching and learning science in order to justify the related literature in preparing an alternative teacher education programme for the ERA curriculum in Sri Lanka.

## **2.2 Development of teacher education**

Teacher education refers to the policies and procedures designed to equip teachers with the knowledge, attitudes, behaviours and skills they require to perform their tasks effectively in the school and classroom. In other words, the main purpose of teacher education is that of preparing effective teachers for the school system.

Hattie (2002) identified the significant impact of teachers on the learning of children and the correlation between initial teacher education and the quality of teaching and learner achievement. Equally, Cameron and Baker (2004) argue that the quality of initial teacher education has implications for the quality of teaching and learning in New Zealand. The importance of initial teacher education internationally is also discussed within the quality improvement of teaching and learning in the actual classroom.

Darling-Hammond (2006) emphasised the changes in teacher education in the 21<sup>st</sup> century and stated that previously teachers were expected to prepare a small minority of students for ambitious intellectual work, whereas they are

now expected to prepare virtually all students for higher order thinking and performance skills once reserved for only a few.

Further, she states that there are many ways of configuring the knowledge teachers may need. In articulating the core concepts and skills that should be represented in a common curriculum for teacher education, the National Academy of Education committee on teacher education adopted a framework that is organised into three intersecting areas of knowledge, as found in many statements of standards for teaching (Darling-Hammond, 2006).

To embrace the changing role teachers should have:

- Knowledge of learners and their development in the social context
- Knowledge of subject matter and curriculum goals
- Knowledge of teaching (p.11)

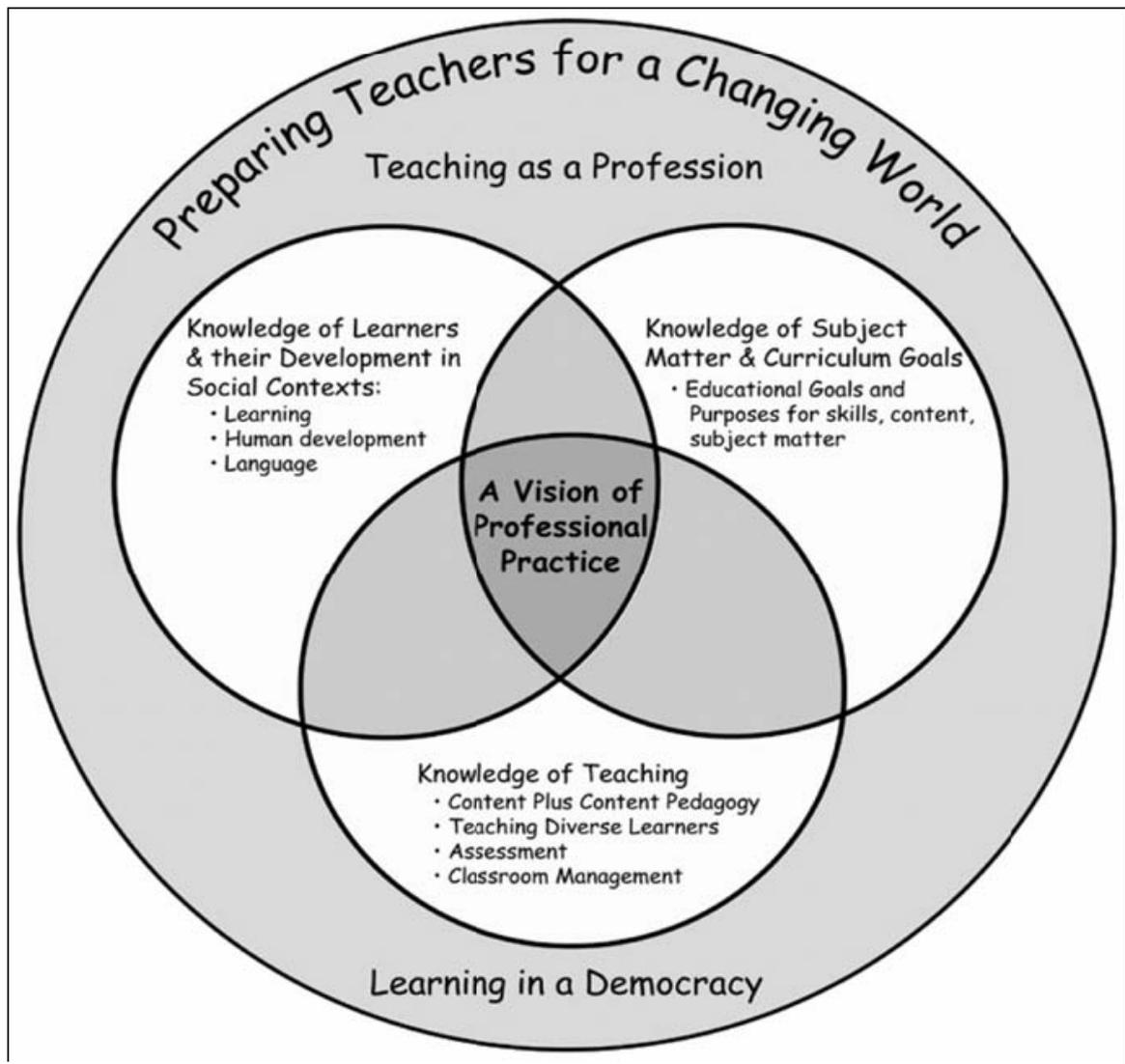


Figure 3: A Framework for understanding teaching and learning  
 Source: Darling-Hammond & Bransford (2005, p. 11).

According to the view expressed in Figure 3, teacher education involves not only gaining a set of skills and management techniques for teaching but also contains aspects of understanding students, how students learn, what they need to study and how to provide the best learning opportunities. In other words, this perspective emphasises the importance of the changing role of the teacher from the traditional teaching role to provide meaningful learning opportunities. Goodlad (1991) also recognised the importance of quality teacher education being needed when preparing teachers for the changing world. Similarly, a report published by the Australian Council for Educational Research (ACER, 2006) says that the quality of teachers is the most important

educational resource in schools and that, teacher education providers should have the capacity to provide quality teacher education.

Bridges (1999, cited in Wickramasinghe, 2004) suggests that teacher education should be focused on professional behaviour including subject matter knowledge, pedagogical knowledge and an understanding of the broader social and cultural context, communication skills and team working skills. Further, evidence from Rice (2003) shows teachers who have a solid foundation both in pedagogy and subject matter are more effective teachers and have a positive influence on their students. Shulman's (1987) categorisation of a knowledge base for teaching describes the specific knowledge needed for a good teacher. Shulman's model comprises seven components that he viewed as essential to the work of teachers. This categorisation includes:

- a. Content knowledge - understanding of the substantive structures of the field or discipline that inform the learning area (factual information and concepts)
- b. General Pedagogical knowledge - understanding of the generic features of teaching, with particular reference to classroom management, organisation and planning, teaching strategies, assessment
- c. Curriculum knowledge - knowledge of curriculum documents and programme of work
- d. Pedagogical content knowledge - an amalgam of content knowledge and pedagogy that is unique form of professional understanding held by teachers which make the comprehensible to students
- e. Knowledge of learners- knowledge of student characteristics, how students learn, motivation and developmental levels
- f. Knowledge of educational context- class size, classroom environment, community character and culture
- g. Knowledge of educational aims, goals and purposes- philosophical and historical grounds helping teachers put their own goals in a larger perspective

Shulman's categorisation offers valuable insights about teacher's knowledge. The challenge for teacher education is to provide student teachers opportunities to gain this kind of knowledge as they are expected to be able to transform this knowledge in the actual classrooms.

However, this does not always happen in practice. Darling-Hammond (1999) states that many teachers do not feel their teacher education programmes prepare them adequately for certain teaching tasks. She argues that practice is important for improving the quality of teacher education and that it is necessary to redefine teacher education programmes according to the changing role of the teacher.

Thiessen (2000) describes a three phase pedagogical framework as essential for teacher education:

- ❖ Studying about skills,
- ❖ Observing and trying out skills under simulated and actual classroom conditions,
- ❖ Comparing and developing skills in classrooms.

Thiessen (2000) argues for the necessity of connecting all three aspects in order to prepare effective teachers. He emphasises that the third phase should focus on encouraging self-evaluation, transforming new knowledge into the natural environment, providing a variety of practices inducing reflection and providing full support for use of these skills in natural settings. The idea of connections within a three-phase pedagogical framework is an essential need to developing theory/ practice links to reach the goals of teacher education.

The traditional teacher's role is to pass on to students, information, knowledge and understanding in a topic appropriate for the stage of their studies (Harden & Crosby, 2000). According to Snook (2000) there are two models of teaching. The first one describes a good teacher who has sound teaching methods, a general familiarity of with all aspects of the curriculum and the ability to control students. The other conception describes a teacher as a person who is a change agent. In addition, Harden and Crosby (2000) pointed

out that the new trends are appearing in teaching roles and states that the move to a more student-centred view of learning has required a fundamental shift in the role of the teacher. Curriculum reforms in Sri Lanka also emphasise the changing role of the teacher from the traditional teacher's role and the process of integrating theory and practice. In Sri Lanka, student teachers gain general pedagogical knowledge, subject specific knowledge and subject matter knowledge from their pre-teacher education courses (Syllabi for Primary Pre-service Teacher Education, College of Education, Sri Lanka, 1998). Although these theories are embedded in the course they are successful only when implemented in actual practice. Georg Lind (2001) also emphasises the importance in teacher education of making links between theory and practice. During the policy changes in 1998 several innovations were introduced in Sri Lanka and the integrated primary curriculum was a major change in the education system. So far, however, teacher education in Sri Lanka has not fully embraced the changing role of the teacher.

Similarly, in the research findings about initial teacher education in New Zealand 1993-2004, Cameron and Baker (2004) state that some student teachers appear to lack understanding about science and mathematics, and/or hold beliefs and attitudes about science and mathematics that may prevent them from creating positive learning opportunities for students within these subject areas. Equally, there is evidence from the international literature that teachers' limited subject matter knowledge results in distortions and significant omissions in the content of science instruction (Wittrock, 1986).

It therefore appears necessary to find new ways to rethink the development of teacher education so it would be suitable for today's education. Thus, educationalists in Sri Lanka and New Zealand, as well as elsewhere, are seeking ways to reform teacher education and improve the quality of teacher education so that teachers who have a solid foundation both in pedagogy and subject matter become more effective teachers and have a positive influence on their students' achievement. Darling-Hammond (2005) supports this notion by explaining how quality teachers can make a difference in the classroom through quality teaching.

In support of this, in the key note speech at the Problem Based Learning Symposium 2007, Pratt (2007) described eight qualities of highly effective teachers as:

- Understanding of learning - know that learning is a process of searching for meaning and influenced by prior knowledge, experience and beliefs.
- Perception of assessment - know that students' approaches to learning are influenced by their perception of how they will be assessed.
- Provision of feedback - provide students with feedback in advance of, and separate from, high stakes accountability.
- Learning environment - create a challenging but supportive learning environment.
- Role modelling - teach as much by what they do, as by what they say.
- Ways of thinking - teach through a signature pedagogy that characterises their discipline's way of working or thinking.
- Knowledge/experience – have a keen sense of their discipline or field with a deep understanding of its structure and essential questions or issues.
- Engagement - know that if students are not addressing issues, questions or problems that matter to them, answers will not matter to them.

The qualities teachers bring to the classroom can make a difference to how children learn. As Cameron and Baker (2004) describe, preparation of quality teachers for quality teaching is important and teacher education should focus on how they can make a difference in the classroom by improving the quality of teacher education. Kaplan and Owings (2002) demonstrate this idea in their book *Teacher Quality, Teaching Quality and School Improvement* and say there is significant research to indicate that the quality of the teacher and teaching are most powerful predictors of student success. Fullen (1999) also suggests that educational change depends on what teachers do and think.

Similarly, Hattie (2002) argues that in terms of learning, teachers make a difference and values the teacher and teaching as major change agents.

All these studies support the idea that the teacher has to play a major role as a change agent in making a difference in the classroom. These researchers state that integrating theory and practice of teacher education is needed to improve teacher quality and to make a difference in the classroom. Ferrini-Mundy (2002) reviewed North American teacher education over the last twenty years and pointed out the necessity of doing more research in the area of teaching and teacher education in order to address the common problems associated with teacher preparation.

### 2.2.1 Gap between theory and practice of teacher education

The literature confirms that pre-service teachers learn many strategies and methods of teaching (professional knowledge) through their University or College study. They are then required to integrate that professional knowledge to practice in the real classroom teaching. Even though student teachers learn many teaching strategies, teacher education programmes have frequently been criticised for failing to connect theory and practice (Darling-Hammond & Baratz-Snowden (2005); Korthagen, Loughran, & Lunenberg, 2005).

During the last two decades the theory-practice gap in teacher education has been widely discussed. The relationship between theory and practice is viewed as a matter of application theory (Leinhardt et al., 1995). Research on pre-service teacher education indicates that what pre-service teachers learn in their education course often does not transfer to classroom teaching (Zeichner & Tabachnick, 1985). Similarly Ball (2000) points out that

“..... although teacher education programmes help pre-service teachers to collect ideas, learning theories and develop strategies , beginning teachers often report that their professional preparation was of little use of practicability.” (p. 243)

Similarly, Korthagen and Kessels (2005, cited in Jule, 2009) also confirms that pre-service teachers learn many strategies and methods for teaching but they “do not learn how to discover in the specific situations occurring in

everyday teaching, which methods and strategies to use” (Korthagen & Kessels, 1999, p. 7). Further they have argued that traditional approaches to teacher education have been inadequate in their conception and teaching needs to be viewed through the eyes of the student teacher. According to them:

“Realistic teacher education programmes starts with the real problems encountered by the student teachers during field experiences. The student teacher would then develop his or her own knowledge in a process of reflection on the practical situations in which a personal need for learning was created.....” (p.7)

Shanker (1996, cited in Wijayawardana, 2000) also pointed out:

“Theory is unrelated to practice; content knowledge is disconnected from teaching methods; instructional practices are unrelated to learning and development” (p. 221).

Feiman –Nemser (2001) suggests that teacher education programmes need to link theory and practice and insist that the important question is “how to integrate the two in such a way that it leads to integration within the teacher” (p. 4).

In this chapter of literature review the researcher explains how teacher education connects with the primary curriculum in Sri Lanka in order to locate the research questions. The next section of this chapter provides related literature on Education policy and the primary curriculum in Sri Lanka.

### **2.3 National education policy and curriculum development in Sri Lanka**

Curriculum has been defined as a ‘structured series of intended learning outcomes’ (National Education Policy, Ministry of Education, 1999). More comprehensively, it may also be defined as:

“a course of study provided in school to include the aims, objectives, content, teaching strategies, evaluation and essential learning resources to facilitate learning and teaching of a given discipline.” (p. 11)

It serves as the plan for the teaching and learning activities not only for the teachers but also guides the teacher educators, supervisors, policy makers and others involved in the education field. However, there is a difference between the intended and the actually practiced curriculum. Societies, and the needs of

society, are changing continuously and the role of the teacher should change according to the changing conditions. Therefore, curriculum development is a complicated and a continuing process.

As mentioned in section 1.4 of this thesis, systematic curriculum development in Sri Lanka commenced in the late 1960s with the establishment of the Curriculum Development Centre. Later, with the establishment of the National Institute of Education (NIE) in Sri Lanka in 1986, it became the responsibility of the NIE. In 1999 a major curriculum revision occurred, mainly focused on the National Education Policy requirements. According to the National Education Policy major curriculum changes are introduced on the basis of the national goals of the country and the basic competencies for education. “Towards the National Education Policy” became the main slogan of quality improvement of education in the current decade (National Education Policy, Sri Lanka, 1999, p. 11).

In 1999, basic competencies for education were introduced by the National Education Commission (Reforms in General Education, 1999).

1. Competencies in Communication.
2. Competencies relating to the Environment.
3. Competencies relating to Ethics and Religion.
4. Competencies in Play and Use of Leisure.
5. Competencies relating to Learning to Learn.

Thus, in Sri Lanka, the present primary curriculum is based on the above competencies in order to fulfil the educational objectives derived from the national goals.

### **2.3.1 Environment Related Activities (ERA) curriculum in Sri Lanka**

Environment Related Activities (ERA) is a major subject in the Sri Lankan primary curriculum. The subject takes up almost one-third of the instructional time in the school day and is taught for more hours than either first language or mathematics teaching (Primary Curriculum, National Institute of Education

Sri Lanka, 1999). The Primary Curriculum Framework and Time allocation for Primary Grades are shown in Figure 2 in Chapter 1.

The ERA curriculum consists of major themes and nearly all learning activities are focused on “Learning through the Environment.” Themes are related to the everyday life of children. The philosophy that underpins this approach is the theory that children learn more effectively when new ideas are introduced in their natural settings and surroundings. The children then construct new knowledge and develop new skills on the foundation of their past experiences and in a real life context. This idea was also elaborated in the generative learning model developed by Osborne and Wittrock (1985).

To fulfil the goal above the role of the teacher in its implementation is the most important factor (Snyder et al., 1992). They further state that curriculum knowledge is created by experts outside the classroom and implementation is deemed successful when teachers carry out the curriculum changes as directed.

To ensure success of this integrated primary curriculum it is necessary to develop strength in teachers so they understand their role in the changing school curriculum. It is obvious that without developing teacher education it would not reach the goals of the new curriculum. Coates (2003) stated that teachers’ lack of pedagogical skills or lack of subject knowledge are identified as having an effect on the implementation of curriculum. Similarly, Ariav (1988) revealed that teachers’ lack of skill in how best to teach the curriculum, affected the extent and degree of implementation. Therefore, it is necessary to investigate ways to improve teaching approaches that would enhance curriculum integration in Sri Lanka; the research questions are, therefore, based on the above purpose.

The main purpose of this research was to explore the potential for an alternative teacher education programme for the ERA curriculum, based on the PBL approach used in a New Zealand University College of Education. It is necessary, therefore, to understand the key features of New Zealand

curriculum and teacher education in order to locate the research questions and find out key features that would match with the Sri Lankan context.

## **2.4 The New Zealand school curriculum**

New Zealand was first settled in 800-1000 AD by the indigenous people known as Maori. Later, New Zealand was colonised by the English crown and in 1840 a treaty was signed between the English crown and representatives of some Maori tribes. The education system was developed on the British model with an academic competitive curriculum (Davies, 1994, cited in Mutch, 2003). As mentioned in Chapter 1, Sri Lanka, also a British colony, became an independent country and the education system has developed from the influence of the British Education system. After the establishment of education through the influence of the British system there were many educational changes that occurred from time to time, both in New Zealand and Sri Lanka.

The researcher paid attention only to New Zealand curriculum innovations occurring between 1993 and 2007 as there are similarities in these curricula and the existing Sri Lankan school curriculum. The New Zealand Curriculum Framework, Ministry of Education, 1993 and Science in New Zealand documents (Ministry of Education, 1993) describe the New Zealand curriculum as ‘a set of national curriculum statements which define principles and achievement aims and objectives which all New Zealand schools are required to follow’. The New Zealand Curriculum Framework is the foundation policy statement that describes teaching, learning and assessment for all students in all New Zealand schools. Mutch (2003) describes:

“The government’s objective, broadly expressed, is that every person whatever his level of academic ability whether to be rich or poor, whether he lives in town or country has a right as a citizen, to a free education for which is best entitled and to the fullest extent of his powers. So far is this from being a mere pious platitude that full acceptance of the principle will involve a reorientation of the school education system.” (p. 41)

This curriculum document describes a set of principles for all teaching and learning in New Zealand schools as follows:

The New Zealand Curriculum:

- establishes direction for learning and assessment in New Zealand schools;
- fosters achievement and success for all students, and at each level clearly defines the achievement objectives against which students' progress can be measured;
- provides for flexibility, enabling schools and teachers to design programmes which are appropriate to the learning needs of their students;
- ensures that learning progresses coherently throughout schooling;
- encourages students to become independent and lifelong learners;
- provides all students with equal educational opportunities;
- recognises the significance of the Treaty of Waitangi;
- reflects the multicultural nature of New Zealand society;
- relates learning to the wider world (details are included in Appendix VII)

The area of essential skills of the New Zealand Curriculum Framework was reviewed and a set of key competencies was then introduced instead of essential skills. The New Zealand Curriculum 2007 describes that competencies are broader than skills and prior to the Revised Curriculum, Stocktake 2004 Report (Ministry of Education, 2004) described these categories as:

- Creative and innovative thinking.
- Participating and contributing in communities.
- Reflecting on learning and developing self-knowledge.
- Making meaning from information.
- Relating to other people.

Barker (2004), Hipkins (2004) and Bartholomew (2004) describe competencies as:

- broader than skills;
- can be very closely related to aims;
- can be very closely related to values.

According to them essential competencies provide a suitable platform for New Zealand education in each of the eight essential learning areas. As such, it is essential to develop science competencies that can be clearly seen to resonate with the essential competencies described in the revised curriculum.

## **2.5 Dynamic status of the curriculum**

Baker and Bell (1997) pointed out that the word “curriculum” has a wide meaning. Similarly, Goodson (1995) describes curriculum as a broad term and a multifaceted concept, constructed, negotiated and renegotiated at a variety of levels and in a variety of arenas. Begg (1994) also stated there are five additional aspects of the term ‘curriculum’. These five aspects are the planned, taught, learned, assessed and hidden curricula. The planned curriculum is the curriculum that a teacher plans and intends to implement in the classroom. The taught curriculum may or may not be the same as the planned one. Baker and Bell (1997) describe how the taught curriculum could differ from the planned one, with examples pointed out by Osborne and Wittrock (1985). However, students do not acquire all the concepts taught by teachers. Therefore, the learned curriculum may or may not be the taught curriculum. Osborne and Wittrock (1985) explained how the taught curriculum differs from the learned curriculum through his first hand experience. The assessed curriculum may or may not be similar to the planned, taught and learned curricula. There is a hidden curriculum and Baker and Bell (1997) describe the multi-layered and dynamic status of the curriculum. McGee (1997) also suggests different aspects of a curriculum; enacted curriculum and a received curriculum which are similar to the taught and learned curriculum described

by Begg(1994). The taught curriculum or the enacted curriculum is what actually happens rather than what is written in curriculum documents for particular subject. It is located in classrooms rather than in national policy. McGee and Fraser (2001, cited in Mutch, 2003) describe an “operational curriculum” (p. 88), which results as teachers follow through on plans and put them into action in the classroom. Therefore taught and learned curriculum is a classroom experience of teachers and students curriculum practice which is occurred in the teaching learning process in the classroom. In other words, these two aspects of a curriculum refer to what is happening in the classroom and the reality of students’ experience. It seems that curriculum innovations will not go further unless the teachers change their roles according to curriculum requirements stated in the national curriculum. This means there is a need for new approaches to the classroom and it is necessary to investigate how these new approaches would suit the innovations made in the curriculum. Swann and Brown (1977, cited in Rawaikela, 2004) found that teachers were vague when implementing the National Curriculum in Scotland because of the gap between theoretical framework and the actual practice. It is important, therefore, to undertake more extensive research to find out suitable teaching approaches for the integrated primary curriculum in Sri Lanka.

From the above literature, the researcher understood that curriculum development and implementation of a curriculum is a very complex process and it may be different from the goals set out of the initial policy document. Curriculum development cannot be done by a sudden change of a policy statement. There should be a consideration of how it is actually implemented in the school. Teachers, therefore, should be actively involved in this process. In other words, teacher education and school curriculum development should be a reciprocal and intertwined process. Wittrock (1986, cited in Coates, 2003) has shown that teachers with limited curricula knowledge in certain subjects may teach incorrect content or fail to recognise their students’ faulty understanding. Teacher educators, therefore, have a responsibility to play a key role in ensuring quality teaching and learning in order to prepare high quality teachers who are capable in providing the best learning experiences for school children.

Carless (1998) points out that:

“... if teachers are to implement an innovation successfully, it is essential that they have a thorough understanding of the principles and practice of the proposed change. It is desirable that they understand both the theoretical underpinnings and classroom application of the innovation, but it is the latter that tend to prove most essential, especially in context where teachers are not well – trained and or lack sound subject knowledge.” (p. 355)

Woldfendale (1992) also describes:

“The planning and management of the curriculum rightly belongs primarily to curriculum and subject specialists. Where collective action comes in is at points when teachers want to plan appropriate learning opportunities.” (p. 50)

Therefore, curricula reforms would not be successful if the teachers are unable to pass the changes through to their teaching. In other words, teacher education has to play a crucial role in preparing teachers to implement a new curriculum in order for the successful development of the innovation.

## **2.6 Teacher education in New Zealand**

Until the 1990s, New Zealand teachers completed their initial teacher education in one of a small number of specialist Colleges of Education. In 1990, because of the deregulation of teacher education, a competitive market was introduced. The changes in funding policies in the 1990s saw significant growth in the number of new providers and qualifications. By 2005, there were 27 providers offering 85 different qualifications.

Since 1996, there has been a series of reviews of initial teacher education, such as the Education and Science Parliamentary Select Committee inquiry, which indicated disquiet about the quality of initial teacher education in New Zealand. However, there has been no clear evidence for the concerns and, in particular, no national review of initial teacher education that takes into account the diversity of qualifications being offered.

New Zealand government policies focusing on teaching quality and anecdotal evidence about quality and variability of initial teacher education have reinforced the need for a systematic research to inform future policy and practice. In 2005, the Ministry of Education and the New Zealand Teachers Council commissioned a research programme comprising four studies. These four studies provide a comprehensive overview of the characteristics of initial teacher education in New Zealand.

**The four studies are:**

- Quality of Initial Teacher Education: Analysis of New Zealand Teachers Council Documentation. This is a small study of archived initial teacher education programme approval documents and monitoring reports held by the New Zealand Teachers Council and was conducted by Marie Cameron in February 2004.
- Research on Initial Teacher Education in New Zealand: 1993–2004. Literature Review and Annotated Bibliography. This literature review and annotated bibliography was completed by Marie Cameron and Robyn Baker of the New Zealand Council for Educational Research.
- Initial Teacher Education Policy and Practice Report (2005). This is a systematic description of initial teacher education in the early childhood, primary and secondary sectors in New Zealand. The lead researcher was Professor Ruth Kane, College of Education, Massey University.
- Perspectives of People outside Tertiary Institutions Involved in Initial Teacher Education (2005). This paper explores what those involved in teacher education, excluding providers, understand as quality initial teacher education. The lead researcher was Dr Janinka Greenwood of the Christchurch College of Education.

The Cameron report analysed documents held by the Teachers Council relating to programme approval, monitoring and moderation, entry standards, graduation standards and quality assurance mechanisms of primary and secondary teacher education programmes. The study looked at a sample of

programmes from 12 different providers and the sample reflected the different types of qualifications offered from a range of providers. The Cameron and Baker literature review included New Zealand research conducted since 1993. The Kane report (2005) was a national survey of initial teacher education qualifications in New Zealand. The data were obtained from documents provided by the initial teacher education providers and interviews with staff. The study looked at providers' qualifications in terms of the philosophy and content of the qualifications, the standards for entry, the standards for graduating and the quality assurance processes in place. It covered all providers and qualifications. However, there is no direct information about the differences in modes of delivery, for example, between campus based, distance or flexible delivery.

The Greenwood paper investigated the perspectives of people outside the provider institutions, but who were involved in initial teacher education – that is, stakeholders such as employers, principals, lead teachers and associate teachers. It included the perspectives of stakeholders in all sectors, including Māori-medium and Pasifika settings. It focused, in particular, on stakeholder perceptions of the qualities desirable in beginning teachers, stakeholder perceptions of the nature and value of the practicum and how stakeholders viewed their relationships with tertiary providers.

Taking into consideration the above literature about teacher education in New Zealand, the researcher paid attention to:

- initial teacher education programmes: content and curriculum and approaches;
- quality assurance policy and processes in New Zealand.

The four studies show the provision of initial teacher education in New Zealand is complex and diverse. The number of providers has increased significantly from the six Colleges of Education up to the 1990s to 27 providers in 2005. Cameron and Baker (2004), however, argued that quality of initial teacher education has important implications for the quality of teaching and learning in New Zealand. These reports highlights the initial teacher education in New Zealand has a fundamental goal to graduate teachers who

are able to ensure the high quality learning outcomes for all the students in each and every level. Further these reports highlight the importance of increasing higher order thinking, reasoning and student collaboration around real problems. In addition to that the responsibility of teacher education is highly emphasised.

## **2.7 Effective approach to teacher education**

National and international research shows the significant impact teachers have on the quality of teaching and learning and the correlation between initial teacher education and quality of teaching and learner achievement. Korthagen (2001) pointed out that a more effective approach to teacher education needs to provide pre-service teachers with opportunities to construct understandings of practice which draw on relevant theory to inform understandings of the teaching and learning process. In addition to that Korthagen et al. (2006) have examined effective teacher education programmes in several countries and proposed seven fundamental principles to guide the development of responsive teacher education programmes that make a difference in preparing student teachers. Similarly, Snowden (2005, cited in Jules, 2009) describes common characteristics of a coherent and effective teacher programme that include:

- a core curriculum grounded in knowledge of development, learning, subject matter pedagogy and assessment taught in context;
- well-defined standards of practice and performance used to guide the design and assessment of coursework;
- extended clinical experience that are interwoven with coursework and are carefully monitored;
- strong relationships between universities and schools that share standards of good teaching which are consistent across course and clinical work;

- the use of case study methods, teacher research, performance assessments and portfolio examinations that teachers learning to classroom practice.

On the other hand the New Zealand Teachers Council (NZTC), a government professional body which is responsible for accreditation and auditing of pre-service teacher education programmes, as well as the registration of teachers in New Zealand has published a set of seven standards for graduates entering the teaching profession. (NZTC, 2007). Graduating teachers:

- Know what to teach.
- Know about learners and how to learn.
- Understand how contextual factors influence teaching and learning.
- Use professional knowledge to plan for a safe, high quality teaching and learning environment.
- Use evidence to promote learning.
- Develop positive relationships with learners and the members of learning communities.
- Are committed members of the profession.

The first three standards focus on “professional knowledge”; standards four and five focus on “professional practice”; and the last two focus on “professional values & relationships”(NZTC,2007).

A paper presented at AARE conference, 2007, (Harris et al., 2007, cited in Jules, 2009) describes the necessity of higher standards in teacher education.

“In New South Wales and much of the developed world, the call for higher standards in teacher education has created a climate within which it is mandatory for all graduating teachers to be accredited against a consistent set of professional standards. This presents a new challenge for teacher education institutes, which now need to demonstrate that their courses provide Pre-Graduate Teachers with sufficient opportunities to attain these standards.” (p .18)

As the quality improvement of the teacher education in New Zealand, universities broadened to include more understanding of the nature of the

curriculum construction and implementation courses in Colleges of Education, New Zealand (Mutch, 2003).

The introduction of a PBL approach to the Integrated Curriculum: Science and Technology course at one university in New Zealand is an example of moving towards to a practically oriented teacher education innovation. The hand book of particular course describes how PBL focused on primary science teacher preparation in order to teach primary science curriculum in New Zealand.

Therefore, the researcher paid much attention to science teaching and the science curriculum documents available in the Ministry of Education in New Zealand as Science is an important learning area that would suit for ERA curriculum in Sri Lanka, the focus of this study.

## **2.8 Issues in science and technology teaching**

Science and technology are two of the essential learning areas in New Zealand. The format and presentation of science in the New Zealand curriculum are described in Appendix V11. According to the researcher, this is the most suitable learning area that would match the primary ERA integrated curriculum in Sri Lanka as the learning outcomes are similar. Therefore, issues in science teaching are an important aspect to consider. Figure 8 illustrates how science links with the themes in the ERA integrated curriculum. The New Zealand Council of Educational Research carried out several studies on the New Zealand primary school curriculum and revealed that most primary teachers are not confident enough to teach science (Cameron, 2004). Lack of confidence in science teaching was identified by Varely (1975) and Symington & Hayes (1989) and has been consistently reported. This appears to be shared by teachers in other countries as evidenced by many educators who research in this area (Biddulph and Osborne, 1984; Duschi & Gitomer, 1991; Bell, 2005).

Symington and Hayes (1989) noted that pre-service teachers avoided acquiring the necessary science background knowledge when preparing science lessons.

McDonald et al. (1991, cited in Rawaikela, 2004) analysed curriculum implementation in New Zealand and clearly stated that junior primary teachers frequently do not organise their lessons around science. Biddulph and Osborne (1984) pointed out that little time is devoted to teaching science and instruction is often a matter of covering topics rather than helping children learn.

A case study, Science-Technology-Society (STS) as a context and conceptual framework for identifying and developing content knowledge for teaching primary science, by Baker (1995), investigated the use of related views and perspectives. It was found that the STS approach enabled student teachers to adopt a more coherent and contemporary view of science. Even though this approach helped student teachers to gain an understanding of science concepts, the research revealed that translating these ideas into classroom practice was a difficult task for them. Yager (1996, cited in Yieng, 1999) also defined STS as the teaching and learning of science and technology in the context of human experience. Instead of a STS curriculum, STS is a context for a curriculum. In addition, STS has been regarded as an appropriate learning context for all learners. The applications of science, such as advances and issues concerning food, clothing, shelter, transportation, are close to the lives of the students (Yager, 1996, cited in Yieng, 1999). In other words, STS has been regarded as an appropriate learning context for all learners (Tobin, 1994, cited in Yieng, 1999) and it is an outlook about science education and education through the environment. Further, STS emphasises science and technology through cultural economics and social context. In this view of science education students are encouraged to learn and analyse issues pertaining to the impact of science on everyday life (Solomon, 1993, cited in Rawaikela, 2004). PBL is an approach based on constructivism that can be used to teach STS education and also address the everyday issues in the environment to gain a holistic view of the environment.

Primary school teachers, including pre-service teachers, tend to have little science content knowledge and harbour misconceptions about science (Appleton, 2003). Further, Hudson's (2004) study reveals that student teachers did not receive adequate pedagogical knowledge from their mentors. This research argues that mentors/teacher educators require pedagogical knowledge of primary science for guiding their mentee/student teachers with planning, preparation, implementation, teaching strategies, science teaching knowledge, problem solving strategies and assessment techniques.

Appleton (2003) describes how Pedagogical Content Knowledge (PCK) helps beginning primary teachers cope with science. Science PCK is a form of teacher knowledge transformed from other forms of teacher knowledge. It has inherently close links to the teacher's science content knowledge and is developed through the teachers own experiences and science teaching practices as well as the recommendations from colleagues' experiences. In developing science PCK, teachers draw on a range of other forms of teacher knowledge such as knowledge of curriculum, context, general pedagogy and children.

Hipkins (1998) argues that teachers need to have an understanding of the theoretical basis on which new scientific knowledge is constructed to offer meaningful opportunities for students. She further describes that a group of teachers from a compressed course of primary teacher education programme for graduates do not have sufficient coherent understanding about science to assist their future students.

Lewthwaite (2000) describes a similar idea from a study about primary student teacher perceptions of their previous science experience and their development during the initial teacher education course. According to Lewthwaite, after the completion of the course a majority of student teachers recognised the necessity of having further science content knowledge.

However, Salter (2000) describes a different idea from another group of pre-service primary teacher education students. This survey aimed to measure student teachers' attitudes about science, their conceptions of learning science, their perceptions of science knowledge and their ability to teach science. It

was found that the student teachers had positive-tending attitudes towards science and they felt confident about their ability to teach science even though their knowledge base was low. The author concludes that there is evidence that those with positive attitudes are more likely to devote time to teaching science. On the other hand, the author describes the lack of science knowledge in some of the cohort may lead to reluctance to teach science. Finally, the author pointed out that some findings were inconclusive and needed further study.

It, thus, appears that more research on a curriculum for teacher education is needed (Burgess, 2000). The focus for the current study lies in exploring the potential for an alternative teacher education programme for the integrated primary curriculum in Sri Lanka. As a pathway to address the research questions the researcher will compare and contrast the primary curriculum in New Zealand and Sri Lanka.

## **2.9 Comparing and contrasting the primary curricula in New Zealand and Sri Lanka**

The New Zealand Curriculum Framework (1993) describes the elements fundamental to teaching and learning in New Zealand schools. It states the principles which give direction to all teaching and learning. It specifies seven essential learning areas which describe in broad terms the knowledge and understanding all students need to acquire. The framework sets out the essential skills to be developed by all students. It indicates the place of attitudes and values in the school curriculum. It gives direction to the development of the more specific national curriculum statements which describe in more detail the required knowledge, understanding, skills, and attitudes. Finally, the framework outlines the policy for assessment at school and national levels.

Similarly, in Sri Lanka, the intended curriculum includes aims, objectives, content, teaching strategies and recommended evaluation procedures. To

achieve the national goals in Sri Lanka the foundation is focused on five sets of basic competencies. Analysis of both curricula show there are similarities in educational objectives; these are:

- Opportunities for educational attainment in keeping with the potential of each individual
- Providing an education to fulfil the national goals of the country

However, a major difference of the curriculum between New Zealand and Sri Lanka is the structure of the intended curriculum. New Zealand introduced the outcome based education (OBE) model of curriculum development in 1993. The New Zealand Curriculum Framework (Ministry of Education, 1993) document describes how New Zealand curriculum reform made a shift from content based approach to an outcome based model. The Curriculum Stocktake Report 2004 (Ministry of Education, 2004) states that a fundamental principle underpinning the New Zealand curriculum is the premise that the individual student is at the centre of all teaching and learning. The curriculum statements contain achievement objectives and some suggested learning experiences. It does not, however, list out the content to be covered. Eltis (1995) stated that this OBE approach in curriculum development is available only in a handful of countries including New Zealand, Australia, England, Canada and the United states. Further, Eltis (1995) describes OBE as successful curriculum integration, however, there is very little evidence available for supporting this view.

According to Donnelly (2006), the New Zealand curriculum has the following characteristics.

- A student approach to education.
- A constructivist view of pedagogy.
- A developmental approach to learning.
- An inquiry based approach to learning.
- An emphasis on process to the detriment of detailing essential content.

In the context of what is practised in Sri Lanka, the intended curriculum includes aims objectives, content, teaching strategies and recommended evaluation measures; it is a standard curriculum with the following characteristics.

- Separate curriculum for primary and secondary
- Based on academic disciplines
- Based on specific grade levels
- Uses methods of evaluation
- Teacher friendly and lists content to be covered

Even though the structure of the curriculum is different in both countries the key foundation for the curriculum development is based on a set of competencies.

The researcher's intention was to explore the potential for an alternative teacher education programme for an integrated ERA curriculum in Sri Lanka and so it is necessary to read the available literature about integration and models of integration in order to do understand the different methods and views of curriculum integration.

## **2.10 Integration and models of integration**

Some education philosophers and curriculum theorists (e.g. Bruner, 1973; Howey, 1996, cited in Yieng, 1999) noticed the benefits of curriculum integration. The curriculum can be integrated from general strands and principles to specific practices and contents from basic to advanced levels.

Humphreys et al. (1981) stated that integrated study is one in which children broadly explore knowledge in various subjects related to certain aspects of their environment. Similarly, Shoemaker (1991) states that an integrated curriculum cuts across subject matter lines, bringing together various aspects of the curriculum into meaningful association to focus upon broad areas of

study. It views learning and teaching in a holistic way and reflects the real world which is interactive.

Dressel's (1985) definition goes further, as according to his view an integrated curriculum planned learning experience not only provides the learners with a unified view of commonly held knowledge but also motivates and develops a learner's power to perceive new relationships and thus to create new models, systems and structures.

According to Susan Drake (2000), curriculum integration is making meaningful connections between topics or skills that are usually addressed in different subject areas. There are various definitions for the integrated curriculum. Roberts and Kellough (2000) state:

“The term integrated curriculum . . . refers to a way of teaching, planning and organizing . . . so the discrete disciplines of subject matter are interrelated and 1) match the developmental needs of the learners; 2) help to meaningfully connect the students' learning to their current and past experiences.” (p. 4)

According to Brazee and Capelluti (1995):

“Integrated curriculum is based on a holistic view of learning and recognises the necessity for learners to see the big picture. ... integrative curriculum ignores traditional subject lines while exploring questions that are most relevant to students. As a result, it is both responsive to students' needs and intellectual—because it focuses on helping learners use their minds as well.” (p. 9)

A seminar was held in 2004 in Saudi Arabia where participants portrayed integration as a basis for making linkages between the knowledge and skills from different subjects to reach a common goal. The main purpose of this seminar was to reshape the curriculum based on international trends and good practice such as student competencies and curriculum integration. The keynote speaker pointed out that curriculum integration is a set of practices for addressing learner's needs, making connections between different areas of learning and development, given the complex relationship of the natural and manmade world.

Recent findings from neuro-psychology and cognitive studies were presented at the above seminar as evidence for supporting the idea of how integration could be meaningful to learners. Georgescu (2004, cited in Caine & Caine, 2005) illustrated with the ideas from neuro-psychology that learning is best accomplished when information is presented in connected patterns. Further, she described how learners could build up mental models through integrated learning. Previously this idea was presented by Caine and Caine (1991) and they stated that the search for meaning and patterns is a basic process in the human brain. Therefore, the brain may resist learning fragmented facts that are presented in isolation. Learning is believed to occur faster and more thoroughly when it is presented in meaningful contexts.

Several authors have gone beyond a single definition of curriculum integration. For example, Forgarty (1991) has described ten levels of curricula integration (details are included in Appendix IX), as follows.

1. Fragmented: The traditional model of separate disciplines
2. Connected: Topics within a discipline are connected
3. Nested: Multiple skills (social, thinking, and a content-specific skills) are targeted within a subject area
4. Sequenced: Similarities are taught in concert, although subjects are separate.
5. Shared: Team planning and/or teaching that involve two disciplines with a focus on shared concepts, skills or attitude.
6. Webbed: Thematic teaching, using a theme as a basis for instruction in many disciplines
7. Threaded: Thinking skills, social skills, multiple intelligences and studying skills are threaded throughout the disciplines
8. Integrated: Priorities that overlap multiple disciplines are examined for common skills, concepts and attitudes
9. Immersed: Learner integrates by viewing all learning through the perspective of one area of interest

10. Networked: Learner directs the integration process through selection of a network of experts and resources

Drake (2000) presents a similar continuum of three approaches to integrated curriculum: multidisciplinary, interdisciplinary and transdisciplinary. Drake (2000) describes the following definitions:

- **Multidisciplinary**—two or more subjects are organised around a common theme or topic such as “pioneers”; or different disciplines may be viewed as “lenses” to explore a problem or issue. There is an attempt to make explicit connections across subject areas.
- **Interdisciplinary**—interdisciplinary skills (process skills such as literacy, research, or numeracy skills) are the organising centre for two or more subject areas. Connections are also made with content through teaching concepts that cut across subject areas.
- **Transdisciplinary**—there is a real-life context. An instructional unit puts the focus on the issue and assumes that the embedded disciplines will come into play as needed or desired throughout the unit. Drake cites project-based learning as one example of a transdisciplinary curriculum.

Harden (2000) provides another description of curriculum integration and includes an integration ladder in his description. There are 11 steps in this ladder, which builds on further development of Jacob, Fogarty and Drake’s models.

#### 1. Isolation

The first step is isolation - departments or the subject teachers organise teaching without consideration other subjects or disciplines. This step is similar to Fogarty’s model Level 1, Fragmented.

#### 2. Awareness

Teacher in one subject is made aware of what is covered in the other subject. Integration does not occur. Teachers can take account of what other staff members cover in the other parts of the course.

### 3. Harmonisation

The disciplines remain separate but the teacher may make explicit connections within the subject area to the other subject areas. This is similar to Level 2 of Fogarty's model, which called connected.

### 4. Nesting

Content drawn from different subject areas in the curriculum may be used to enrich the teaching of other subject. The teaching, however, remains subject based. The term

“infusion” has been applied to this stage.

### 5. Temporal- coordination

Similar topics are taught on the same day or week while the remaining part of a topic is subject based. Students study the similar concepts from different subjects separately. This is very similar to Level 4 Fogarty's model, which is called sequenced.

### 6. Sharing

Two disciplines may agree to plan and jointly implement in a teaching programme. This is more effective than either could achieve alone. This level is similar to Fogarty's fifth level, which is called shared.

### 7. Correlation

Disciplines remain separate but one session or course is introduced in addition to the subject based teaching.

#### 8. Complementary programme

Involves both subject based and integrated teaching. Integrated sessions represent a major feature of the curriculum.

#### 9. Multidisciplinary

Number of subject areas in a single course with themes. This is similar to Fogarty's webbed model.

#### 10. Interdisciplinary

Further shift of integration. It is a high level of integration with the content of all or most subjects combined into a new course with a new menu.

#### 11. Trans-disciplinary

In this trans-disciplinary approach the disciplines become part of the learner's real world experience and through this they filter the broader aims and goals of the integrated curriculum. This stage of integration has been termed authentic integration.

The above 11 steps describe the extremes of subject- based and integrated teaching. When moving up the integration ladder the most important aspect is communication and making joint plans between teachers from different subjects. This means there should be an agreement between course outline aims and objectives of the programme and methods of student assessment. The move from a traditional subject-based curriculum to an integrated curriculum would be a big step and may involve major changes. It is difficult to move up to the top of the ladder. In other words, it is very difficult to change the whole curriculum from subject-based to an integrated curriculum

straight away. Therefore, alternatively, someone could start something small and manageable.

## **2.11 Different approaches to curriculum integration**

Several researchers provide evidence that curriculum integration takes time and Shoemaker (1991) lists the key essential components of an integrated curriculum.

- Core skills and processes - e.g. basic skills such as reading and mathematics as well as social skills and problem solving.
- Curriculum strands and themes - organising principles around which the curriculum is built.
- Major themes- each curriculum strand is further divided into major themes.
- Questions - questions are used to further define major themes and focus activities.
- Unit development- from the major theme and the questions, knowledge and skills related to the concepts, teachers plan activities that will lead to the development of knowledge and skills which will answer the questions. Teachers also collect resources and develop actual lesson plans and assessment strategies.
- Evaluation- the unit is evaluated through an assessment of student progress

According to the literature, an integrated curriculum is a gift to experienced teachers. However, the successful implementation depends on the plan. Jacobs (1991) identified four integral steps to success the process. These are:

### Phase 1

- Conduct action research to learn about current resources and best practices.

This should be done six months to a year ahead of when the school is going to attempt curriculum integration.

#### Phase 2

- Develop a proposal for integration.

#### Phase 3

- Implement and monitor the pilot programme with continual assessment of students and the programme. This should take place in the second year of the plan.

#### Phase 4

- Adopt a programme and continue to assess. This should takes place in the third year of the plan.

Jacob (1991) indicates that the largest obstacle to curriculum integration is that people try to do too much at once. Successful implementation must take into account the various levels and phases of integration that might be possible in a school/institute. Further, she emphasised that integration does not have to be interdisciplinary. The first step toward integration is to foster integrated thinking within each discipline.

The move from a traditional subject-based to an integrated curriculum is not an easy task. The most important thing is to identify the possible level that would suit each actual implementation. When this researcher investigated various curriculum implementations in New Zealand, she found that the second and third year primary pre-service Integrated Curriculum: Science and Technology course at one university in New Zealand used PBL as the major teaching approach. This approach challenges students to learn through real life problems. The researcher decided this may match the ERA curriculum in Sri Lanka, which is an integrated curriculum that uses real life context as the

focus for learning through the environment. Thus, it seemed relevant to study more about the Problem Based Learning approach to address the research questions in Chapter 1 of this thesis.

## **2.12 Problem Based Learning approach (PBL)**

PBL is an exemplar of a learning environment based on constructivist learning theory (Savery & Duffy, 1995). In PBL, learning is centred around an authentic problem of interest to students, in which they are active learners, and teachers are guides or coaches. PBL has a history of several decades in medical education but has only more recently become a strategy used in K-12 education (Torp & Sage, 1998).

PBL is both a curriculum organiser and an instructional strategy which:

1. Engages students as stakeholders in an ill-structured problem situation.
2. Organises curriculum around this problem, enabling student learning in relevant and connected ways.
3. Creates a learning environment in which students are active learners and teachers are coaches of student thinking and inquiry, facilitating deeper levels of understanding.

Savery and Duffy (1995) summarised the key instructional principles associated with planning, managing and delivering integrated curriculum models with the PBL approach as follows:

1. Anchor all learning activities in a problem.
2. Support the learner to develop ownership for the overall problem or task.
3. Design an authentic task.

4. Design the task and learning environment to reflect the complexity of the environment that students should be able to function in at the end of learning.
5. Give the learner ownership of the process used to develop a solution.
6. Design the learning environment to support and challenge the learner's thinking.
7. Encourage testing ideas against alternative views and alternative contexts.

### **2.12.1 The role of the tutor in PBL**

In the PBL process the tutor is a facilitator whose role, therefore, is very different from the usual teacher's role. A facilitator is responsible for guiding students to identify the key issues in each case and to find ways to learn in those areas to an appropriate breadth and depth. Although students have much more responsibility in PBL than in most conventional approaches to teaching, the tutor is not just a passive observer. He or she must be active and directive about the learning process to ensure that the group stays on task and makes reasonable choices on what issues are important to study further.

The Queen's University Hand Book for PBL learning (2006) describes the PBL process conducted by the University.

According to the handbook PBL tutors should have the knowledge and understanding of the:

- overall goals, objectives and specific components of teaching programme;
- rationale and the self directed learning procedures;
- necessary steps to promote PBL; and
- mechanics of group dynamics and peer feedback.

Further, the handbook emphasises personal attributes of the tutor to fulfil goals of the PBL it is necessary to have following:

Acceptance and responsibilities:

- The PBL approach as an effective method for acquiring information and for developing the ability to think critically.
- The self directed learning approach.
- The small group tutorial as a forum for integration, direction and feedback.
- Arranging meetings, supporting and coordinating where necessary.

Skills:

- Facilitating: appropriate questioning, indicating when additional information needed, opposing views or cues as needed, referring students to resources.
- Promoting group problem solving and critical thinking.
- Promoting efficient group function.
- Promoting individual learning.
- Engaging student evaluating and coordinating the peer evaluation of students.

### **2.12.2 Student learning in PBL**

The PBL method not only enhances students' knowledge of the basic principles but also has the potential to increase students' ability to solve real life problems and to increase students' motivation for learning (Nendaz & Tekin, 1999, cited in Bhattacharya et al, 2004). PBL is a curriculum design and a teaching/learning strategy which is focused on active student learning. In this section, the researcher explains how PBL would be beneficial to student learning in different programmes in different countries.

The PBL approach used in a teacher education programme (Integrated Curriculum: Science and Technology course ) for both online and on campus students is based on the following conceptual model proposed by Madhumita and Akahori (1997, Bhattacharya et al, 2004).

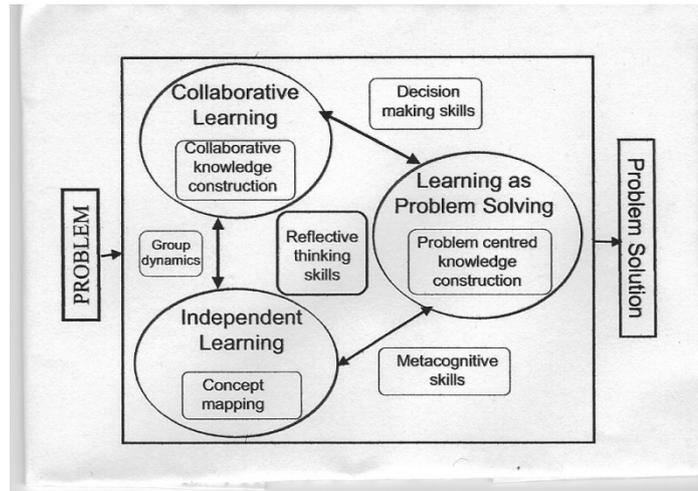


Figure 4: Model for Problem Based Learning proposed by Madumita and Akahori (1997)

Finkle and Torp (1995) state that PBL is a curriculum development and instructional system that simultaneously develops both problem solving strategies and disciplinary knowledge bases and skills by placing students in the active role of problem solvers confronted with an ill-structured problem that mirrors real world problems. According to Bhattacharya et al. (2004), the PBL process provides students with ill-structured problem scenarios to give the scope for a range of meaningful learning activities which students can perform to work towards defining a problem statement, identifying the activities, conducting the investigation and trying to solve the problem. Students are presented with a set of PBL scenarios from which individual students will choose a scenario and provide reasons for their choice. The students are then placed into small groups of three students each and are instructed through the steps as follows.

- Read and analyse the scenario.
- List what is known.
- Develop a problem statement.
- List what is needed.
- List possible actions.
- Analyse information.
- Present findings and give self-reflection.

Further detailed instructions, strategies, tools, exemplars and exercises are provided throughout the process to facilitate students learning. According to Bhattacharya et al. (2004), the students of the PBL programme reported that they have:

- Learnt a lot more about the subject areas through the PBL process.
- Gained knowledge and skills by going through the PBL process that will be applicable and transferable in other facts of life.
- Become confident ICT users in their teaching-learning.
- Achieved a clear understanding of the concept of curriculum integration through this approach. (p. 5)

This supports Barell (2007) who describes PBL as an effective way to organise a quality learning experience where he describes quality learning experience as:

- An active process in which students connect new ideas with prior understandings.
- Optimised by student-to-student dialogue in cooperative settings.
- Most motivating and interesting to students when situated in real-world, discovery-oriented contexts.
- Participants are given the opportunity to make decisions about their own learning.

Further he states that PBL:

- Enhances student learning.
- Motivates students.
- Prepares students for real life decision making. (p. 8)

The University of Delaware is recognised as a centre of excellence in the use and development of PBL for more than ten years, and provides evidence for

successful PBL. They describe PBL participants as having the ability to do the following:

- Think critically and be able to analyse and solve complex, real-world problems.
- Find, evaluate and use appropriate learning resources.
- Work cooperatively in teams and small groups.
- Demonstrate versatile and effective communication skills, both verbal and written.
- Use content knowledge and intellectual skills acquired at the University to become continual learners. (p. 9)

Similarly, in a case study on the implementation of PBL in a tertiary education classroom at Tun Hussein Onn University, Malaysia, Othman (2007) provides evidence for effectiveness of PBL and states that the effectiveness of this approach is not only proven in producing the skilful graduates but also in developing humanistic values. Othman (2007) introduced PBL to a group of students in a humanities study classroom and the research finding shows that the learning process has successfully transformed the students from rote learning to meaningful learning.

### **2.12.3 Methods of assessment in PBL**

The main purpose of an assessment process is to enhance student learning. Therefore, assessment is an integral part of PBL as well as in other methods of teaching and learning as it provides ongoing feedback to the students. Boston (2002) defines formative assessment as a diagnostic assessment which provides feedback to teachers and students over the course of instruction. In contrast, summative assessment, which generally takes place after a period of instruction, requires making judgements and giving scores about the learning that has occurred (Boston, 2002).

The literature on PBL indicates the importance of using suitable assessment procedures as traditional paper pencil tests are not suitable for assessing PBL.

In PBL students have to be aware of what they already know, can do and where the gaps are in their knowledge and competence. Assessment, therefore, needs to be developed that encourages open and honest reflecting about how well students are learning and not just how much they have learned. In addition, in developing assessment criteria it is important to place an emphasis on providing constructive feedback. Therefore, new methods of formative assessment are needed to be able to assess the student progress in PBL in order to give them relevant and meaningful feedback.

In assessing students in a PBL course, a range of assessment tasks may be used. Macdonald and Savin-Baden (2000) describe details about assessment in PBL and point out:

- Assessment should ideally be based in a practice context in which students will find themselves in the future.
- Assessment should reflect the learner's development from a novice to expert practitioner and so should be developmental throughout the programme of studies.
- Students should be able to engage in self-assessment and reflection as the basis for future continuing professional development and self directed learning.
- Lecturers need to ensure that there is alignment between the objectives of the course and the students' anticipated learning outcomes, learning and teaching methods adapted and the assessment of learning strategies, methods and criteria.

MacDonald and Savin-Baden (2000) list some of the forms of assessment that have been used successfully in PBL.

- Self assessment
- Peer assessment
- Reflective journals
- Reports
- Portfolios

- Group presentations
- Individual presentations

Further, they state that through peer, self and collaborative assessment students can make judgments about how well they are learning and not just how much they have learned. Self assessments allow students to think more carefully about what they do and do not know and what they still need to know to accomplish certain tasks. In other words, students' judge their own work through self assessment. Boud (1995) has defined self assessment as the involvement of students in identifying standards and/or criteria to apply their own work and making judgements about the extent to which they have met these criteria and standards.

Peer assessment involves students making judgements about other students' work. This provides learning and supportive environments for each other. Within the one year teacher education programme at York University, Canada, the practice of peer pairing has been introduced as an effective practice for encouraging pre-service teacher education (Wijayawardana, 2000). In peer pairing the partners work together and provide helpful feedback to each other. However, it is important that all students should emphasise respecting each other and providing constructive feedback. Through reflective journals students can write their experiences, questions and understanding about how they are engaging with the PBL process. Knight (2002, cited in Yuzhi, 2003) describes a number of assessment methods that can be used in PBL. However, it is important to ensure that the assessment is aligned to the learning outcomes and the principles of PBL.

Yuzhi (2003) describes assessment criteria for the PBL approach used in Hunan University in China as follows:

- effectiveness of the work;
- responsibility and independence;
- information processing skills;
- problem solving skills; and

- interpersonal communication skills.

However, developing assessment methods and criteria for assessing students in PBL is not an easy task. Woods (2000), who used PBL in chemical engineering course at McMaster University, defines assessment as a judgement based on the degree to which the goals have been achieved based on measurable criteria and on pertinent evidence. It is important, therefore, to adopt a more strategic approach to develop formative assessment procedures in PBL to enhance student learning to fulfil the goals of successful PBL application.

This examination of the literature serves to provide justification of the study in that it highlights a crucial role the teacher education has to play in the successful development of education innovation and PBL approach, which could make a difference in the classroom as it provides constructive and transformative learning experiences. PBL is different from traditional direct instruction and begins with an authentic problem without any prior preparation by the students. Further, this approach develops skills required for lifelong independent learning.

There is evidence from teacher education in New Zealand that PBL helps students to take an active role in their educational experiences as they are actively involved in the learning process and they learn in the context in which the knowledge is to be used. In addition, PBL approach helps them to plan their integrated lessons in the classroom. Further, this literature review provides evidence that PBL has the strength to develop the skill of transforming knowledge into a new setting of learning environment, a skill that the students can carry with them throughout their teaching careers.

According to Savin-Baden (2000) PBL can be implemented in diverse contexts describe:

“Problem Based Learning is thus an approach to learning that is characterised by flexibility and diversity in the sense that it can be implemented in a variety of ways in and across different subjects and disciplines in diverse contexts. As such it can thereafter look very different to different people at different moments in time depending

on the staff and students involved in the programmes utilising it. However, what will be similar will be the focus of learning around problem scenarios rather than discrete subjects.” (p. 3)

Pre-service student teachers in Sri Lanka have to be successful in their teaching in different classroom settings and in different geographical regions after their training. Therefore, it is important to develop the skill of transforming knowledge into new domains as pre -service student teachers have to play a crucial role in teaching ERA curriculum in different geographical environments and this study was focused on main features of PBL that would be suitable for ERA teacher education Curriculum in Sri Lanka.

### **2.13 Chapter summary**

In this chapter, a review of the literature is provided. In order to locate research questions this literature was reviewed under the following headings.

- Development of teacher education.
- The changing role of the teacher and the gap between the theory and practice of teacher education.
- Comparing and contrasting primary curriculum and teacher education in New Zealand and Sri Lanka.
- Effective approaches to teacher education.
- Models of integration and different approaches to integration.
- Problem Based Learning approach and how it manages self directed learning and transferring knowledge into new domains.

Research gaps were identified for the focus of the current study. The following chapter describes the research methodology and the research process.

## Chapter 3.0 - Research methods and Research Process

### 3.1 Research process

In this chapter, the researcher describes the methods used in the study followed by data collection process, participants, ethical issues, data analysis and the process of the research.

The following diagram demonstrates the details included in this chapter.

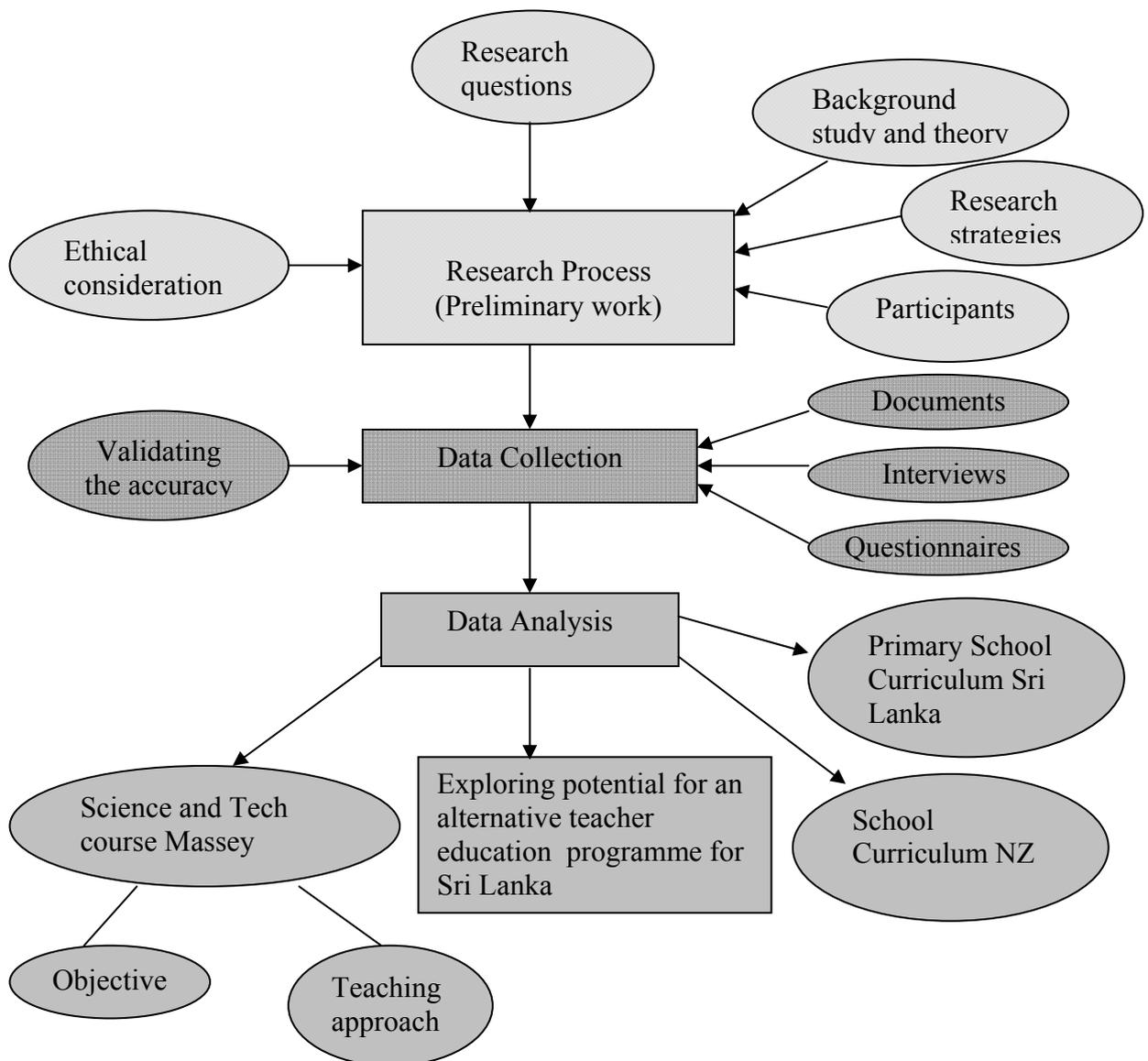


Figure 5 : Flow diagram for the research methods

According to Janesick (1994, cited in Mutch, 2003), the qualitative research design has three stages. In the stage one, the researcher makes decisions about the questions that guide the study; the participants; agreements with the participants; timeline; selection of appropriate research strategies; the place of theory in this study; identification of the researcher's own views; and ethical issues. This stage is shown in the upper section of Figure 6.

In the stage two the researcher make decisions about the direction the research is taking and engages in data gathering. This is shown in the middle section of Figure 6.

In the stage three the researcher analyses the data, constructs models or develops theories and writes up the thesis. In this study, the researcher explored the potential for an alternative teacher education programme for the Environmental Related Activities teacher education programme in Sri Lanka on the basis of the Problem Based Learning Approach used in the Integrated Curriculum: Science and Technology course in Pre-service Primary Teacher Education programme at one university in New Zealand.

### **3.2 Research questions**

This research focused on the following research questions, as stated in Chapter 1.

1. a). What are the main objectives of the Integrated Curriculum: Science and Technology course in Pre-service Primary Teacher Education programme conducted by one University in New Zealand?
- b). What are the major teaching approaches used in this integrated course?
- c). What are the student teacher expectations from taking the Integrated Curriculum: Science and Technology course?

2. What are the benefits of using the Problem Based Learning approach in teacher education?
3. a). How could Problem Based Learning fulfil the objectives stated in the National Primary school science curriculum in New Zealand?  
  
b). What are the key features that would match the primary school curricula in Sri Lanka and in New Zealand?
4. How could the Problem Based Learning approach be transferred to Pre-service Primary Teacher Education in Sri Lanka?

### **3.3 The objectives of the proposed study**

- Analyse the curriculum documents with special attention to Environment Related Activities and Science.
- Find out the main features of Problem Based Learning approach used in one university in New Zealand.
- Explore the potential for an alternative Teacher Education programme in the context of Sri Lanka.

### **3.4 Research methods**

In general, research methods can be described as a discussion of the ways in which research is conducted and includes a discussion of the research process and writing. This study used qualitative method to explore the potential of the Problem Based Learning approach used in, one university in New Zealand. Taylor and Bogdan (1998) stated that:

“Qualitative methodology refers in the broadest sense to research that produces descriptive data, people’s own written or spoken words and observable behaviour....It is a way of approaching the empirical world.” (p. 7)

Qualitative research is an inquiry process and it allows the researchers to know the detailed information about the participants, their experiences, perspectives and understandings as well as the context and setting which they occur (Bogdan & Biklen, 2007, cited in Jules, 2009). The researcher used a qualitative approach focused upon teacher educator and the student perspectives in order to explore the main features of the PBL approach used in the Integrated Curriculum: Science and Technology course conducted by one university in New Zealand. From the data analysis she explores the potential for a suitable programme in Environmental Related Activities curriculum for pre-service teacher education in Sri Lanka as visualised in the Figure 6.

The sections 3.5, 3.6, 3.6.1, 3.6.2 and 3.6.3, 3.7 describe the details of the data collection sources and the justification for each of the data gathering tools used in this research. The data analyses involved in this research are:

#### Documentary analysis

- Analysis of study materials - study guide, and readings of the Integrated Curriculum: Science and Technology.
- Analysis of New Zealand curriculum documents.

The description of the documents are described in section 3.6.1

#### Interview data analysis

- Interview responses of academic staff involved in the design and delivery of the particular course.

The description of the interview process is described in section 3.6.2

#### Student responses analysis

- Questionnaire responses of students.

The description of the documents are described in section 3.6.3

### 3.5 Data collection sources and participants

The data collection sources and participants selected for the study are shown in the Table 1 below.

Table 1: Data collection sources and participant

Data collection method	Process and participants
Documents	Curriculum materials <ul style="list-style-type: none"><li>• Primary School curriculum documents New Zealand 1993</li><li>• Draft Curriculum 2006 and Implementing Curriculum 2007 for school curriculum New Zealand</li><li>• Primary School curriculum, Sri Lanka</li><li>• Primary teacher Education curriculum documents, Sri Lanka</li><li>• Integrated Science and Technology teacher education curriculum (one New Zealand University) and study materials and the Course Administration Guide</li></ul>
Interviews	Four Lecturers (design and delivery of the paper)
Questionnaires	Twenty ( Internal) Students

### 3.6 Sources of data and data collection techniques

Documents, questionnaires and interviews are common techniques (Cortes, 2006) used for data collection for qualitative research. In this research documents, interviews and questionnaires are used as data collection sources.

#### 3.6.1 Written and policy documents

Documents can serve as sources of rich descriptions of how the people who produced the materials think about their world (Bogdan & Biklen, 1998, cited

in Rawaikela, 2004). The researcher has analysed relevant documents for this study.

The documents used for this research are:

- Science in the New Zealand Curriculum.
- New Zealand Curriculum Framework.
- Primary Curriculum in Sri Lanka.
- Pre-service Teacher Education Curriculum in Sri Lanka.
- Prospectus –National Diploma in Teaching, Sri Lanka.
- Curriculum and Policy planning Report, Sri Lanka.
- The New Zealand Curriculum 2007.
- Course Administration Guide and other course materials for Integrated Curriculum: Science and Technology teacher education course conducted by a University in New Zealand

The researcher studied the course related materials to establish the following details of the programme.

1. Design of the course .
2. Main features of integration.
3. Links and relationships to the school curriculum.
4. Evaluation procedures.

The researcher carried out an analysis of curriculum documents available on the current education system in New Zealand and Sri Lanka.

### **3.6.2 Interviews**

The interview technique involves data collection through direct verbal interaction between individuals. Interviewing allows the researcher to gain others' perspectives about the phenomena under study. Similarly, a research interview is a conversation with a purpose (Lincoln & Guba, 1995, cited in Mutch, 2003) and an opportunity to find out things that the researcher cannot directly observe (Patton, 1990). Interviews are classified into different

categories. Fontana and Frey (1994) categorised interviews as structured, group and unstructured. Patton (1990) categorised interviews into informal conversational interview; the general interview guide approach, standardised open-ended interviews and closed field response interview. According to Carspeken (1996), the ideal qualitative interview will be a semi-structured respondent interview.

In this study, the researcher used semi-structured respondent interviews (Interview questions are given in Appendix IV). Fully unstructured interviews did not seem to be reliable enough; they required specific expertise from the interviewer to ask important and relevant questions at the right time and to exercise the necessary authority over the situation simultaneous with offering enough liberty and opportunity to the interviewee (Coates, 2003).

In a semi-structured interview, an interview guide or checklist is used with some freedom that offers the interviewer considerable flexibility to ask more questions if necessary, that are not in the interview schedule. The questions are a mixture of closed and open questions. According to (Cohen, Manion, & Morison, 2000, cited in Coates, 2003) open-ended questions have a number of advantages.

- Allow flexibility.
- Allow the interviewee to go into more depth as needed or clear up any point.
- Enable the interviewer to explore what the interviewee really believes, values and wants to express.
- Create an environment for the interviewee to unveil her/his feelings.

A tape recorder was used in this research project during the interviews. Using a tape recorder is important to maintain the individuality and clarity of the data without any invasion of bias. By doing a tape recording, a researcher can focus total attention on the interviewee maintaining appropriate eye-contact and non-verbal communication (Blaxter, 2001, cited in Rawaikela, 2004).

In this particular study, the researcher wanted to find out the actual process of the course implementation and she clearly needed to discover the things demonstrated in the administration booklet. In this study questions were asked to capture the actual words from four members of the staff who were involved in this particular course (Integrated Curriculum: Science and Technology) Before the start of the interview the researcher explained the purpose of the study as she emailed the interview questions together with the information sheet and consent form. Potential participants were also informed that the research study was approved by the Massey University Human Ethics Committee (Appendix I). Interview questions are listed in Appendix IV. The interviews took place at two campuses and the interviewees each took place in private. Each interview lasted approximately one hour. The researcher interviewed four staff members who had agreed to participate in this study.

### **3.6.3 Questionnaires**

In many ways the interview and the questionnaire are similar. Both attempt to elicit the feelings, beliefs, experiences or activities of respondents (Coates, 2003). They may also be as structured or unstructured as the situation demands. In this study the researcher wanted to have the student responses from using questionnaires to compare with the staff responses (Questionnaire is given in Appendix V).

In writing about real world research Robinson (1999, cited in Rawaikela, 2004) showed that questionnaire data can be used to explore aspects of a situation or to seek explanation and provide data for testing hypotheses. Similarly Jenkins (1999) comments

“...surveys can be used to describe, to explain, to explore to predict and to evaluate...” (p. 1)

Further, he claims that surveys have other benefits. One being, that the view of a particular population can be obtained. In the case of this research, questionnaires were used to understand the views of the students who were taking the Integrated Curriculum: Science and Technology primary teacher education course. In this questionnaire open questions made it possible to

gather the details of the main features of the PBL approach such as teaching approaches, assessment techniques and so on. Further, it helped to gather the students' points of view on taking this course and find out whether it helped them to prepare them for the real life classroom and the new integrated primary curriculum in New Zealand.

In addition, to ensure the data gathering was comprehensive the researcher used questionnaires as a method of data collection in order to triangulate the data. Yin (1994) highlights the idea of using more than one method of data collection and wrote:

“...Thus any finding or conclusion is likely to be much more convincing and accurate if it is based on several different sources of information following a corroboratory mode.” (p. 76)

The researcher herself handed the questionnaires to a staff member who was not involved in this Integrated Curriculum: Science and Technology teacher education course and asked that the questionnaires be circulated to all students in the class. Before handing out the questionnaires she discussed all the arrangements for administering the questionnaire (Questionnaire is given in Appendix V).

### **3.7. Details of data collection instruments**

In order to answer the research questions the research methods focused on describing and analysing the Integrated Curriculum: Science and Technology course by using three different data collection sources as described in the section 3.6. The framework below demonstrates the links between research questions and the data collection instruments.

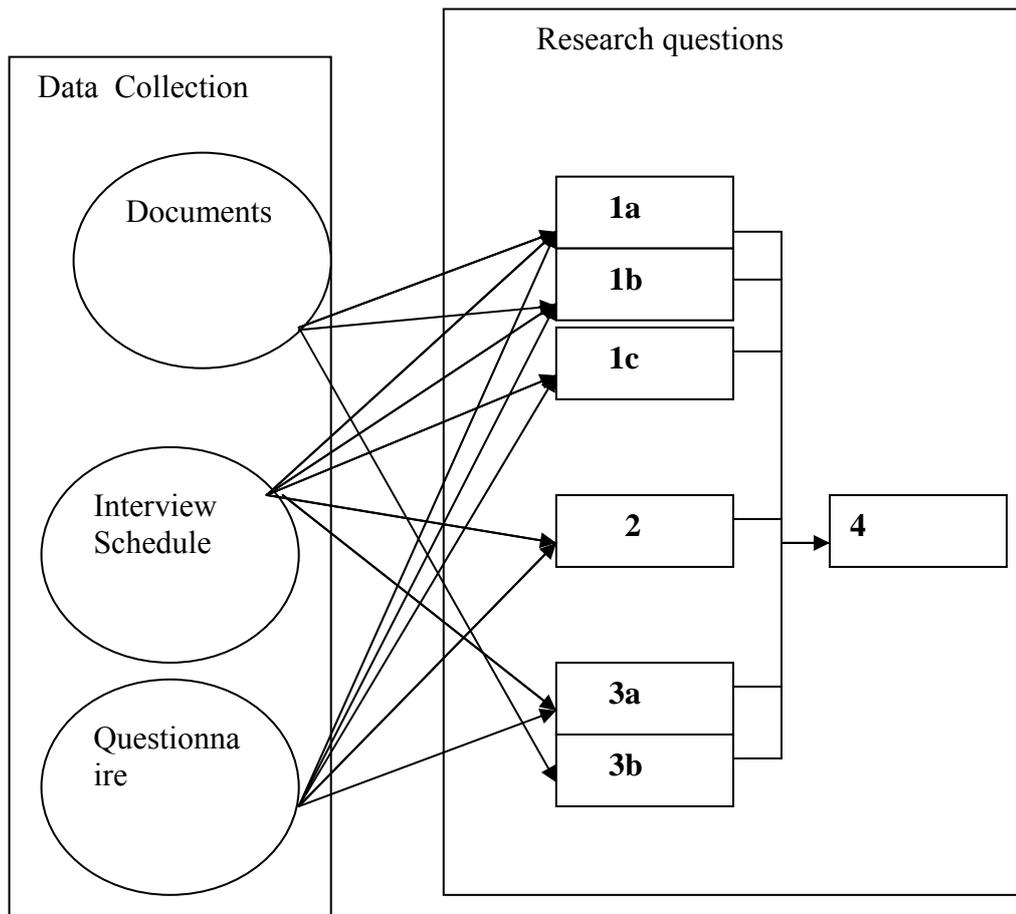


Figure 6: Links between Data collection instruments and research questions

### 3.7.1 Documents

Lincoln and Guba (1985) argue that documents open up new sources of understanding. Documents are the stable sources of information grounded in the setting and language in which they occur, they provided the opportunity for longer periods of study (Lincoln & Guba, 1985). In this study the researcher studied several documents mentioned in 3.6.1, which are available in New Zealand and Sri Lanka in order to find out the key features of primary curriculum in Sri Lanka and New Zealand. She was able to use documents as a data gathering tool and the links between document data and the research questions are shown in the Figure 6.

### **3.7.2 Interview schedule**

The interview schedule for the lecturers (teacher educators) was mainly focused on obtaining key objectives and the key features of the Integrated Curriculum: Science and Technology course with special attention to the PBL approach used in this particular teacher education course. Therefore the questions in the interview schedule were categorised into the following themes.

- Key goals of Integrated Curriculum: Science and Technology course.
- Lecturer's/teacher educator's role as facilitator in PBL.
- Changes in teaching approach when using PBL.
- Assessment procedures in PBL.
- Using ICT in PBL approach.
- How PBL approach fits with New Zealand primary school curriculum.
- How this particular course is different from traditional teacher education course.

### **3.7.3 Questionnaire**

The questionnaire for the students who were taking the Integrated Curriculum: Science and Technology course was mainly focused on obtaining data as a method of triangulation and verifying the data obtained from the lecturers/teacher educators. The items in the questionnaire were categorised into the following themes.

- General information about students.
- Expectations from taking this course.
- Assessment procedures.
- How PBL make a difference in preparing them as successful beginning teachers.
- Learning support they received from their lecturers as PBL facilitators.
- How this course match with the New Zealand primary school curriculum.

### 3.7.4. The themes of data collection, instruments and how it relates with the Research Questions

The following table demonstrates the links between research questions and how they relate to the three sources of data collection.

Table 2: Links between Data Collection Sources and Research Questions

Major Research Questions						
Integrated Curriculum: Science and technology			PBL approach	Primary school Curricular		How could they be transferred
1)a	1)b	1)c	2)	3)a	3)b	4)
D In q 1 In q 2 In q 3	D In q 5 In q 6a In q 6b In q 7a In q 7b Q9 Q10 Q13	In q 4 Q4 Q5 Q6 Q11 Q12	In q 5 In q6b In q 7a In q 7b In q 8 In q 9 In q 10 Q8 Q13 Q14 Q16	In q 5 In q 4 In q 8 Q4 Q5 Q6 Q8 Q15 Q17	D	Analysing all of the data

(D= Documents, In q= Interview questions , Q= Questionnaire)

### 3.8 Development process

The development process began with analysing the curriculum documents, This process established the similarities and differences between the Sri Lankan primary curriculum and the New Zealand curriculum. Further, the new 2007 curriculum and how it links with the existing primary curriculum was examined. As shown in the figure below, the next step was an analysis of the

course materials of the Integrated Curriculum: Science and Technology course. This permitted the links to be made between New Zealand school curriculum documents and the Integrated Curriculum: Science and Technology primary teacher education course and how it links with the curriculum implementation procedures. As demonstrated in Figure 7, the next step focused on reviewing the Integrated Curriculum: Science and Technology course in order to find out the main features of the course with the aim of exploring the potential for developing an alternative programme for Sri Lanka.

### **3.9 Research procedures**

In formulating this research process the researcher attempted to consult with a wide range of academic sources including the science curriculum team at the Ministry of Education, New Zealand, to gain an understanding of science in the New Zealand curriculum. The researcher's own experience in teacher education and curriculum preparation has been an important resource in the process of the research and she focused on the special features of the Sri Lankan curriculum documents by reading all available materials in the primary curriculum in Sri Lanka to identify the similarities and differences between the primary curricula in Sri Lanka and New Zealand. The course materials for the Integrated Curriculum: Science and Technology course conducted by one New Zealand University were analysed, including study guides, course description and readings for the course with the aim of exploring the potential for an alternative teacher education programme for ERA teacher education curriculum in Sri Lanka. This analysis focused on following key aspects.

- Identification of the patterns, issues and outcomes of the programme
- Major teaching approaches
- Study assessment rubrics and procedures

#### **3.9.1 Ethical issues**

Research is a systematic investigation and ethical consideration in research involves balancing the risk and benefits of the research activity. If any researcher obtains data from a living individual there should be a process of ethical consideration. This research was carried out at one College of Education in New Zealand with the collaboration of the staff and student teachers. The researcher was responsible for obtaining consent from all the human participants. Under the code of ethical conduct for research at Massey University (Appendix I) the researcher was required to prepare an information sheet (Appendix II) and consent form (Appendix III) and submitted a notification of the research topic to the Ethics Review Committee. The researcher received ethics approval from the Human Ethics Committee before commencing data collection from staff and students.

### **3.10 Methods of data analysis**

This section describes the methods used in the analysis of the data collected from various sources. In this study the first step of data analysis was the review of primary school curriculum materials in New Zealand and Sri Lanka in order to identify the similarities and differences. In the second step, the researcher paid attention to the review of the primary teacher education course, Integrated Curriculum: Science and Technology with special attention to the PBL approach used in this particular course.

Miles and Huberman (1994, cited in Mutch, 2003) suggest that qualitative data analysis consists of three procedures:

**1. Data reduction.** Data is reduced and organised by coding, writing summaries and discarding irrelevant data. This process should start at the very beginning of data collection and it should be an ongoing process throughout much of the research.

**2. Data Display.** Displaying data in the form of tables, charts and graphical formats.

**3. Conclusion drawing/verification.** Initial conclusions will be verified and the validity will be examined through reference to existing field notes or further data collection or even critical discussions with colleagues at the institute.

At the first step of the above process, as described by Miles and Huberman (1994, cited in Mutch, 2003), the researcher transcribed the interviews leaving a column in the transcript for writing comments and tentative emerging themes (Bogdan & Biklen, 2003; Miles & Huberman, 1994, cited in Mutch, 2003). A sample of interview transcript is in Appendix XIII. First the researcher began the analysis by familiarising herself with data and made notes about preliminary thoughts and ideas (Coffey & Atkinson, 1996; Kervin et al., 2006, cited in Jules, 2009). Then the researcher perused the document analysis over and over again and developed coding categories in order to organise the data collected through the interviews of particular university teacher educators who were teaching in this science and technology course. Then she was able to organise the data by developing sub categories by the comparing of the analysis of the course materials of the above science and technology course. As the next step, the important key points were identified through the themes and subcategories. Then the student responses from the questionnaire were summarised according to the data collection themes and the direct quotations were identified and highlighted under each category of above data collection themes. The interview data analysis was completed concurrently with the data analysis of student responses in order to draw conclusions. Samples of student responses are given in the Appendix XIV as the evidence for student responses.

### **3.11 Validity and Reliability**

The notions of validity and reliability originate from the positivistic approach to research and traditionally these terms have been used in quantitative research. Strauss and Corbin wrote:

“.. the definitions of reliability and validity in quantitative research reveal Two strands: Firstly with regards to reliability whether the research is replicable. Secondly with regards to validity whether the means of measurement are accurate and whether they are actually measuring what they are intended to measure. However concept of Reliability and Validity are viewed differently by qualitative researchers who strongly consider concepts defined in quantitative terms as inadequate.” (p. 37)

Cohen, Manion and Morrison (2000) describe validity as a requirement for both quantitative and qualitative research and relate the idea of fitness of the purpose, which means whether the study will answer the research questions. Within qualitative designs the concepts of validity and reliability become modified or adapted to emphasise what is relevant and possible within such designs.

Harrison, Macgibbon and Morton (2001) have explored the trustworthiness of qualitative research in terms of “criteria of validity, credibility and believability” (p. 334).

### **3.11.1 Trustworthiness and credibility**

In respect of validity, trustworthiness is the key qualitative idea. It focuses on an overall assessment of whether the results can be trusted and understood to readers. Therefore in a qualitative paradigm, judgements about the quality of work are based on criteria such as credibility, transferability, dependability and conformability (Denzin & Lincoln, 1994). According to them the credibility and trustworthiness in qualitative research are established through data collection, analysis and reporting.

It is necessary to identify how credibility and trustworthiness are considered within this research. The credibility and trustworthiness of this research were established by:

- Data source triangulation.
- Giving voice to the participants when reporting findings (the use of quotations).

- Conducting the research in a systematic procedure.

#### **3.11.1.1 Data Source triangulation**

Triangulation, as it commonly understood and used, is the practice of multiple information of data collection. In other words, the use of multiple data sources to gain understanding of a phenomenon (Lincoln & Guba, 1985). In this research the data were obtained from three different sources. These sources were:

- Curriculum and policy documents which are available in New Zealand and Sri Lanka;
- Interviews with lecturers/teacher educators who were responsible for design and delivery of this particular course; and
- The questionnaire for the students who were taking the Science and Technology primary teacher education course.

#### **3.11.1.2 Giving voice to the participants**

According to Lincoln and Guba (1985), giving voice to the research participants when reporting findings is a way of establishing credibility of the research. In the data analysis the researcher used direct quotations from the interviews and the questionnaires and these quotations are included in Chapter 4 sections 4.3.2.1, 4.3.2.2, 4.3.2.3, 4.3.2.4, 4.3.2.5 and 4.3.3.

#### **3.11.2.3 Conducting the research in a systematic way.**

The Literature review provides an analysis of the underlying theory and identifies the theoretical framework for undertaking the research process. In addition to that, selecting the most appropriate methodology, developing valid and reliable instruments, conducting interviews and the other data gathering procedures in a systematic way and ethical consideration all impact on the judgment of credibility. Chapter 2 of this research provides the literature review

of the study and the sections 3.1 to 3.11 in this chapter describes step by step how the research has undertaken systematically.

### **3.12 Chapter summary**

This chapter has outlined the research methods and procedures used in this study. Three different data collection sources and all the steps including ethical consideration are also described in this chapter. Then, the method of data analysis is discussed. In addition, trustworthiness and the credibility of this research are described.

## Chapter 4.0 - Data Analysis

### 4.1 Analysis of curriculum materials

#### 4.1.1 Primary school curriculum and Environment Related Activities (ERA) curriculum in Sri Lanka

As described in Chapter 3, the main purpose of this research was to explore the potential for an alternative teacher education programme for the ERA curriculum for Sri Lanka. Therefore, the researcher began by analysing the features of the primary curriculum in Sri Lanka.

Primary education has been emphasised in the national education reforms in Sri Lanka. The primary curriculum framework and time allocation for primary Grades are shown in Figure 2 in Chapter 1. In addition, the structure of the curriculum is presented in a new mode of Instruction, as illustrated in the diagram below:

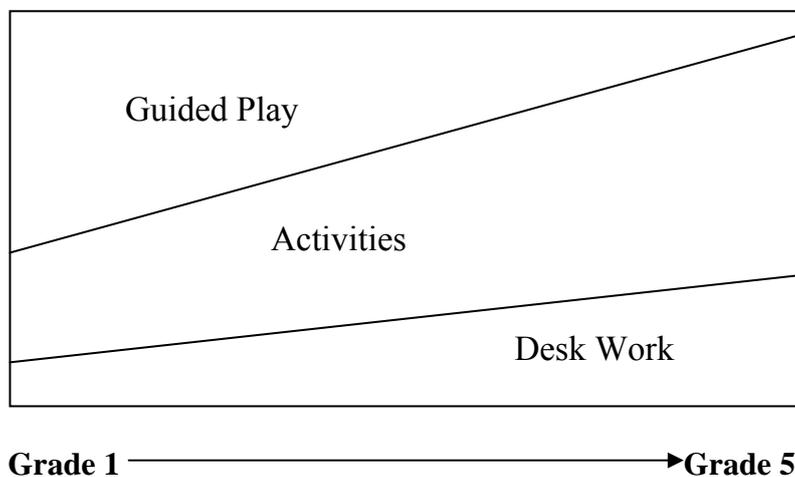


Figure 7: Mode of Instruction

ERA is a major subject in the Sri Lankan Primary Curriculum. The ERA curriculum consists of major themes and all learning activities focus mainly on “learning through the environment”. The integrated ERA curriculum in Sri Lanka is fixed within several subject disciplines, as shown in the following diagram, which is similar to Fogarty’s (1991) webbed model.

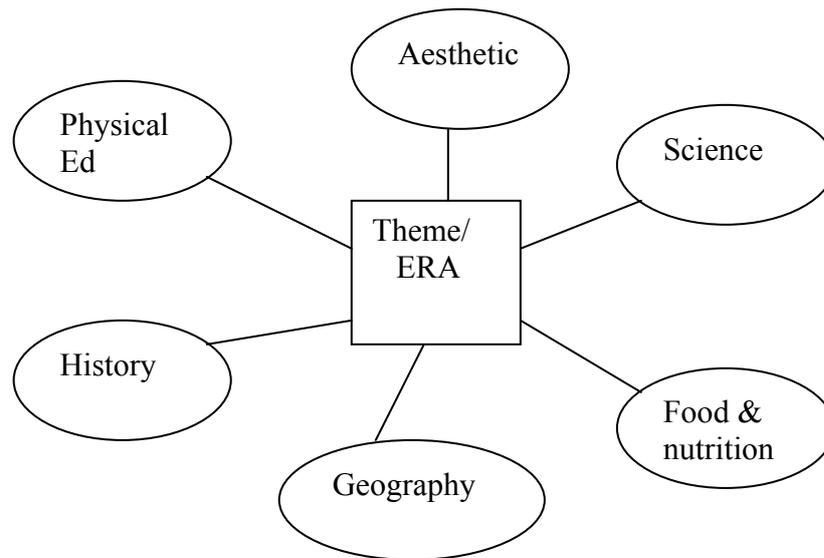


Figure 8: Model for ERA integrated curriculum

The ERA curriculum consists of fourteen themes, for example “Our School”, “How Information is Received” and “Transportation”. The researcher will describe how ERA as a subject has a broad scope and fits into a number of subject disciplines using the transportation theme as an example. Within this theme a series of activities for children include gathering information about how their family members travel to work, to the market, to festivals and so on, as well as collecting information about local roads and other information from their grandparents to find out about the history of transportation. These concepts are related to the subject areas of History and Geography and Culture as well. Children also draw different kind of vehicles, sing and do plays about riding on different kind of vehicles and it relates to the Art, Culture. Therefore, these activities fit into Aesthetics.

Science comes into the theme of **Transportation** when children consider forces like the pushes and pulls that make vehicles move. Also, there are activities related to the ill effects on the environment caused by vehicles. Here children deal with environmental science as vehicle exhaust, air pollution and sound pollution. Children also learn about natural resources such as petrochemicals.

As demonstrated, ERA is an integrated subject of Science, Aesthetics, Food and Nutrition, Physical Education, Geography and History. It provides opportunities for children to develop their knowledge, skills and attitudes through processes such as observation, data gathering, recording and interpreting.

While conducting her research the researcher found that some changes had occurred in the New Zealand school curriculum and a new curriculum was ready for discussion. So, she then studied the new curriculum and tried to understand the major changes that had occurred in the New Zealand curriculum and the similarities with the primary curriculum in Sri Lanka.

#### **4.1.2 New Zealand and Sri Lankan curricula**

“It is generally agreed that the field of curriculum is very complex, as the term itself different things to different people.”  
(McGee, 1997, p. 8)

As mentioned in Chapter 2, some writers see the curriculum as a plan and the others see it as what occurs when teachers implement it in a classroom. From the document analysis the researcher found that there are ongoing developments in curriculum occurring in both New Zealand and Sri Lanka. The purpose of the curriculum reform in both countries is to ensure the quality of teaching and learning over a broad balanced curriculum with the focus of nation building and quality improvement of education. In addition, both countries' curricula set the direction for teaching and learning with considerable flexibility when determining the details. Both curricula identify the values to be encouraged by students and the key competencies students should develop. In the New Zealand curriculum learning areas describe the subject specific learning needing to be covered and experiences and values, key competencies, knowledge and skills are integrated to address the real life experiences. The curriculum, therefore, conceptualises the New Zealand government's intent for education to have clear and positive directions for the world of today and tomorrow. Similarly, the primary curriculum in Sri Lanka

conceptualises the nation building and socio-economic growth and adaptability to change for the world of tomorrow.

In analysing the New Zealand curriculum documents the researcher found the following key aspects are demonstrated with the aim of successful learning.

- Direction for learning and assessment in New Zealand schools in systematic way;
- Links between achievement objectives and student assessment;
- Provides for flexibility, enabling schools and teachers to design programmes that are appropriate to the learning needs of their students;
- Learning progresses coherently throughout schooling;
- Encourages students to become independent and lifelong learners;
- Provides all students with equal educational opportunities;
- Tries to recognise the significance of the Treaty of Waitangi;
- Reflects the multicultural nature of New Zealand society;
- Relates learning to the wider world.

Bruner (1973) stated that the curriculum of a subject should be determined by the most fundamental understanding that can be achieved of the underlying principles that give structure to that subject. Teaching specific topics or skills without making clear their context in the broader fundamental structure of a field of knowledge is unsuccessful (Yeoman & Sewell, 2005, cited in Jules, 2009).

Even though the curriculum document provides the learning context through achievement aims, possible learning experiences and assessment examples, it is the responsibility of the subject teacher to decide, to understand and to select appropriate methods to achieve the goals.

Therefore, there might be diversity in the intended learning outcomes and achieved learning outcomes in different schools who are following the same curriculum. A literature review in science education by the Ministry of Education (2002) pointed out the key dimensions for diversity in the outcomes

intended/achieved in different school settings and by individual pupils as follows:

- The manner in which actual scientific inquiry is characterised and delineated from other types of human inquiry.
- The degree of integration of process and content knowledge, and the variation of content areas linked to each specific achievement objective of the developing scientific skills and attitudes strand.
- The actual skill development in various specific techniques of scientific inquiry.
- The extent to which investigations are linked to authentic questions/settings.

The Curriculum Stocktake Report (Ministry of Education New Zealand, 2004) provides the evidence from a sample of teachers throughout the New Zealand and states that there was insufficient information in the science curriculum statement and supporting documents to enable them to teach the integrating strands.

On the other hand the New Zealand Curriculum Framework (Ministry of Education, 1993) states:

“**The New Zealand Curriculum** comprises a set of national curriculum statements which define the learning principals and achievement aims and objectives which all New Zealand schools to follow.

**The school curriculum** consists of the ways in which a school puts into practice the policy set out in the national curriculum statements. It takes account of local needs, priorities, and resources, and is designed in consultation with the schools community.” (p. 4)

The New Zealand Curriculum was revised in 2007 and the new curriculum (Ministry of Education, 2007) was designed in the aim of providing more direction for teaching and learning in New Zealand schools and it is designed in a three stage process in order to address the particular needs, interests and circumstances of the school’s students and the community.

“Curriculum is designed and interpreted in a three stage process: as the national Curriculum, the school curriculum and the classroom curriculum. The national curriculum provides the framework and common direction for schools, regardless of type, size, or location. It gives the scope, flexibility and authority they need to design and shape their curriculum so that teaching and learning is more meaningful and beneficial to their communities of students. In turn, the design of each school’s curriculum should allow teachers the scope to make interpretations in response to the particular needs, interests, and talents of individuals and groups of students.” (p. 11)

The New Zealand Curriculum (Ministry of Education, 2007) has a key consideration in following areas:

- The relationship between the New Zealand Curriculum and the school curriculum
- Principles
- Values, Key competencies and learning areas
- Achievement Objectives
- Assessment
- Learning Pathways

The revised New Zealand curriculum (2007) is in the in the implementation stage it emphasises the following aspects:

- Restructuring essential skills and attitudes as key competencies.
- Ensuring achievement objectives for each learning area clear appropriate and future focused.
- Providing curriculum support material.

In addition to the above aspects, schools have an on-going responsibility to continually design and review their own school curriculum aligned to the New Zealand curriculum.

The principles of the new New Zealand curriculum (2007) can be shown as follows.

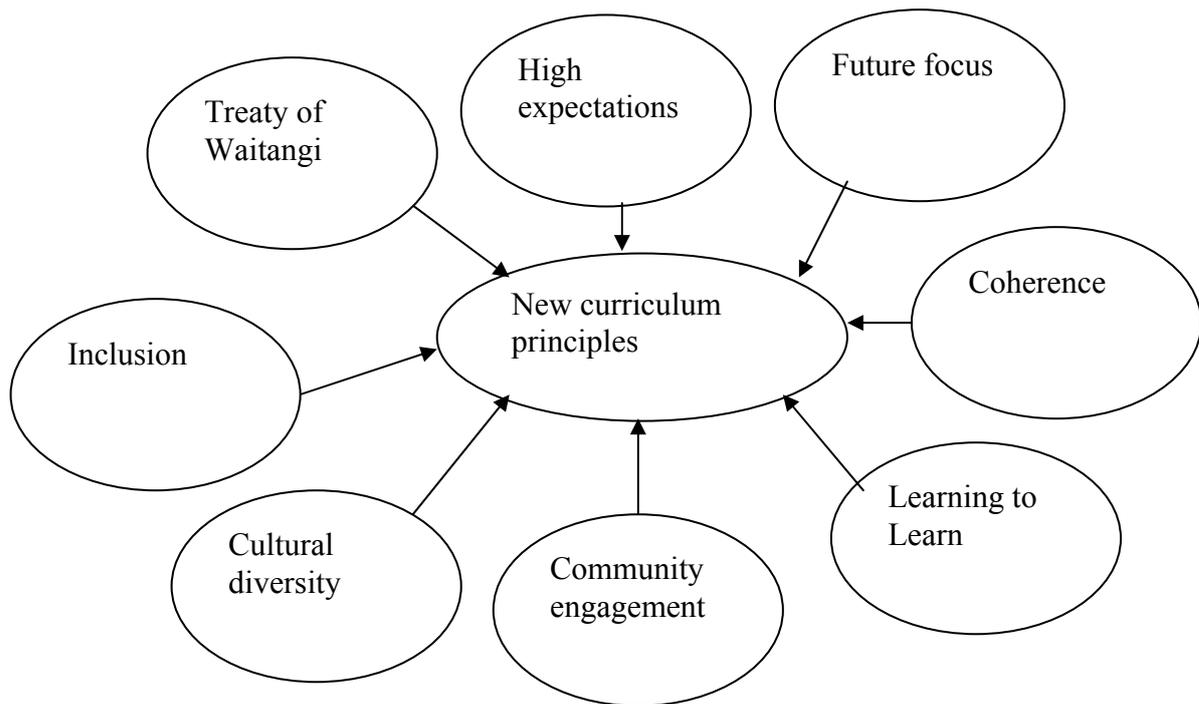


Figure 9: Principles of New Zealand curriculum

To match with the above principles a set of competencies is introduced in this new curriculum (Ministry of Education, 2007).

- Thinking.
- Participating and contributing in communities.
- Managing self.
- Using language, symbols and texts.
- Relating to others.

Each competency “includes all the skills, knowledge, attitudes and values needed to do something” (Ministry of Education, 2005). They are “more than discrete skills and attitudes: they integrate all aspects of learning” (Ministry of

Education, 2005, p. 9). Therefore, these competencies provide a suitable platform for education in each of the eight learning areas described in the curriculum.

One of the important elements of the revised New Zealand curriculum is the introduction of competencies instead of the eight essential skills listed in the curriculum framework in 1993 (New Curriculum NZ, 2007).

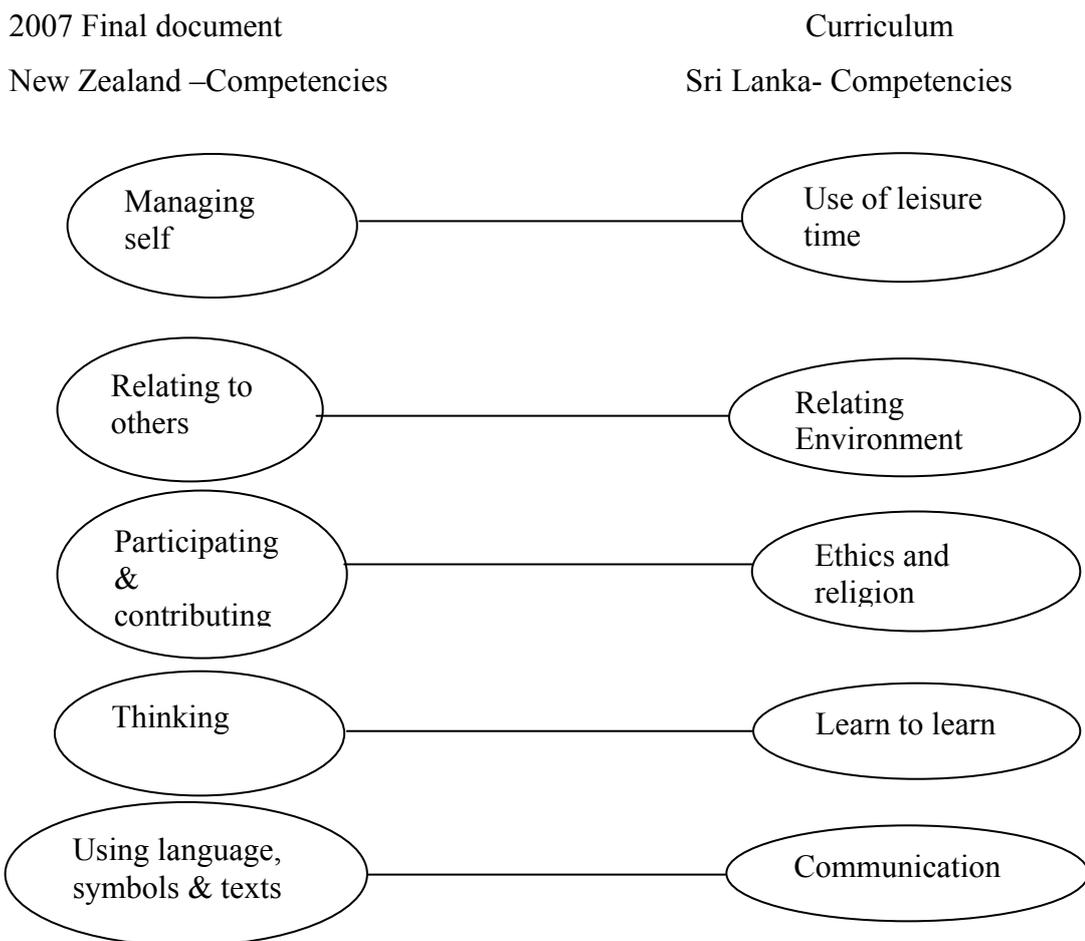


Figure 10: Comparison of Key Competencies in New Zealand and Sri Lanka

When considering both sets of competencies it is understood that the main purpose of the intended curriculum of both countries is focused on educational attainment in keeping with the potential of each individual and both curricula are based on competencies which are very similar even though the wording is slightly different.

The New Zealand Curriculum emphasises that people use the above competencies to live, learn, work and contribute as active members of their communities (New Zealand Curriculum, 2007). Similarly, the education reforms in Sri Lanka highlights the importance of developing competencies among school children with the aim of nation building and having life-long total experience (Education Reform, 1999).

However, Sri Lanka has a special interest in religion (Primary Curriculum Sri Lanka, 1999) while in New Zealand education is secular. The researcher understood that Sri Lanka is an Asian country and the origin of the education came from religious temples or institutes and this would explain why education and religion have strong bonds with each other. In New Zealand there is no state religion but private education establishments may maintain the 'special nature' of education in a religious setting, providing they fulfil the national requirement for educational outcomes.

In contrast to the New Zealand Curriculum, there are specific competencies relating to primary education that children are expected to develop in Sri Lanka. These are:

- Follow instructions-spoken, written and memorised.
- Correct errors.
- Be self-critical and self-appraising.
- Indulge in simple communication with others.
- Think in a divergent, convergent, linear and lateral manner.
- Plan and act in a goal-directed and quality-oriented manner.
- Be prepared for an unpredictable /uncertain future.
- Relax, recover, recuperate.
- Practise sensory awareness.
- Practise on going improvement.
- Learn in a self- directed and self-guided manner.

Later in the curriculum document it describes how learning in the classroom will initiate these behaviours in a rudimentary manner that is in keeping with age and readiness (Ministry of Education Sri Lanka, 1997).

#### **4.2 Curriculum implementation and the teachers' role**

All the aspects above describe how the intended curriculum belong to New Zealand and Sri Lanka. However, it is important to find out how the implemented curriculum and the attained curriculum relate to the intended curriculum. It is important to think of what actually occurs in the classroom and what students have mastered and understood in the classroom. Effective pedagogy is one of the most important aspect and the New Zealand Ministry of Education (1997) has identified that:

Students learn best when teachers:

- Encourage reflective thought and action.
- Make connections.
- Provide multiple opportunities to learn.
- Facilitate shared learning.
- Enhance the relevance of learning.
- Create a supportive learning environment.

To fulfil the above teacher qualities, curriculum development and teacher development should be reciprocal.

Similarly, the Ministry of Education, Sri Lanka (1999) identifies that effective teachers should demonstrate:

- Good organisation of subject matter.
- Effective communication.
- Knowledge of and enthusiasm for the subject matter and for teaching.
- Positive attitudes toward students.
- Fairness in examination.

- Flexibility in approaches to teaching.
- Thinking carefully about diversity of students.

Under Reforms 1999, pre-service teacher education is geared to a revised set of aims and objectives of pre-service teacher education. These aims are:

- A commitment to the rigorous training of prospective teachers for the school system.
- The recognition that prospective primary and secondary teachers need to acquire a firm basis of knowledge, understanding and skill to support the effective planning, teaching and assessment of national curriculum subjects.
- A belief in the value of developing reflective teachers, able to adopt and modify approaches in the light of changing needs and demands and able to deliver high quality education.
- A recognition of the need to address cross-curricula themes, provide preparation for national integration and peaceful co-existence, protect the environment and obtain awareness of human rights and promote equality of opportunity through teaching in school.

In addition, the curricula in Sri Lanka and the New Zealand mainly focus on

- Achievement of basic competencies.
- Promotion of metacognition and reflective processes.
- Active learning including discovery, experimentation, practical work and providing meaningful learning experiences.
- Using of a variety of resources.
- Using of a variety of assessment strategies rather than using summative tests.
- Making use of real life experiences.

However, the success of reframing the curriculum depends on actual curriculum implementation. The curriculum implementation would be

unsuccessful in the absence of a clear understanding of the goals, aims and the methods of integration. .

When the researcher studied at during her block courses she found that the Integrated Curriculum: Science and Technology primary teacher education course at one university in New Zealand had a key focus on curriculum integration and preparing students to plan integrated science and technology units appropriate to years one to eight of New Zealand schools. Therefore, the researcher's next step was to understand the key features of the Integrated Curriculum: Science and Technology course at one university in New Zealand.

### **4.3 Features of the Integrated Curriculum: Science and Technology course**

#### **4.3.1 Goals of the Integrated Curriculum: Science and Technology course**

The Integrated Curriculum: Science and Technology course is a third year paper in the pre-service primary education programme. The intention of this course is to model appropriate pedagogy that allows for effective integration of science and technology.

The teaching approach that is used in this particular course was the PBL approach. As described in Chapter 2, PBL is a curriculum model designed around real life problems that are ill-structured. In PBL, learning is initiated through ill-structured real life problem scenarios. The Integrated Curriculum: Science and Technology particular course used this approach and real world problems are used to motivate students to identify and research the concepts and principles they need to know to work through those problems. The process of PBL used in this course is shown in the following diagram.

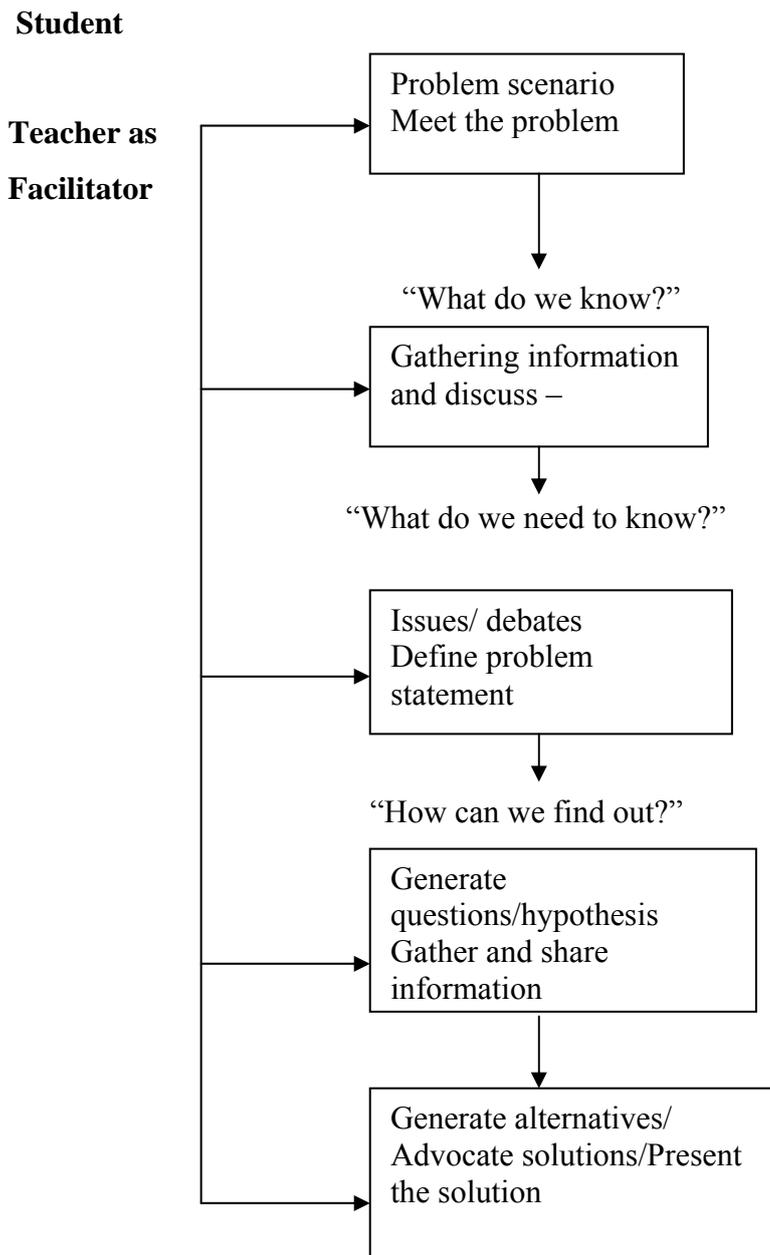


Figure 11: Steps used in PBL in the Integrated Curriculum: Science and Technology course

This process is similar to the PBL process described by Boud and Feletti (1977). The researcher found that PBL is a method of learning in which the problem is encountered and then there is a systematic student-centred enquiry process, as demonstrated in Figure 11.

Initially, the students form or are, placed in a group of three students each. Then they either choose a problem scenario from the given ones or create their own scenarios. Using concept mapping tools, students engage in

brainstorming activity to formulate the problem statement and reach the focus of their investigation, the problem questions. Students work in groups, organise their ideas and previous knowledge relating to the problem and fill out the “Need to Know” template as they progress towards identifying the solutions to the problem(s) in hand. Throughout the discussions, students have to identify the learning issues that make them exercise their metacognitive skills. In other words, these learning issues are recorded by the group and help generate metacognitive questions. Students are continually encouraged to define what they know and, more importantly, what they don’t know.

Students rank, in order of importance, the learning issues generated in the session. They decide which questions are to be followed up by the whole group and which issues can be assigned to individuals, who later teach the rest of the group. Students and the instructor also discuss what resources will be needed to research the learning issues and where they could be found.

When students reconvene, they explore the previous learning issues, integrating their new knowledge into the context of the problem. Students are encouraged to summarise their knowledge and connect new concepts to old ones. They continue to define new learning issues as they progress through the problem. Students soon see that learning is an ongoing process and that there will always be (even for the teacher) learning issues to be explored.

Course materials demonstrated the following key aspects:

- Emphasis is on learning rather than teaching.
- Learning is student- centred and students are responsible for their own learning.
- Use “Need to Know” templates .
- Work collaboratively and cooperatively in teams and learning occurs in small groups and also individually.
- Diverse ways of thinking in search for the knowledge in science and technology and its application.
- Develop intellectual curiosity and integrate academic knowledge.

- Content is interdisciplinary.
- Team work and social skills are promoted.
- Knowledge has to be constructed to apply to the solution of problems.
- Problem relates to the real world and professional practice.
- Teacher educators/lecturers act as facilitators.
- Develop time management and organisational skills.
- Use formative assessment at different stages of PBL to provide feedback.
- Help students to progress through PBL.

### **4.3.2 PBL approach and responses from the lecturers (teacher educators) and the students**

PBL is an instructional strategy that promotes active learning. According to the interviews held with teacher educators the researcher found the special features of this course.

#### **4.3.2.1 Key goals of the course**

According to the lecturers (teacher educators) this particular course is designed to fulfil the following key goals.

1. Understand the meaning of curriculum integration
2. Ensure the understanding of science with special attention to:
  - (a) scientific phenomena
  - (b) technology knowledge and understanding.
  - (c) technological capability
  - (d) links to society appropriate to learning areas identified in Science in the New Zealand Curriculum and Technology in the New Zealand Curriculum
3. Plan an integrated unit around science and technology
4. Locate and use a wide range of science and technology teaching resources

5. Identify and experience appropriate teaching pedagogy to achieve teaching integrated units in science and technology
6. Acquire abilities to use problem solving process in science and technology.

One of the major goals was to give the opportunity to understand integrated curriculum and the meaning of integration. Course developers believe that an understanding of integration should be the first step as it is necessary to get an overall idea of what is integration. However, this was not as easy as the teacher educators/lecturers expected at the planning stages. Lecturer B (teacher educator) pointed out that:

“... this paper is a third year paper and it’s a compulsory paper. We thought we were able to do more through the goal of understanding of integration very quickly. Subsequently, we found out it was not...so we had to do little bit more work with this group.”

This course is a third year paper. However, the students have already learnt and completed the professional inquiry and practice component, even though they still lack knowledge in science and integration.

Lecturer A (teacher educator) described their method as follows:

“First approach is to do reading. Some of these reading would be more equal their work. First assignment is like that. Students learn how to do integration and learn about modes of integration.”

Students, therefore, have an opportunity to learn how to plan an integrated science and technology unit on their own. The main thing is first they have to understand, through reading the literature, what integration is.

“We teach it an integrated way. And students learn it an integrated way. Then they will find it very easy to do it where it comes to the classroom.”

Students are responsible for their own learning and lecturers motivate them to engage in the learning process. Lecturer D (teacher educator) described:

“They understand their own learning, their own motivation, their own attitudes by knowing that the students will be experiencing the same when they teach integrated units in the classroom. Having gone through with themselves, this PBL activity and gone through with themselves they even themselves know what will be happening to the students in their classroom....”

#### **4.3.2.2 Lecturer’s (teacher educator’s) role as a facilitator in a PBL approach**

The literature on PBL indicates the importance of the teacher/tutor in the success of any PBL programme and it requires changes in the way teachers’ plan, instruct, direct learning, transmit knowledge, oversee instruction and assess learning (Torp & Sage, 1998).

From the interviews the researcher found that the teacher educator’s role changes from the traditional lecturer’s role. According to the analysis:

Lecturer (Teacher educator) as facilitator:

- Design ill-structured problem scenarios and select concepts that would suit the course concepts.
- Work in teams and enhance student learning.
- Recognise the interdisciplinary nature of the course.
- Act as models to ask metacognitive question.
- Be supportive and flexible.
- Indicate when additional information is required.
- Refer students to resources as appropriate.
- Keep the learning process moving.
- Understand the learning process to make PBL successful.

Lecturer B (teacher educator) pointed out that

“ ...differences have led to us changing teaching styles this particular paper caused us ...teaching into this coaching role, this facilitative role, this questioning mode. For me personally I learnt how the questions work effectively, to help students move towards them

confronting original ideas in front of new ideas. This also has got me thinking about my own evaluating, my own thinking about thinking. And saying, well, if I'm going to this process, how do I get the students to engage with a similar type of process as they are learning about integration learning about science..."

Further, Lecturer B (teacher educator) emphasised the importance of using questioning to facilitate students moving towards the right direction.

"...So a lot of students realise that the answer I give them is another question which leads them towards the answer for themselves."

The facilitator role is more difficult than the traditional lecturer's role.

Lecturer C (teacher educator) pointed out that:

"Mainly students are responsible for their learning. We guide them and we are facilitating. One major difference is that it does not mean we do not do anything. We have to work more than that we are working in a traditional course. Students are free to ask anytime. They can come with problems and also we use team teaching approach. I teach one part. If they don't find me they could go to someone else and get more information and better reference."

#### **4.3.2.3 Changes in teaching approach from traditional methods to PBL**

The teaching approaches used in this particular course are different from the traditional lecture method. Lecturer B (teacher educator) pointed out how teaching approach is different:

"Traditional courses is mainly, ...this is my personal opinion, traditional courses tend to say read this do this read this do that. You may get your hands on a lot of things that go through the course that you have to keep up with and what this particular approach paper does is, I think differs in two major ways. One way is we do quality over quantity. We want quality understanding of curriculum integration and about science investigating and technology investigations. We want investigations rather than read, read, read. We want students involved in both of those curriculum areas and that's a big point that we want which is quite different. So a lot of time is their time, it's us as facilitators, coaches, modellers and what we are asking to do."

Lecturer A (teacher educator) describes major differences as:

"Traditional courses are lecture-centred. Course like this is student centred. Students have freedom. They have freedom to inquire. They

have freedom to plan. They have freedom to research ...They know that we expect them to be thinking and questioning in very high level. We do use Bloom's taxonomy."

#### **4.3.2.4 Assessment procedures in PBL**

A variety of assessment techniques are used in this course that are different from traditional paper-pencil tests. Assessment One focused on analysing methods of integration with special attention to the literature on problem based learning. Assessment Two was an integrated science and technology project. The science investigation using PBL approach was an integral part of this project. The initial step of this project was finding a suitable problem scenario. The Project report was presented electronically and a power point presentation was done by groups. Assessment Three was focused on preparing lesson plans for integrated primary science units by using PBL approach. All of these assessments were different from traditional paper pencil tests.

Lecturer A (teacher educator) notes:

"We are constantly assessing them. Traditional papers assessed very conventional manner. Paper and pencil tests. We do diagnostic tests. Diary or logs some other assessments. Electronically, they have to do power point presentations."

Lecturer C (teacher educator) notes:

"Evaluation process is changed. We are also evaluating the process not the product only. The process of learning how they have being through."

#### **4.3.2.5 ICT is embedded**

Using ICT in teacher education is a special aspect of this particular course. The researcher wanted to capture the staff perspective on this particular programme as Ministry of Education, Sri Lanka has a long term objective to integrate ICT in teacher education as a tool, a subject and an education resource. Therefore, she clearly needed to discover more about using ICT in this paper.

Lecturer C (teacher educator) stated that:

“... expected them to demonstrate an ability to use new educational technologies. Some of them are coming with a very low level of computer literacy; we expect them to raise that to a quite a high degree in this paper and so we force them to do work electronically and they have to submit it and they are forced to use a bit of software that we put out online or in class we set up action environments that between External and Internal students.”

Lecturer B (teacher educator) stated that:

“We created a CD ROM with activities and exercises which help them to do similar things that we do in the class.”

In addition, Lecturer C (teacher educator) pointed out:

“They had to do digital presentation of their work in submission. This is another goal from MOE, NZ. Integrating ICT in the curriculum as well as from other sections.”

### **4.3.3 Student views on the Integrated Curriculum: Science and Technology course**

In this section, the researcher presents a brief description of the responses given by the students of the Integrated Curriculum: Science and Technology course. These responses demonstrated the students' views on this course and provide a broad picture of the course implementation and how PBL works. According to the students' views on this particular course the learning experiences were rewarding. Most students commented that the knowledge gained through PBL was highly retained. In addition, most students commented that it was very helpful to them in preparing themselves for teaching in primary classrooms. As mentioned in section 2.1 (the literature review), there is evidence that primary teachers in New Zealand schools are facing problems in teaching science because they lack science knowledge, have misconceptions and an insufficient coherent understanding about science so they do not organise their lessons around science.

The students commented that the course helped them to plan and implement integrated units in the primary curriculum. PBL scenario discussions gave them an opportunity to interact with each other's opinions and enabled them to share ideas, knowledge and gain transformative learning experiences. They found that PBL provided them with an active way to learn in a challenging environment. This is the important aspect that ERA teacher education in Sri Lanka has to focus on in order to fulfil the objectives stated in the ERA curriculum for Sri Lanka. The student responses were summarised according to the data collection themes and are described below. The direct quotes from the student responses are included in each section as evidence for the summarised ideas. (A sample of student responses is given in the Appendix XIV)

1. Student expectations from taking this course:

- To gain experience for practical ways to integrate science and technology.
- To teach successfully in the classroom.
- To get a deeper understanding of science
- To understand that science and technology are difficult subjects to teach and they need higher order cognitive skills to teach those subjects in the classroom.

Direct quotes from student responses for the question no. 4 in the questionnaire are given below.

*“ practical way by which science and technology can be successfully integrated”*

*“That I will be employ an integrated unit of science and technology in the classroom.”*

2. Contribution in preparing them for classroom preparation:

- Gained opportunities to understand integration
- Learned how science and technology integration could be accomplished
- Understand the school curriculum areas

- Understand the integration process first hand through the assignments.
- Learned how to integrate science and technology with other subjects as well.

Direct quotes from student responses for the question no. 5 in the questionnaire are given below.

*“I believe this paper was key to my preparation as a teacher as I was learning the integration processes first hand during assignments.”*

*“Teaches us how to integrate subjects well, though science and technology are not the only subjects that integrate well.”*

*“It opened my eyes up to the learning opportunities that arise from teaching in an integrated manner. The assignment were very useful and relevant to teaching.”*

### 3. How the students met their expectations through this course

- Built up confidence to teach science and technology.
- Recognised the subject areas.
- Learned integration through PBL
- Understood how to integrate with other subjects as well.

Direct quotes from student responses for the question no. 6 in the questionnaire are given below.

*“It helped me gain confidence and passion for areas that I wasn’t quite so confident or passionate.”*

*“It is making us really think about the whole of teaching; integration & inclusion in both.”*

*“Shows **the integration and Problem Based learning process.**”*

### 4. Enhancing real classroom practice

- Practise enabled them to model the classroom teaching
- Gave them an awareness of how to do integrated teaching
- Directed them to classroom teaching in an integrated manner

Direct quotes from student responses for the question no. 8 in the questionnaire are given below.

*“Really models classroom practice as we actually move through the processes.”*

*“Very well. It makes me more aware of other things that may be integrated successfully with science and technology.”*

*“The learning was real and motivating and could easily be implemented into classroom.”*

*“Yeah, it would be possible to do this in a classroom. I have never actually seen science or tech. taught in a classroom. It has shown me that **Problem Based learning** is a great way to do it”.*

#### 5. Different teaching approaches

- Moved from teacher-centred to completely student-centred methods
- Engaged in PBL
- Saw the lecturers as facilitators

Direct quotes from student responses for the question no. 9 in the questionnaire are given below.

*“Yes, we were. We looked at how you can move along a contribution in relation to integration, you can move from teacher directed to extremely student centered.”*

*“yes, PBL.”*

*“Yes. Very much. Having lecturer as a facilitator of learning.”*

#### 6. Usefulness of different teaching approaches

- Incorporated a fully student centre approach in teaching the course
- Allowed opportunities to adapt to different learning styles
- Gave exposure to way of teaching in this curriculum area in the school.
- Motivated them to try and think about different ways of teaching
- Gave them courage to become more flexible in the classroom.

Direct quotes from student responses for the question no. 10 in the questionnaire are given below.

*“Yes, new ways of teaching to curriculum areas.”*

*“ Yes, it shows you different ways of doing things. Thoughts of how to best teach become broader and more flexible.”*

*“Everyone found one that they ‘clicked’ with and felt that they could incorporate this into their teaching philosophy. I enjoyed the extreme student centered strategies.”*

*“To create different learning styles to adapt to children’s needs.”*

#### 7. Assessment procedures

- Supported their learning
- Provided constructive feedback
- Beneficial for their development
- Recognised their needs to acquire new knowledge
- Promoted learning

Direct quotes from student responses for the question no. 11 in the questionnaire are given below.

*“They do very much, the evaluation process was extremely beneficial.”*

*“Yes, very much so.”*

#### 8. Workload of this course compared with other courses

- Workload is heavy but worked as a group and so it was not a real issue
- Large assignments
- More time needed
- Able to work on assignments within the class time
- Definitely helped them

Direct quotes from student responses for the question no. 12 in the questionnaire are given below.

*“The PBL was a huge assignment.”*

*“It was great being able to have the opportunity to work on assignments within class time. Definitely helped.”*

#### 9. Learning support received when they were doing the course

- ICT
- Other resources
- Academic support from the lecturers

- Support from the peers.

Direct quotes from student responses for the question no. 13 in the questionnaire are given below.

*“Heaps, ICT, resources , etc.”*

*“Lots from Lecturer B. Also the knowledge of other group members.”*

*“both peers and teachers”*

*“B was an extremely supporting lecturer. We sought his assistance on many occasions. I also felt that the learning support from my fellow peers was invaluable.”*

#### 10. Collaborative group activities

- Broadened social skills
- Gained different ideas and views
- Sometimes hard to rely on other people
- Greatly benefited because of so much of the time being spent in a group so you learn more about cooperation and cooperative learning

Direct quotes from student responses for the question no. 14 in the questionnaire are given below.

*“Learnt to work in a group context broadened my social skills.”*

*The support and different ideas is a good way and being able to do it through class time.”*

*“I don’t like group assignments much. It’s hard to rely on other people who are contributing to your mark.”*

#### 11. How does this integrated curriculum fulfil the objectives stated in the national primary school science and technology curriculum?

- Meets criteria set
- Deals with objectives well
- Student centred
- Provided real world and integrated learning

Direct quotes from student responses for the question no. 15 in the questionnaire are given below.

*“Fulfills them as we are providing real world and integrated learning.”*

*“we worked our assignment so that it did met the objectives.”*

12. Teacher characteristics aimed to encourage:

- Participation as fully as possible getting hands-on learning focused on child-centred approach.
- Learning about the facilitator role.
- Collaboration and team work.
- Working with peers/colleagues.
- Development of creative thinking.
- Use of PBL as an approach for learning in the classroom.

Direct quotes from student responses for the question no. 16 in the questionnaire are given below.

*“Problem Based learning, integration, collaborative teamwork.”*

*“The use of Problem Based learning as a tool for learning in the classroom.”*

*“to have the class participate as fully as possible hands on learning , child centred, have them ask questions and come up in which ever way with the answers-you are there to support-not just tell.”*

13. Confidence built up by completion of this course

- Extremely capable because it gives a real passion for the subject area
- Much more confident than prior to taking this paper
- Very good experience
- Gave us the basis of what technological investigation is versus science investigation
- Very confident

Direct quotes from student responses for the question no. 17 in the questionnaire are given below.

*“Extremely capable. I have a real passion for these subjects now after having taking the paper.”*

*Gain confidence will always give thing a go. It is fun so will be a good experience with students.”*

*“It has helped me tease out the basis of a tech. investigation vs. a science investigation which was very helpful.”*

#### **4.4 Discussion and implication of the results**

The teaching approach that is used in this particular course is the PBL approach where learning is initiated by a problem. In this approach real world problems are used to motivate students to identify and research the concepts and principles they need to know to work through those problems. Stepien et al. (1993) provide the following summary of PBL as follows:

“Problem based learning is apprenticeship for real life problem solving...students find a situation with undefined problems, incomplete information and unasked questions. The scenarios presented to the students demand problem solving the way we find it in life: defining and detailing issues, creating hypotheses, searching for and then scanning data, refining hypotheses with the help of the collected data, conducting empirical experiments or other research, developing solutions that fit the conditions of the problem and evaluating and/or justifying their solutions. ...” (p. 342)

In addition to that Gallagher et al. (1995) used a framework of PBL that emphasised a series of questions and these questions are: What do I know ?, What do I need to know ?, What do I need to learn ?, How do I measure or describe the results? Similar process was used in this particular Science and Technology course and the Figure 13 in this chapter describes the details.

From the teacher educator and the student responses the researcher found the following key elements of PBL approach:

- Use problem scenarios that relate to real world
- Emphasis is on learning rather than teaching
- Teacher educators (lecturers) act as facilitators

- Students work cooperatively in teams and learning occurs in small groups/individually to gain confidence in teaching integrated science units in primary school

#### 4.4.1 Use problem scenarios that relate to real world

PBL is initiated by a problem scenario. The problem scenarios provided students with a learning style that was meaningful and helped them to think deeply about important issues and becoming intentional learners as they generate their own questions, plans and goals.

- Problem solving motivates the learning.
- Pose questions and identify what they need to know in order to address the questions.
- Gather needed information through individual and group investigation.
- Generate and evaluate possible solutions and work together in their problem solving process.
- Integrated learning is promoted through the problem.

#### 4.4.2. Emphasis is on learning rather than teaching

Students were engaged in ill-structured open-ended problems which there are no prescribed solutions. As Edwards and Hammer (2007), describe PBL draws on many of the fundamental principles associated with constructivist and social constructivist philosophies of learning. The students were responsible for their own learning and the experience they received provided opportunities to broaden their knowledge. The following aspects of PBL were found from this study are:

- Student-centred learning.
- Self-directed learning.
- Learning about learning.
- Constructive and transformative.

#### 4.4.3. Teacher educators (lecturers) act as facilitators.

The teacher educators act as meta cognitive coaches through out the PBL process. They model and coach, giving guidance as needed but encouraging students independence in goal setting and decision making. The literature on PBL indicates the importance of the teacher in the success of any PBL programme and PBL requires changes in the way teachers plan instruction, direct learning, transmit knowledge and assess learning (Gorgdon et al., 2001; Torp & Sage, 1998). The teacher educators emphasised how they changed their teaching role as facilitators. According to findings:

- Teacher educators serve to guide and facilitate but the ownership of the problem is given to the students
- Teacher educators provide the resources and academic support when necessary

4.4.4 Students work cooperatively in teams and learning occurs in small groups/individually to gain confident in teaching integrated science units in primary school.

According to Savin-Baden (2000) PBL encourages students to work together in their problem solving and product development.

“As a learning approach PBL draws on essentially constructivist and social constructivist principles of learning, advocating student centred engagement with course materials and content as well as student interaction with peers as central to the process associated with learning how to apply theoretical knowledge to professional contexts. In this sense, PBL similarly emphasises the relationship between theory and practice.” (pp 5-6)

Student perspectives on the particular course provided evidence for the above idea and these aspects of PBL were emphasised:

- Group discussions and finding solutions as a team are encouraged.
- Group work helps them learn new skills.
- The diversity of the ideas, opinions and knowledge is shared.
- Social skills and team work are promoted.
- Understand the integrated nature of the subject area.
- Make them confident in classroom teaching as beginners.

From this study the researcher found that PBL provides opportunities to:

- examine and try out what the student knows
- discover what students need to learn
- gather information and learn new concepts, principles, or skills
- use “Need to Know” template and understand the process of finding alternative solutions
- understand the integrated nature of the primary curriculum

From the teacher educator and student responses the researcher found that as a learning approach PBL draws on constructivist principles of learning, advocates student centred engagement and interaction with peers that is associated with learning how to apply theoretical knowledge to a variety of practical settings (Savin-Baden,2000).

The subject ERA is an integrated subject with several disciplines, as described in Chapter 4 page 80 of this thesis. From the student and the teacher educator responses of the Integrated Curriculum: Science and Technology course the researcher discovered that PBL is highly motivating for both students and the teacher educators. The problem scenarios simulated the real world context and enabled the students to acquire the new skills needed for 21<sup>st</sup> century learners. The scenarios provided them with a learning style that was meaningful and helped them to think deeply about important issues facing as begging teachers. PBL is closely aligned with the objectives of the ERA curriculum in Sri Lanka which focuses mainly on learning through the environment. As mentioned in section 4.1.1, all themes in the ERA curriculum are related to everyday life. PBL begins with an authentic problem and it matches the philosophy that underpins ERA. It is aimed at

introducing new ideas and concepts through the natural settings and surroundings. On the basis of research findings the researcher suggests that PBL has the potential to make a valuable contribution in preparing effective primary teachers. Therefore, PBL would be beneficial for the Environment Related Activities pre-service primary teacher education programme in Sri Lanka; the researcher wants to explore its suitability for use in Sri Lanka.

#### **4.5 Chapter summary**

In this chapter the researcher described the analysis of data including document analysis, interview data and student views about the Integrated Curriculum: Science and Technology course and revealed the characteristics of PBL approach used at one of the university in New Zealand. The research findings and an exploration of the potential suitability for an alternate teacher education programme for Sri Lanka is discussed in Chapter 5.

## **Chapter 5.0 - Research findings and an exploration of the potential suitability for an alternate teacher education programme for Sri Lanka**

### **5.1 Key elements of PBL and why it would be suitable for pre-service primary education in Sri Lanka**

The researcher's aim was to explore the potential of an alternative teacher education programme in the ERA primary pre-service teacher education curriculum and in this chapter she explains why the PBL approach would match the ERA teacher education curriculum in Sri Lanka in order to fulfil the purpose stated in the teacher education programme in Sri Lanka.

From the data analysis described in Chapter 4, section 4.3.3, the researcher found that the students' view of the PBL approach used at one New Zealand university's Integrated Curriculum: Science and Technology education course is that it helps them become

- Extremely capable because it gives real passion for the subject area.
- Much more confident than prior to taking this paper.
- Very confident in classroom teaching.  
and was a
- Very good experience.
- Gave the basis of what technological investigation versus science investigation is.

As described in Chapter 2, the particular course, Integrated Curriculum: Science and Technology education is aimed at the primary school science and technology curriculum in New Zealand; science is also part of the ERA curriculum in Sri Lanka. The researcher's focus was on exploring the potential for an alternative teacher education programme for ERA. She also wanted to focus on the acquisition of new knowledge, as used in the PBL approach, that would be suitable for integrating several different subject disciplines in ERA (Chapter 4, section 4.1, Figure 8: Model for ERA). In the PBL approach all

problem scenarios are taken from the real world and the researcher expects that PBL could help in preparing student teachers to be successful in different classroom settings, and different geographical regions, as it provides authentic learning environments. The concept map built up from the scenario discussion would provide an impetus for the acquisition of new knowledge and the researcher foresees that it would be the ideal approach for curriculum integration. The use of concept mapping in PBL scenario discussion is shown in Figure 14.

Keppell (2006) writes of the benefits of PBL for teacher education suggesting that the approach is a useful means of bridging the gap between theory and practice for pre-service teachers. Students from the Integrated Curriculum: Science and Technology course provided evidence for the above idea and indicated that engagement with the scenarios kept them motivated; its authentic nature made the learning meaningful and encouraged them to think beyond just how to carry out their teaching and what to include.

Similarly, Savery and Duffy (1995) also described PBL as an instructional model from the cognitive constructivist perspective to motivate learners in an authentic learning environment. Further, learners construct new knowledge based on what the students already know about the problem. In addition, Kain and Tan (2003, cited in Hsu, 2004) described PBL as a powerful pedagogy; it develops collaborative learning, critical thinking and self directed learning to improve teaching.

From the data analysis in Chapter 4 the researcher has identified the following key features of the Integrated Curriculum: Science and Technology particular course.

- Use problem scenarios that relate to real world.
- Emphasis is on learning rather than teaching.
- Teacher educators (lecturers) act as facilitators.
- Students work cooperatively in teams and learning occurs in small groups/individually.

From the teacher educators and student responses the researcher found that as a learning approach PBL draws on constructivist principles of learning, advocating student centred engagement and interaction with peers associated with learning how to apply theoretical knowledge to variety of practical settings. In this way, the researcher wanted to discover how to apply theoretical knowledge to practical applications. It is theorised that these key features suit the ERA teacher education programme in Sri Lanka.

The subject ERA is an integrated subject with several disciplines, as described previously in Chapter 4, Figure 8. As a teacher educator from Sri Lanka she found that student teachers find difficulties in preparing integrated units in the ERA curriculum particularly those involving several subject disciplines.

From this study the researcher found that PBL provides opportunities to

- Examine and try out what he/she knows.
- Discover what he/she needs to learn.
- Gather information and learn new concepts, principles, or skills.
- Use what do they know about templates and understand the process of finding alternative solutions.
- Understand interdisciplinary education.

Therefore, PBL would be suitable for the ERA curriculum pre-service teacher education in Sri Lanka and the researcher describes ways of possible application in an alternative teacher education programme for Sri Lanka by introducing problem scenarios taken from real life contexts in Sri Lanka.

### **5.1.1 Introducing a problem scenario for the ERA teacher education programme in Sri Lanka**

ERA is a major subject in the primary school curriculum in Sri Lanka (see Chapter 1, figure 2, p. 10).

The ERA primary curriculum consists of major themes, for example:

- Our home our school
- Animals in the garden
- Festivals and we are Sri Lankans
- Things we eat
- Water
- The sky we see

All these themes relate to the everyday life of children and all learning activities are focused almost exclusively on “learning through the environment.” As mentioned in Chapter 1, the philosophy that underpins this approach is that children learn more effectively when new ideas are introduced in their natural settings and surroundings. In this way children construct new knowledge and develop new skills on the foundations of their past experiences and in the real life context.

Therefore, the ERA teacher education curriculum is focused on achieving the above purpose. To fulfil the above goals students who are following the teacher education course will be able to:

- Understand the nature and objectives of the primary ERA curriculum, including a thematic integrated approach
- Work effectively with the primary school ERA teachers’ guide in the preparation of lessons and learning aids, including adapting the content to local situation and needs
- Understand the varying developmental levels and learning needs of pupils through gathering and assessing what environmental knowledge, experience and attitudes primary children bring with them

to school and also at the three key stages in regard to the learning objectives in the primary ERA curriculum.

- Acquire strategies to help pupils develop investigation skills for gathering, recording, interpreting and reporting information in all learning areas

According to the definitions within the research and from the analysis of student and teacher educator responses it appears that the PBL approach used in the Integrated Curriculum: Science and Technology teacher education course fits with the New Zealand curriculum goals. Similarly, the ERA teacher education programme in Sri Lanka would fit the PBL approach as it focuses on similar goals.

As mentioned earlier, the researcher's aim was to explore the potential suitability of an alternate teacher education programme in Sri Lanka. PBL starts with problem scenarios and selecting a suitable problem scenario is one of the most important aspects of the PBL approach. Two teacher educators who contributed to the designing of this particular course described the importance of choosing the correct scenario in order to balance the technology and science aspects in the science curriculum. One teacher educator commented on the necessity of choosing problem scenarios that were manageable. Based on this comment, the researcher finds it is important to present a number of sample scenarios and analyse one to determine how PBL could make a difference in the classroom in order to understand the potential of PBL for an alternative teacher education programme for ERA in Sri Lanka. An example of a problem scenario that would fit the Sri Lankan context is presented in order to justify the suitability of PBL for the ERA curriculum. These problem scenarios would give an idea of the starting point for an alternative teacher education programme in Sri Lanka.

#### 5.1.1.1. Example. Theme: Water

Sub theme: Contamination of water

The news article below describes an environmental problem which occurred in the Mahaveli River in Sri Lanka. In Sri Lanka, the Central Environment

Authority is the governing body that controls and investigates environmental problems in the country. Further, this organisation conducts awareness programmes for school children on environmental protection and reducing environmental pollution.

If any environmental problem occurs in a particular area in Sri Lanka the Regional Environmental Officer in charge of the Central Environmental Authority in that particular region is responsible to find out what is the problem with his/her team and needs to submit a report on every aspect of the problem and give suggestions to mitigate it.

This is a real, contextual and local problem scenario that could be used in an alternative teacher education programme. Student teachers could use PBL approach and find out the solutions by assuming they are the team of Environmental Officers in the Gampola region in Sri Lanka. The PBL tutor could provide the memo and the newspaper article given below to student teachers at the beginning of the PBL process.

MEMO

Date: 11 Jul 2007

To: Environment Officer –Gampola Region

From: Central Environmental Authority

Subject: Contamination of Mahaveli River

Drawing your attention to the attached Newspaper article on 10 July, 2007 in Daily News. It provides details of contamination of Mahaweli River due to garbage dumping practices and mismanaged sewage systems in your area. In addition to that it is the only source for pipe borne water to that area.

As the environmental officer in this area you need to determine how this contamination will affect the drinking water in this area.

There also needs to be a report on how you will solve this problem and do the environmental clean up. I would appreciate a report from you by.....(Date)

(Newspaper article is attached herewith)

# Daily News.lk

Tuesday, 10 July 2007

 EMAIL |  PRINT |  FEEDBACK

## **Mahaweli river contaminated**

Manjula Fernando

**GAMPOLA:** Poor garbage dumping practices and mismanaged sewage systems in the Gampola town have contributed to the contamination of the Mahaweli river which serves as the only source for pipe borne water to the area.

The National Water supply and Drainage Board (NWS & DB) warns if the problem is left unattended, there will be a major environmental disaster, not to mention heavy burden of switching into costly advanced water purifying techniques to ensure safe water for the people in the area.

"The water in the Mahaweli river, especially in the Paradeka tributary where our water plants are located, is highly polluted by garbage and waste from the buildings on the river boundary," NWS & DB Deputy General Manager for Central and Sabaragamuwa, Eng.M.A.M.S.L.Attanayake said.

He said the Board had to chlorinate the water in an extensive process to turn it into a potable state.

Attanayake ensured the water was 100 per cent safe to drink once it is purified by the Board, complying with the Sri Lanka Standard (SLS) norms as they continue to do. This technique goes even beyond the World Health Organisation standard.

But if the current rate of contamination is not immediately arrested, it will not be long that they are compelled to switch to advanced techniques of purification which are very costly.

He blamed the Gampola Urban Council for not managing the environment and maintaining a proper system. The shops and boutiques in the Gampola township, adjoining the Mahaweli river, dump its waste directly into the river.

Gampola experienced an outbreak of Hepatitis A epidemic in May this year. Mainly spread through drinking water, the wrath for the epidemic was directly levelled at the Water Board.

The above problem can be matched with the steps given in the PBL approach used in the science and technology course as follows:

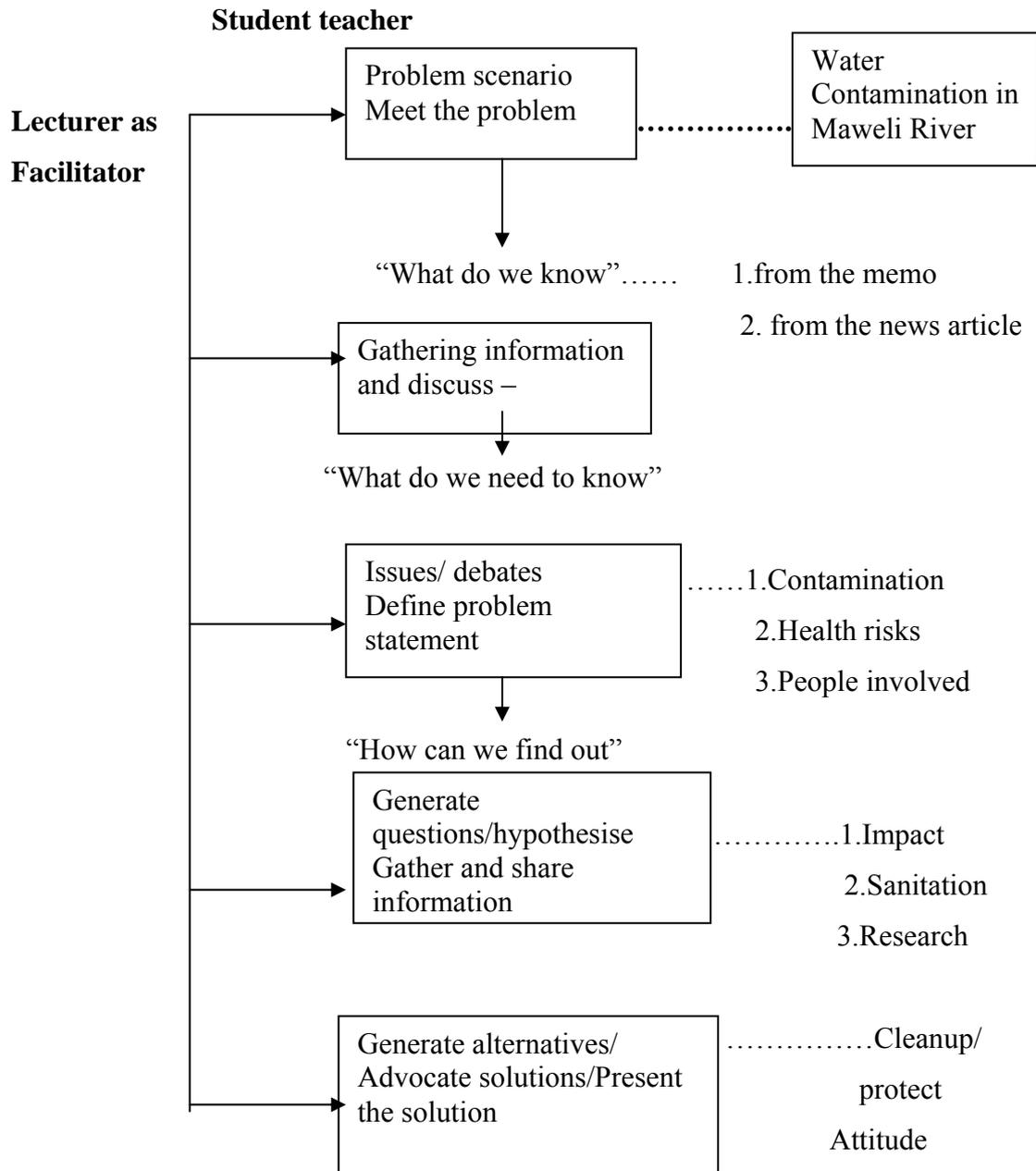


Figure 12: Matching the steps used in PBL with possible application in Sri Lanka

Matching with “What do we know” templates used in the PBL approach at this particular College of Education in New Zealand

**What do we know** (from the memo) ?

- Bad practices in garbage dumping in this area
- Mismanaged sewage systems
- Contamination at the Mahaweli River
- Newspaper article has more information

**What do we know** (from the newspaper article) ?

- There will be a major water pollution problem if the situation is not controlled
- Health risk for public as it is affected by drinking water
- Gampola Regional Council is responsible for managing the environment
- There is warning from the National Water Supply and Drainage Board
- Hepatitis epidemic spread in this area due to bad drinking water
- Advanced purification methods are very costly

**What do we need to know?**

- What are the main causes for water contamination?
- How it happens?
- From where the garbage comes from?
- Who is responsible for keeping it clean?
- Are there any leaky home septic tanks near the river?
- How would it affect the drinking water?
- What type of bacteria are found?
- How will it affect public health?
- What is the best solution to that problem?

### **How can we find out?**

- Causes for the contamination
- Evidence of contamination
- Possible solutions

As demonstrated by the model described in Figure 13, the above example provides evidence that PBL could be transferred to the Sri Lankan context. Following the key steps demonstrated of the PBL process used in the Integrated Curriculum: Science and Technology course at one university will help in understanding the way to proceed in an alternative teacher education programme in Sri Lanka.

- Student teachers are presented with a problem. They work in groups, organise their ideas and previous knowledge relating to the problem and attempt the broad nature of the problem. This is the basic principle supporting the concept of PBL. In other words, learning is initiated by a problem scenario.
- Student teachers are continually encouraged to define what they know and, more importantly, what they do not know.
- Student teachers and the lecturer also discuss what resources will be needed to research the learning issues and where they could be found. A variety of questions is used to get more information
- Student teachers are integrating their new knowledge into the context of the problem. They are encouraged to summarise their knowledge and connect new concepts to old ones. They continue to define new learning issues as they progress through the problem. Students soon see that learning is an ongoing process and that there will always be (even for the teacher) learning issues to be explored.
- In addition, to find possible solution for the above problem student teachers are able to develop their skills relating to multi-dimensional community based research, developing questionnaires, recording qualitative and quantitative data, communicating, etc

- Students understand the integrated nature of the science and technology units and interpret what is possible to do in the primary school
- Students work in teams to plan primary school lessons

### **5.1.2 Lecturer's role as a facilitator - facilitator role found in the PBL approach used in New Zealand and how it matches the ERA teacher education programme in Sri Lanka**

The literature on PBL indicates the importance of the teacher/tutor in the success of any PBL programme. It requires changes in the way teachers plan, instruct, direct learning, transmit knowledge and oversee investigations and assess learning (Torp & Sage, 1998). The data analysis in Chapter 4 provides evidence in this particular course, Integrated Curriculum: Science and Technology, how the teacher educator's role changes from the traditional lecturer's role to a facilitator while using PBL approach. This changing role of the lecturer in New Zealand closely matches that of the ERA teacher education programme in Sri Lanka.

#### **5.1.2.1. Designed ill-structured problem scenarios and selecting concepts that would be parallel to the required course concepts**

From the data analysis described in Chapter 4, the researcher found that the Integrated Curriculum: Science and Technology course demonstrated several problem scenarios in the course. The researcher would suggest development of contextual problem scenarios for students of the Sri Lankan pre-service primary teacher education Programmes particularly for the ERA curriculum as in the Integrated Curriculum: Science and Technology course. The problem scenarios would help student teachers at the Colleges of Education in Sri Lanka to:

- Engage in collaborative learning
- Make links between theory and practice

- Understand the teaching role that they are required to play in the real classroom

The above problem scenario is one example that would match with the themes in ERA and it provides evidence for developing suitable problem scenarios for ERA in the teacher education programme in Sri Lanka. As with the lecturers/teacher educators involved at this particular College of Education in New Zealand the researcher expects that the lecturers at National Colleges of Education in Sri Lanka would be able to develop suitable problem scenarios in real life contexts in Sri Lanka.

#### **5.1.2.2 Developing concept maps through scenario discussions in PBL and linked subject disciplines**

Concepts, concept links, hierarchies and cross-links are the components of a concept map. A concept is defined as a perceived regularity in events or objects designated by a label (Hsu, 2004). A concept map can provide a visual picture that shows some of the pathways that can be taken to understand the relationship between the concepts visualised. Cross-links are used in a concept map to show the connection between two or more concepts (Hsu, 2004). Kunowski (2005) describes the following key features of the concept maps:

- Concept maps are usually hierarchical;
- The most inclusive or general concept is placed at the top of the map and other inclusive concepts are then placed in a rank order
- The remaining concepts /ideas are arranged in a manner that best illustrates an understanding of the topic;
- Lines/arrows are drawn linking any concepts labels which are considered to be related.

Therefore, concept mapping can be used to assist student teachers to construct the meaning of what is to be learned. Further, a concept map is a graphical representation that takes into account the knowledge framework and detects students' knowledge structures after an educational intervention. In addition, a concept map can demonstrate some of the pathways that can be used to

understand the meaning of concepts. Therefore, the researcher understands that concept mapping can be used to move the focus of problem based scenario discussions further as it helps them understand the links and cross-links between concepts. On completion of the map, student teachers can discuss the justification for the arrangement of the map and how it would relate with each area of the subject discipline. The researcher wanted to understand the potential of PBL that could be adapted to the ERA teacher education programme in Sri Lanka and she realised that using the concept map technique during the scenario discussions will help to link several subject disciplines, as stated in ERA.

A concept map developed for the sample problem scenario in 5.1.1.1 is given below.

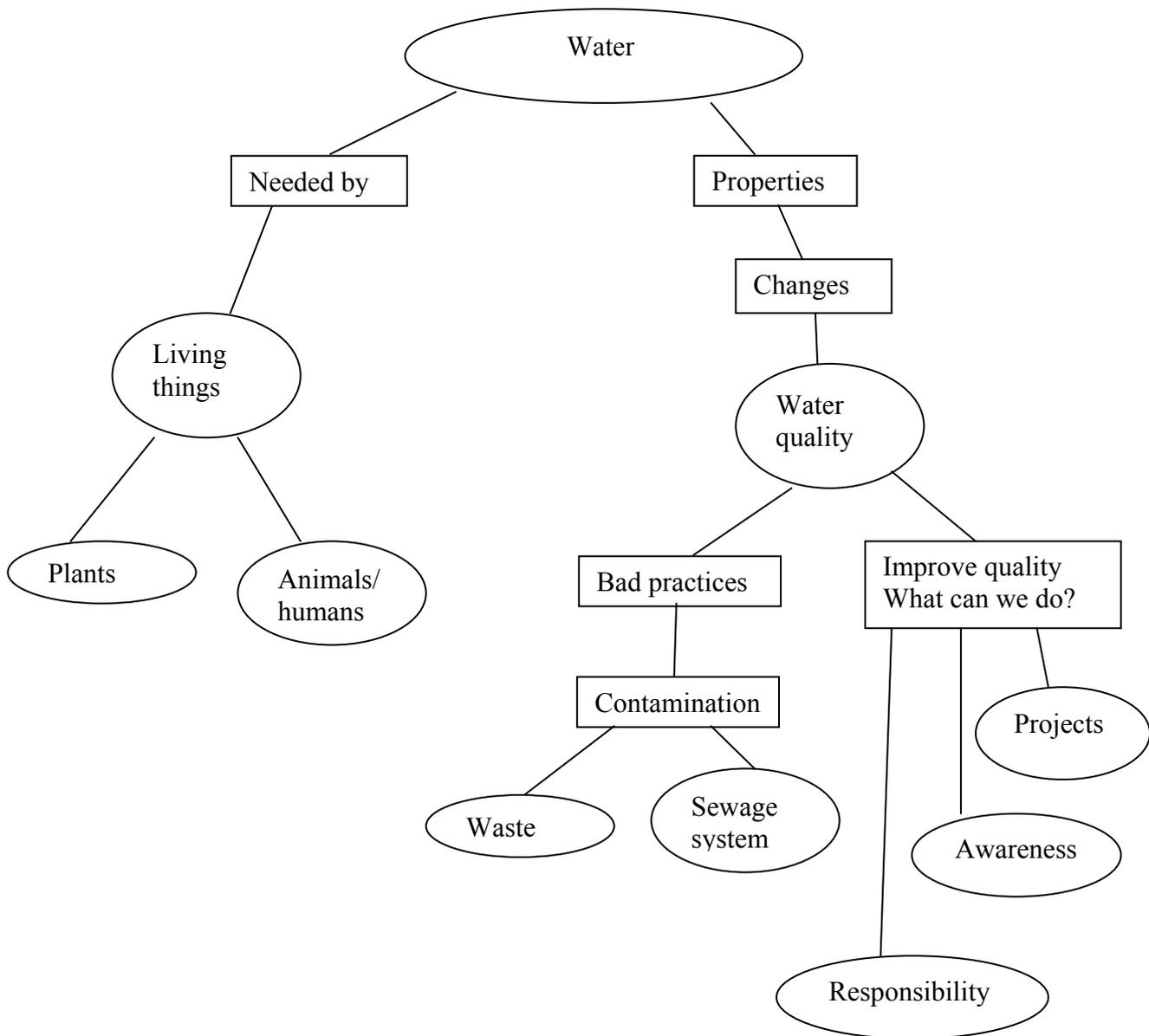


Figure13: An example of a concept map

While students engage in the problem scenario described in the section 5.1.1.1 lecturers could direct them to carry the discussions further using concept maps. The concept map would then direct the student teachers to improve their metacognitive skills and generate the following questions.

Example: Using the above concept map students can generate following questions.

- What are the properties of water?
- How to make water drinkable?
- What is water quality?
- How is water quality measured?
- How can I find out more about water quality?
- What is naturally in water?
- How do we conserve water?
- How would I know whether water is good enough to drink?
- What about bacteria in water?
- How do human activities affect water quality?
- How we could reduce human affected activities?
- Can school children do something?
- How people can change their attitudes?
- What are the awareness programmes?
- How we can start an awareness programme?
- Can we make posters?
- What are the responsibilities to minimise the health risks?
- Do we can start a project to minimise the situation?.....etc

The above questions are not the same as “what do we need to know” questions. However, these questions could direct students to link all the other subject disciplines into ERA.

Using this concept map students could construct a concept map that will help them as follows:

- Discover the themes they want to emphasise.
- Helps students to identify concepts that are keys in more than one discipline, which helps them move beyond traditional disciplinary boundaries.
- Support a holistic style of learning.
- Construct multiple ways of meaning for students.
- Mapping concepts can increase the ability to provide meaningfulness to students by integrating concepts.

The following diagram demonstrates how concept mapping could be used in the scenario discussions.

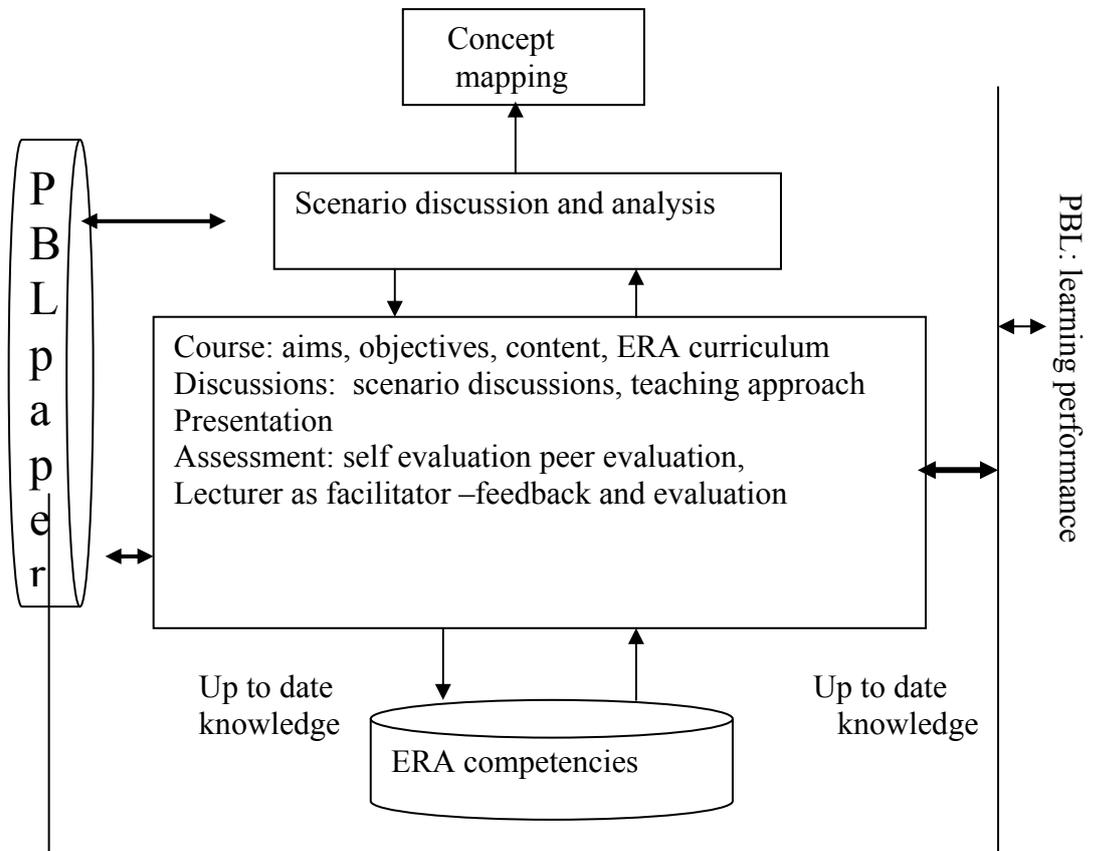


Figure 14: Developing concept maps from PBL scenario discussions, Adapted from Hsu, L. (2004, p. 511).

### 5.1.2.3 Link with other curriculum areas in ERA

To link all subject disciplines to the presented problem and so move from the problem scenario to fulfil the requirements as required by ERA, it is important to elaborate further on the example given in 5.1.1.1

Facilitators could direct students to draw a concept map for the given problem to help them locate all the areas covered in a particular problem. A concept map developed for the sample problem scenario in section 5.1.1.1 is illustrated in the above.

The concept map in the section 5.1.2.2 demonstrates how student teachers could link all the subject disciplines stated in the ERA curriculum (Figure 8) by developing concept maps during problem scenario discussions. Therefore, student teachers could gain the following key ideas through the concept maps they developed in scenario discussions:

- Holistic approach to look at problem.
- Effective strategies for integrating several subject discipline stated in the ERA curriculum.
- Theoretical base and understanding environmental issues .
- Metacognitive skills.

In addition, the concept maps developed through scenario discussions would help encourage further progress in coming to understand the nature of the integrated feature of the ERA curriculum and it would be beneficial in fulfilling the following objectives, as stated in the ERA teachers' Guide (Primary Curriculum, 1999).

- Understand the integrated nature, of and the objectives of, the ERA curriculum
- Help pupils become aware of the influence of man on the environment and develop an understanding and active concern regarding their responsibility towards environmental conservation and sustainable development with reference to selected topics in the primary ERA curriculum
- Acquire strategies for helping pupils to consider values in regard to issues in society
- Identify learning experiences to encourage pupils to develop an appreciation of the nature

#### **5.1.2 4. Teacher educators work in teams and enhance student learning**

From the data analysis described in Chapter 4, the researcher elaborated the lecturers' role and this demonstrated the course was a collaborative effort of all the staff involved in the course using a team teaching approach. Preparation is an on-going process. Students are free to ask any questions and the preparation process is dynamic.

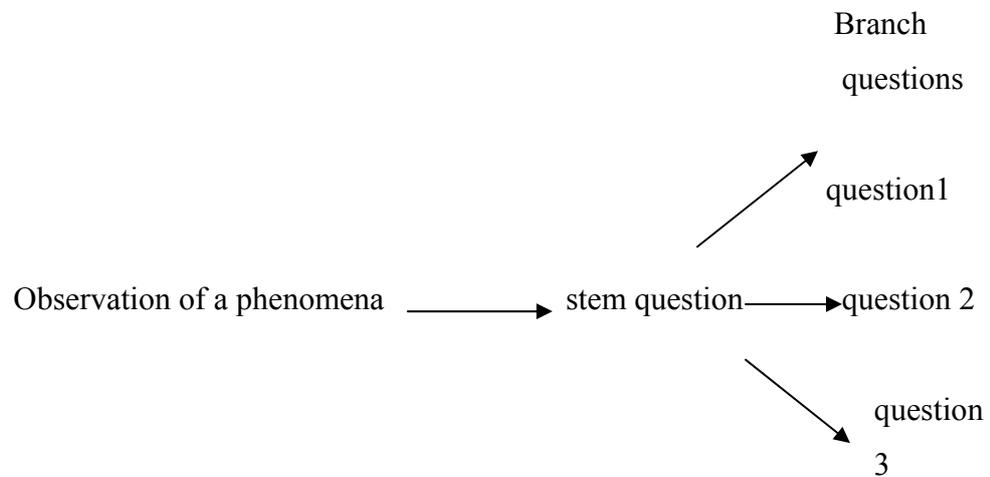
As described in Chapter 2, ERA is an integrated subject area and all learning activities focus on Learning through the Environment. ERA lecturers in Colleges of Education in Sri Lanka need to use a team teaching approach to deliver programmes for ERA teacher education programmes. In addition to sharing ideas and motivating students, active learning is a key focus of ERA and the researcher strongly believes that PBL would be suitable for the ERA teacher education programmes in Sri Lanka.

#### **5.1.2 5. Act as models to ask metacognitive questions**

In a PBL classroom, teachers act as metacognitive coaches and use a variety of questioning techniques. Students then become familiar with metacognitive questions such as: What is going on here? What do we need to know more? What do you think that is true? How does that apply to this case? What strategies or tasks can I use to learn this? Do I have all the relevant facts?

As stated in the ERA teachers' guide, teachers have the ability to understand the varying developmental levels and learning needs of students through gathering and assessing what environmental knowledge and experience and primary children bring with them to school. They have to start their lessons from that stage. The teachers' guide describes how questions could be used to develop students' investigation skills (Teachers' Guide Primary Curriculum, National Institute of Education, 1999) as follows:

## Developing questions that lead to investigation



From the data analysis the researcher discovered how the facilitator role of PBL is aligned with the questioning mode, as described in the Teachers' Guide Environmental Related Activities, National Institute of Education, 1999. Teacher educator responses from the interviews regarding the PBL process provided evidence of how they encouraged students to learn to think independently. Most students knew that the answer for a particular question they received from the teacher educator led them towards another question and directed them towards self directed learning. Similarly, the PBL approach would be beneficial for the Sri Lankan pre-service teacher education programme students to develop their metacognitive questioning techniques.

### **5.1.2 6. Supportive and flexible**

In the PBL process at the particular University in New Zealand teacher educators establish rapport, group interaction and reinforcement. They mediate the learning environment and value students' questions and points of view. They act as role models to encourage students to develop those qualities to be successful as practising teachers in the classroom. Teacher educators help the group to set goals and action plans while promoting team spirit.

The ERA Teachers' Guide, Sri Lanka, states that teachers have the ability to acquire strategies for helping pupils to consider values in regard to issues in society including family life and living in peace and harmony with neighbours and different ethnic groups. If the student teachers could practise team building and collaborative work with the help of their facilitators during the training programme this would give them ideas and experience to model it in the primary classroom

#### **5.1.2 7. Keeping the learning process moving**

The researcher found that PBL used in the science and technology course teacher educators helped students to explore the richness of the situation and helped them develop critical thinking skills and let the students' learning processes stay on the correct track while monitoring their progress.

The ERA curriculum is mainly focused on learning through the environment. Teachers need to start teaching ERA from the ideas the children hold at present. They need to ask children what they think and encourage them to talk and help them expand their ideas. Therefore, a student-centred active learning process would be suitable for teaching ERA.

#### **5.1.3 Changes of teaching approach and learning styles arising from PBL and its applicability to the ERA teacher education curriculum.**

##### **5.1.3.1 Teaching approaches used in PBL are different from a traditional lecture method.**

Learning is student-centred and students are responsible for their own learning. PBL is based on constructivist learning principles and, as such, it used open-ended questions that involve students in the active construction of knowledge.

ERA comprises a set of themes capable of encompassing competencies belonging to a number of disciplines. Therefore, traditional teacher-centred

methods are not suitable for teaching ERA and the need to get away from a “read this do this, read this do that” approach. Teachers should start from facts the children already know. Student teachers need to be prepared to identify teaching-learning strategies that would be appropriate for the learning needs of the students.

### **5.1.3.2 Use “Need to Know” templates**

Using what do we know; what do we need to know; and how can we find out templates helps students to take the initiative and participate in the acquisition of knowledge in the learning process along with exercising their metacognitive skills. Then students understand learning to learn and engage in self-directed learning processes.

The education reforms in Sri Lanka emphasised the importance of self-directed learning and the Curriculum and Process plan (1999) described the four pillars: learning to know, learning to do, learning to live together and learning to be. Therefore, using what do we know, what do we need to know and how can we find out template working in groups would be an ideal learning experience for the student teachers to practice.

### **5.1.3.3. Work cooperatively in teams and learning occurs in small groups/individually**

PBL groups work with a mandate to learn. Sharing of knowledge by each participant is a key feature of the learning in groups. Students use and build knowledge by challenging one another’s understanding.

Team building is a necessary focus for primary education in Sri Lanka as students acquire strategies for helping other students consider values in regard to issues in society including peace and harmony with neighbours and with special attention to different ethnic groups.

#### **5.1.4 Assessment procedures**

A variety of assessment techniques were used in the Massey University course. These methods are different from traditional paper-pencil tests.

Self assessment: Giving students the opportunity to evaluate their own learning is a key focus in PBL. A “thinking log” allows a student to monitor and visualise his/her own process of learning as he/she works together as a member of a collaborative team and individually.

Teachers need to use a variety of assessment tasks as ERA is different from other traditional subject areas and is an integrated subject consisting of several subject disciplines; teachers have to find different assessment tasks that would be suitable for the integrated nature of the curriculum. Therefore, tasks for assessment used in the PBL approach would be beneficial to student teachers when they are in real classrooms (sample assessment criteria are given in Appendix XI).

#### **5.1.5 ICT is embedded into the programme**

Using ICT in teacher education is a special aspect of this particular course Integrated Curriculum: Science and Technology. It is designed to develop computer literacy and enhance students’ ability to do their presentations electronically.

The Ministry of Education, Sri Lanka, has a long term objective to integrate ICT in teacher education as a tool, as a subject and as an education resource. Therefore, this presents a good opportunity to introduce ICT for teacher education through a PBL approach, as ICT is a current requirement for the development of pre-service teacher education in Sri Lanka.

## **5.2 Key aspects to be considered for an alternative teacher education programme for ERA teacher education in PBL**

The main purpose of this research was to explore the potential for an alternative teacher education programme for the ERA primary education curriculum in Sri Lanka using the PBL approach, as taught at one university in New Zealand. As described in the literature review (Chapter 2), PBL is grounded in constructivist learning theory and sections 5.1 to 5.3 of this chapter described why PBL would be suitable for the ERA curriculum in Sri Lanka and how the PBL process used at the New Zealand university would match Sri Lankan contexts by setting the details within locally-based problem scenarios.

### **5.2.1 Introduction and immersion experience of PBL**

The alternate teacher education programme for ERA could use teaching strategies based on the PBL approach Integrated Curriculum: Science and Technology course. The underlying philosophy is to provide meaningful experiences aimed at students applying knowledge and real world applications towards the improvement of their performance in actual classroom settings, as the subject, ERA, is based on what is happening in the environment surrounding them (Chapter 1-1.3). Section 5.1.1.1 was able to provide one detailed example of a problem scenario and it described the steps of the process in section 4.3.1. Lecturers from National Colleges of Education and the curriculum team of the National Institute of Education, Sri Lanka would be able to match the key features found in the PBL approach for an alternative teacher education programme in Sri Lanka.

### **5.2.2. Managing the transitions**

Facilitators should understand in what ways PBL and its objectives differ from traditional teaching methods and how to prepare themselves for the new role as facilitators. Managing the transition is not easy and Savin-Baden (2000)

describes several challenges. According to Savin-Baden (2000) these are the challenges the educators face:

- The responsibility of enabling student learning.
- The challenges for them as individuals when their prior experience has been about lecturing and giving guidance.
- The shift they have to make in their conceptions of teaching and student learning in order to understand how to implement PBL.
- Teacher educators not being comfortable with their new and changing role.
- The way some teacher educators feel empowered by PBL but the way in which this results in tension with others who do not feel the same.
- The way some teacher educators are expected to facilitate PBL when this approach does not fit with their perceptions about teaching and learning.
- The lack of preparation for PBL that many facilitators experience.
- The lack of cooperation from support staff at the institute.

These all provide challenges for lecturers at National Colleges of Education in Sri Lanka.

### **5.3 Assessment tasks**

#### **5.3.1 Types of assessments**

Macdonald and Savin-Baden (2004) list some of the forms of assessment that can be used successfully in PBL and from this list, the researcher has derived the following types of assessment procedures which would be suitable for the primary ERA teacher education programme in Sri Lanka.

- Self assessment by student teacher- assess own knowledge, skills and attitudes.
- Peer assessment conducted by student teachers.
- Reflective journal by student teacher - the progressive completion of a journal that reports own learning and details the obstacles met and how the student achieved.

- Presentations - either group or individual – oral and written reports on PBL process and product.

#### **5.4 Competencies to be covered by the alternative programme**

PBL would be beneficial to pre-service student teachers for achieving a specific set of competencies that would help them to become quality primary teachers who could use appropriate teaching strategies in the primary classroom. These competencies are:

- Thinking critically and creatively.
- Coping with different problem situations.
- Adopting a holistic approach to look at problems in their surroundings.
- Collaborating with others.
- Appreciating and respecting others' views.
- Identifying their own strengths and weaknesses and undertaking appropriate remedies.
- Demonstrating self directed learning.
- Developing metacognition skills.

However, the transition to a PBL programme is not an easy task. It takes time and there also needs to be commitments from the students, lecturers and the other supporting staff. The implementation of PBL would not be successful without the cooperative effort of all the staff, students and the support staff who are involved in the process. Cambourne, Ferry and Kigging, (2005) describe:

“The transition to a PBL mode of delivery should not be considered as an easy option or a quick fix. Just as the tutor needs to adopt changes to practice the student involved in the transition to PBL also go through certain changes and there need to be understood for a smoother transition to PBL for all concerned. Students involving in PBL need to become self-directed learners and it must be realised that the benefits to this mode of learning are neither immediate nor automatic, the learning curve required with such an understanding is very steep.” (p. 56)

## 5.5 The possible application procedure

A possible application procedure is shown in Figure 15 below. On the basis of the findings of this study the researcher suggests that PBL would be suitable for an alternative teacher education programme and, therefore, the implementation process of that particular alternative programme could be driven through a PBL approach. The main goal is to prepare teachers for teaching ERA in primary schools in Sri Lanka. Outcomes of this process would be the implementation of its successful integration in primary classrooms.

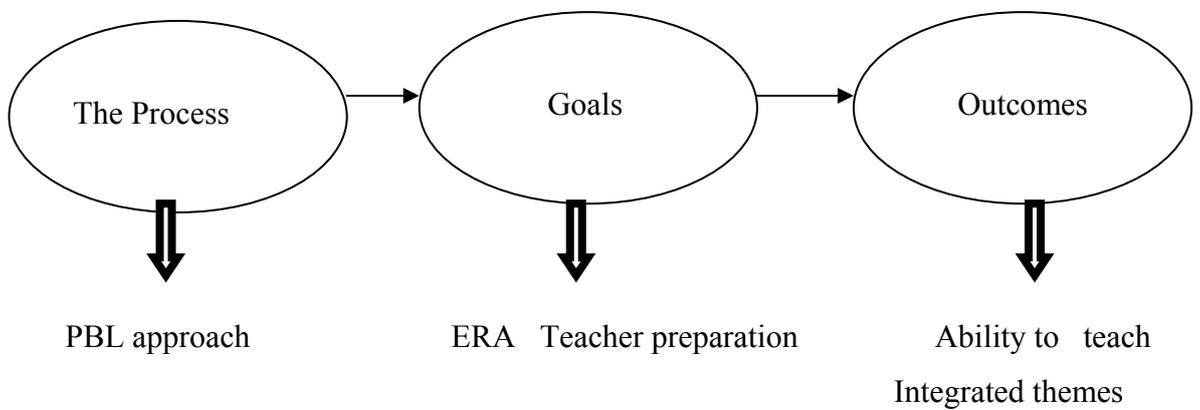


Figure 15: PBL application for ERA

## 5.6 Overall structure for an alternative teacher education programme

The following Figure illustrates the overall structure of the programme.

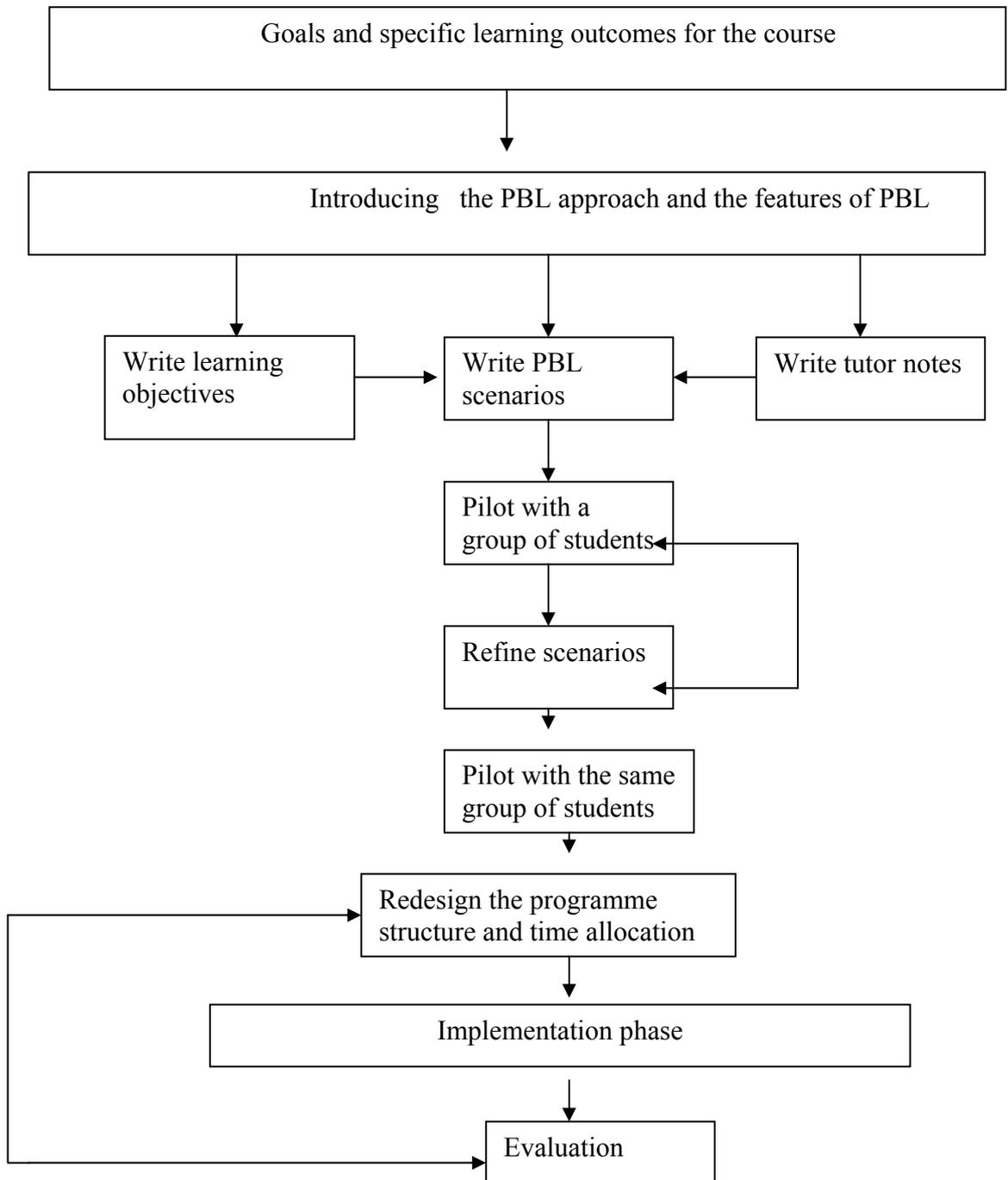


Figure 16. Overall planning and implementation of the programme, adapted from Wood 2003, p.56

As visualised above in Figure 16, in the overall structure for an alternative teacher education programme, the first step is deciding the learning outcomes of the ERA primary teacher education course. The next step is introducing the main features of PBL including sample problem scenarios. This would be the

preliminary stage of the process. At the pilot stage teacher educators could begin the process with a small group of students and see how it works. From that experience teacher educators would be able to find out the strengths and weaknesses and carry out the process again with the same group of students. On the basis of the findings teacher educators could implement the programme with ongoing evaluation.

## **5.7 Chapter summary**

In this chapter the suitability of the PBL approach for ERA teacher education curriculum in Sri Lanka was explained by matching the key features found from the data analysis in sections 4.3.2.1, 4.3.2.2, 4.3.2.3, 4.3.2.4, 4.3.2.5, 4.3.3 and the discussion in section 4.4 of this thesis. One problem scenario from real life contexts in Sri Lanka was presented to justify the suitability of the transformation process. The suitability of the PBL approach for ERA teacher education programme in Sri Lanka was emphasised by explaining how it helps link all the subject areas stated in the curriculum and how it would help fulfil the objectives stated in the Sri Lankan curriculum. Important aspects that should be considered for an alternative teacher education programme are also described.

## **Chapter 6.0 - Conclusions, implications, suggestions and future recommendations**

The main purpose of this study was to explore the potential for an alternative teacher education programme for the ERA curriculum for the pre-service teacher education programme in Sri Lanka using a PBL approach. From this study the researcher found that the PBL approach used in the Integrated Curriculum: Science and Technology course at one university in New Zealand is a curriculum model based on the principles of constructivist learning theories, for example, constructivism and social constructivism. It used problems as a context for students to acquire knowledge. The students of this course were actively engaged in learning that is authentic to the situation as all the problem scenarios were from their real life contexts. In addition, students are responsible for their own learning and developing their metacognitive skills. This particular course clearly links with the theory and practice of teacher education. On the basis of the principles of the PBL approach, the researcher was able to explore the potential for an alternative teacher education programme for Sri Lanka. This concluding chapter consists of the conclusions of the research study, implications, recommendations and future research.

### **6.1 Conclusions**

The summary of findings is presented according to the research questions stated in Chapter 1, section 4 of this thesis.

#### **6.1.1. The main objectives of Integrated Curriculum: Science and Technology particular course**

The key focus of the Integrated Curriculum: Science and Technology course conducted by one university in New Zealand is to prepare students to plan and teach integrated units about science and technology in New Zealand schools with special attention to understanding of the scientific phenomena,

technology knowledge and understanding and linking all of these aspects with society and the environment.

### **6.1.2. Major teaching approaches used in this integrated course**

The major teaching approach used in this paper was PBL. As the researcher listened to the lecturers (teacher educators) who were involved in this paper, she clearly understood that the key focus of PBL was on learners as constructors of their own learning in a context which is similar to the context that they would apply in the primary school in the future as confident primary teachers.

### **6.1.3. The benefits of using Problem Based Learning in teacher education**

PBL is a constructivist learning model. In the PBL process students' achieve authentic context where they learn how to apply the processes in real life situations. It is also most important in teacher education that teachers should understand how children learn from the basis of what they know already. The other strength of the PBL scenario discussions was the sharing among the group with the diversity of ideas, opinions and different knowledge of the group members. In addition, group work helped them learn new skills and provided learning opportunities to actively find out how to learn in a challenging environment.

### **6.1.4. PBL would be useful to fulfil the objectives stated in the national primary school science curriculum in New Zealand**

Almost all the students commented that the learning experience gained through PBL was rewarding and gave them the insights needed to prepare themselves for teaching the actual school curriculum in the classroom.

The interdisciplinary approach of PBL would suit the objectives stated in the New Zealand curriculum. The students of the Integrated Curriculum: Science and Technology course described how PBL helped them to understand the integrated nature of the curriculum and build up their confidence to be

successful teachers in the classroom. Further, students emphasised that the PBL approach prepared them for classroom teaching because it gave them a real passion for the subject area.

#### **6.1.5. How PBL could be adapted to the Sri Lankan teacher education programme?**

This study mainly focused on exploring the potential for an alternate teacher education programme for the ERA curriculum for primary teacher education in Sri Lanka. As described in Chapter 1, ERA is an integrated subject area (Figure 2, page 10) and is a major subject in the primary curriculum. The ERA curriculum consists of major themes and all themes focus mainly on “learning through the environment” which is related to the everyday life of children. The philosophy that underpins this approach is that children learn more effectively when new ideas are introduced in their natural settings and surroundings. The children then construct new knowledge and develop new skills on the foundations of their past experiences and in the real life context (Brooks & Brooks, 1993). Therefore, the PBL approach is ideal for implementing the constructivist learning approach in ERA. Why PBL would be suitable for the ERA curriculum in Sri Lanka and how it could be used was discussed in Chapter 4. In addition, the key features that would be suitable for the transforming process are described in Chapter 5.

## **6.2 Implications**

Implications from findings of this study for different groups are:

### **6.2.1 Teacher educators**

Teacher educators should consider PBL as a successful approach that would be suitable for a teaching strategy because it has clear links with the theory and practice of education. Teacher educators should consider the main features of a PBL approach and understand it can make a significant impact on pre-service teacher education. It is even more important to analyse the impact

of a holistic approach on student learning and how it would help teachers adopt the PBL approach at any stage during their teaching career. Therefore, teacher educators have to understand their facilitator role as a key factor in the successful implementation of the PBL approach.

### **6.2.2 Curriculum developers**

Curriculum developers for environment related activities should consider the main features of the PBL approach and the interdisciplinary match with the goals and objectives of the curriculum. In addition, curriculum developers of ERA should consider the necessity of student-centred teaching strategies rather than using teacher-centred learning. Therefore, PBL would be a very effective pedagogy not only for the ERA curriculum but also for other primary education curricula.

### **6.2.3. Teachers**

Pre-service teachers must have the ability to perform well in the schools, be part of a team and use appropriate pedagogies in the classroom. They have to apply the knowledge gained from the teacher education course in different practical settings and be confident in the classroom as successful teachers. Therefore, both novice and experienced teachers should consider some of the implications of using PBL in the classroom and understand the importance of providing meaningful learning experiences.

### **6.2.4 Researchers**

Researchers should consider how PBL could transform in-service teacher education in different subject disciplines as well as in short term teacher education courses. Especially in Sri Lanka, where there are several refugee centres for displaced people in the war zone and several education programmes launched for the children who are at primary school level, PBL is a good approach for these particular education programmes. If the PBL approach could be used in a pilot programme and progress monitored

continuously throughout, this would have benefits in improving the quality of these education programmes.

### **6.3 Recommendations**

As a result of this study, the following recommendations are presented for teacher education curriculum designers who are considering implementing PBL into their teaching. As a teacher educator, the researcher understands how PBL would be beneficial to link theory and practice in teacher education. Based on the findings of this study, as described in Chapter 4, sections 4.3 to 4.4 of this thesis, the researcher suggests that teacher educators could explore opportunities for using PBL to engage pre-service teachers in active learning and develop their metacognitive skills. Especially in PBL, the focus is on learners as constructors of their own knowledge, and by using PBL student teachers are able to construct knowledge on their own. In implementing PBL teacher educators should understand the differences between the traditional teaching role and the facilitator role and should have the subject expertise, knowledge and skills to be successful facilitators. In addition, following key aspects are recommended:

- Teacher educators should ensure that they have an in-depth knowledge of PBL.
- When developing a programme based on PBL teachers should understand the pedagogical approach, activity planning inside and outside the classroom, and the need to ensure the availability of resources, assessment tasks and procedures.
- Successful implementation of PBL requires students to have the opportunity to be responsible for their own learning.
- The importance of the transferring process of learning to the other learning contexts.
- Teacher educators should be clear about their role and responsibilities as facilitators.

- Teacher educators involved in the design and implementation of PBL should work as a team and share their experience and knowledge with the students as well as with each other.

#### **6.4 Suggestions for further research**

Further research on how the alternative teacher education programme for the Pre-service Primary Teacher Education Programme for Colleges of Education Sri Lanka succeeds in providing meaningful learning experiences for student teachers is recommended. It is essential to assess that student teachers are able to use the PBL approach successfully in the actual classroom settings when they are appointed to different geographical regions throughout the country, and also how they are able to transform their knowledge in new practical settings.

#### **6.5. Chapter summary**

The researcher has summarised the findings of the study and reported the implications, recommendations and suggestions for further research. Sections 6.1.1 to 6.1.5 of this chapter described the findings of this study in relation to the research questions. Implications for teacher educators are described with the potential for an alternative teacher education programme for Sri Lanka using the PBL approach. Section 6.3 stated recommendations for teacher educators. If the Colleges of Education in Sri Lanka have the opportunity to undertake further research on designing and implementing an alternate teacher education programme it could have a major impact on reducing the gap between theory and practice in teacher education.

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## **Appendices**

### **Appendix I: Code of ethics for the research and the approval from the Ethics Committee**

The MUHEC (Massey University Human Ethics Committee) Code of Ethical Conduct for Research, Teaching and Evaluation involving Human Participants describes the major ethical principles as follows:

- a. respect for persons
- b. minimisation of harm to participants, researchers, institution and groups
- c. informal and voluntary consent
- d. respect for privacy and confidentiality
- e. the avoidance of unnecessary deception
- f. avoidance of conflict of interest
- g. social and cultural sensitivity to the age, gender, culture, religion, social class of the participants
- h. justice

The following details were included in the information sheet

- Purpose of the research
- How she/he will participate in the research
- Assuring confidentiality will be respected
- Participation is voluntary and she/he has a right to withdraw her/his consent or discontinue any time

(A signed copy of the information sheet was provided to each participant.)

Ethical issues were considered and addressed carefully prior to the commencement of the study. The research was approved by the Massey University, MUHEC (Massey University Human Ethics Committee) and a copy of the approval is attached herewith.

## **Appendix II: Information sheet for College of Education, Massey University**

**Project Title: A critical review and analysis of the Integrated Curriculum with particular reference to Science and Technology in Pre-service Primary Teacher Education Programme in New Zealand with the aim of designing a suitable programme in the Environment Related Activities Curriculum for Pre-service Primary Teacher Education Programmes in Sri Lanka.**

### **Researcher Introduction**

This letter is intended to provide a brief introduction to my research project and the implementation procedures.

After having been a Teacher Educator for more than 14 years at the National Institute of Education, Sri Lanka, I (Kalyani Wijayawardana, the researcher) am currently undertaking a Doctor of Education Degree at the College of Education, Massey University.

As part of undertake (researcher) Doctoral Degree I (researcher) am engaged in a research project to do a critical review and analysis of the 210.210 Integrated Curriculum: Science and Technology paper in the Pre-service Teacher Education programme conducted by the College of Education, Massey University with special attention to design of a suitable programme in Environment Related Activities Curriculum for pre-service Teacher Education in Sri Lanka.

In this connection I (researcher) intend to conduct questionnaire survey and focus group interviews (audio recording only) of the students (both Internal and Extramural) in the paper 210.210 Integrated Curriculum: Science and Technology and academic staff members involved in design and delivery of the paper (210.210 Integrated Curriculum: Science and Technology).

All the data collected in this regard will be anonymous and will be kept confidential. Results of the data analysis will be used only for this research and any other outcome such as conference presentations and publications related to this research.

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In the proposed study researcher intends to carry out a a critical review and analysis of the ongoing paper 210.210 Integrated Curriculum: Science and Technology based on the study material (study guide, CDROM and readings), New Zealand curriculum documents (science and technology), interviews of the academic staff involved in the design and delivery of the paper 210.210, interviews of present and past students (both Extramural and Internal) of paper 210.210 and the responses to the questionnaire by the present students (both Extramural and Internal) in paper 210.210. with a view to design and develop a suitable programme in Environment Related Activities Curriculum for Pre-Service Teacher Education in Sri Lanka.

## **Participant Recruitment**

### **Recruitment method**

I (Kalyani Wijayawardana, researcher) would like to recruit four academic staff involved in the design and delivery of the 210.210 Integrated Curriculum: Science and Technology paper from College of Education, Massey University

Eight students (four students each from Extramural and from Internal classes) studying in 210.210 Integrated Curriculum: Science and Technology paper in Semester I 2005 based on voluntary participation of the students.

Four students who have already graduated from the course and have taken the 210.210 Integrated Curriculum: Science and Technology paper in the year 2004.

### **Number of Participants:**

Six academic staff from College of Education (All together 6)

Eight students (four students each from Extramural and Internal classes) from College of Education, Massey University (All together 8 student teachers)

Four ex-students, who have graduated from the Pre-service Teacher Education Programme (where 210.210 Integrated Curriculum: Science and Technology is a compulsory paper in the 3<sup>rd</sup> year of the teacher education programme), College of Education, Massey University in 2004.

**Reason for this number:**

Manageable within the requirement for Ed.D in terms of time and resources available.

There is no risk of harm to the participants involved in this study because the researcher is doing a critical review on the design and implementation of the 210.210 Integrated Curriculum: Science and Technology paper in the Pre-service Primary Teacher Education Programme at the College of Education, Massey University and the researcher is not involved in any way in the design and implementation of the 210.210 Integrated Curriculum: Science and Technology paper in the Pre-service Primary Teacher Education Programme at the College of Education, Massey University.

**Project Procedures**

The main aim of the research is to design and develop a suitable programme for Sri Lanka on the basis of a critical review of the design, implementation and effectiveness of the paper 210.210 Integrated Curriculum: Science and Technology in the Pre-service Primary Teacher Education Programme at the College of Education, Massey University, New Zealand.

In this regard the researcher will review the study material (study guide and readings) and the New Zealand curriculum documents (Science, Technology and Social Studies).

Researcher will conduct interviews of the academic staff (selected on the basis of voluntary participation) involved in the design and implementation of the paper 21.210. This will be followed by a questionnaire survey for the students (both Extramural and Internal) to find out the specific design and features and implementation strategies of the paper 210.210 and interviews with students (selected on the basis of voluntary participation).

Finally, the researcher will design a programme for Environment Related Activities curriculum for pre-service teacher education, Sri Lanka

**Participant Involvement**

The researcher would like to interview four academic staff from the College of Education, Massey University, four student teachers from each from Extramural and Internal students enrolled in the paper 210.210 Integrated Curriculum: Science and Technology in Semester I 2005 in the Pre-service Primary Teacher Education Programme and four student teachers who graduated from the Pre-service Primary Teacher Education Programme in 2004.

Further, the researcher will distribute a questionnaire among the students (Internal and Extramural) enrolled in paper 210.210 to gather information from a larger sample on the design and implementation of the paper.

### **Participant's Rights**

Participants are under no obligation to accept this invitation. If you decide to participate you have the right to:

- Decline to answer any particular question
- Withdraw from the study
- Ask any questions about the study at any time during participation
- Provide information on the understanding that your name will not be used unless you give permission to the researcher
- Be given access to a summary of the project findings when it is concluded

### **Support processes**

If you have any concerns about details of the research procedure, please contact my Supervisor, Dr. Madhumita Bhattacharya, College of Education Massey University.

### **Project contact**

If you have any concerns about the conduct of the research, please contact me (researcher, Kalyani Wijayawardana) or my supervisor Dr. Madhumita Bhattacharya.

If you agree to participate in this research study please fill the consent forms and use the enclosed envelope to return it to me by 15 October, 2005.

The success of this study depends very much on your willing cooperation and support.

Thank you.

Kalyani Wijayawardana (Researcher)

This project has been evaluated by peer review and judged to be low risk. Consequently, it has not been reviewed by one of the University's Human Ethics Committees. The researcher named above is responsible for the ethical conduct of this research.

If you have any concerns about the conduct of this research that you wish to raise with someone other than the researcher, please contact Professor Sylvia

V Rumball, Assistant to the Vice-Chancellor (Ethics & Equity), Telephone  
0064 6 350 5249,  
Email: [humanethicspn@massey.ac.nz](mailto:humanethicspn@massey.ac.nz)

### **Appendix III: Participant Consent Form**

*A critical and review and analysis of the Integrated Curriculum with particular reference to Science and technology in Pre-service Primary Teacher Education Programme in New Zealand with the aim of designing a suitable programme in the Environmental Related Activities curriculum for Pre-service Primary Teacher Education Programme in Sri Lanka.*

#### **Participant Consent Form**

I have read the information sheet and have had the details of the study explained to me. My questions have been answered to my satisfaction and I understand that I may ask further questions at any time.

I agree to participate in this study under the conditions set out in the information sheet.

Signature .....

Date.....

Full Name (printed) .....

## **Appendix IV : Interview Questions**

### **Interview Questions**

The following questions were asked in the interviews.

1. What is your involvement in the Integrated Science & Technology Curriculum?  
210.210 paper?
2. What are the goals of integrated paper 210.210?
3. What is your opinion about the goals of this paper?
4. In your opinion how does this integrated curriculum paper fulfil the objectives stated in the national primary school science and technology curriculum?
5. What are the major teaching approaches used in the integrated paper 210.210?
  
6. What are the main differences in the design of traditional courses and this 210.210 paper?
  - a). List these differences.
  - b). How have these differences affected your own teaching and evaluation approaches.
  - c) How will these differences affect your preparation/conduct/planning for teaching?
  
- 7.) a).What resources are available for you to use in teaching in this paper.  
b). How do you utilize these resources?
  
8. How would you describe this paper as a more effective one for introducing an integrated programme in to schools than the traditional type of paper?
  
9. Do you think further changes are needed to improve this 210.210 paper?

10. What do you see as the future direction of this integrated paper with regard to other teacher education programmes (early childhood, primary, secondary, etc?)

## Appendix V: Questionnaire

### Student Teachers' Questionnaire - 210.210 Integrated Curriculum: Science & Technology

Kindly complete the following items by putting a tick (√) in the appropriate box or writing your answer in the space provided.

1. Gender:  Male  Female

2. Kindly state your ethnicity .....

3. Kindly indicate your age group

under 20 yrs       20-24 yrs       30-34 yrs  
 35-39 yrs       40-44 yrs       over45 yrs

4. What are your expectations from taking the paper 210.210?

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5. How does this paper contribute to your preparation as a teacher?

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6. In what ways does this paper meet your expectations?

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7. In what ways is the paper not meeting your expectations?

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8. How well does this paper model/enhance real classroom practice?

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9. Were you introduced to different teaching approaches in this paper?

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10. Did you find these different teaching approaches useful?

a) If 'yes' in what ways?

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b) If 'no' why not?

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11. Do the assignments and evaluation procedure of this paper support the stated learning outcomes of the paper?

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12. How would you compare the workload of this paper with that of other papers?

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13. What kind of learning support is provided for you in this paper?

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14. How have you benefited from the collaborative group activities incorporated in this paper?

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15. In your opinion how does this integrated curriculum fulfil the objectives stated in the national primary school science and technology curricula?

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16. What beginning teacher characteristics does this paper aim to encourage?

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17. How confident do you think you think you will be upon completion of this paper to teach science and technology in the primary classroom?

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## **Appendix VI: Basic Competencies ( Sri Lanka)**

### Curriculum Policy and process plan Sri Lanka 1999 - Basic competencies

#### **1.Competencies in Communication**

Literacy: Listen attentively, Speak clearly, Read for meaning and Write accurately and lucidly

Numeracy: Use numbers for Things, Space, Time, Count, Calculate and Measure systematically

Graphics: Make sense of line and form, express and record details, instructions and ideas with line, form and colour

#### **2.Competencies relating to the Environment**

Social: Awareness, sensitivity and skills linked to being a member of society, social relationships, personal conduct, general and legal conventions, rights responsibilities, duties and obligations

Biological: Awareness, sensitivity and skills linked to the living World, Man and the Ecosystem, the Trees, forests, Seas, water, Air and Life

Physical: Awareness, sensitivity and skills relating to Space, Energy, Fuels, Matter, Materials, and their links with human living

#### **3.Competencies relating to Ethics and Religion**

Values and attitudes- It is essential for individuals to assimilate values-ethical , moral and religious modes of conduct, rituals, practices in everyday living, selecting that which is most appropriate

#### **4.Competencies in Play and Use of Leisure**

Links with pleasure, joy and such human motivations-Aesthetics, art, drama, literature, exploratory research, and other creative modes In human living

#### **5.Competencies relating to Learn to Learn**

Learning will need updating and review

## **Appendix VII: New Zealand Curriculum**

### New Zealand Curriculum (Previous)

The seven essential learning areas which all students need to acquire are:

- Language and Languages
- Mathematics
- Science
- Technology
- Social Sciences
- The Arts
- Health and Physical Well-being

All seven learning areas are essential for a broad and balanced education. Schools must ensure that all students undertake continuing study in all the learning areas during each of the first ten years of schooling. Schools must also maintain a balanced curriculum in the final years of schooling (Years 11, 12 and 13), recognising the diverse educational and training needs of students at these levels.

Schools may achieve a balanced and broad curriculum in a number of ways; for example, by organising their programmes around subjects, by using an integrated approach, or by using topics for thematic approaches. Schools have the flexibility to plan programmes to meet their particular needs; for example, kaupapa Maori programmes, English programmes for speakers of other languages (ESOL), or Pacific Islands language courses. In whatever way programmes are organised, they must incorporate the knowledge and understanding described in all seven learning areas (Ministry of Education, 2003).

Further, the curriculum document states that the essential learning areas are interrelated. Any activity which students engage in will draw on more than one learning area. For example, a study of sound may focus primarily on science, but may also contribute to students' development in the arts,

technology and mathematics. In planning programmes, schools need to understand and make use of the connections between the learning areas.

The New Zealand Curriculum specifies eight groupings of essential skills to be developed by all students across the whole curriculum throughout the years of schooling.

The eight grouping of essential skills are:

- Communication skills
- Numeracy skills
- Information skills
- Problem solving skills
- Self management and competitive skills
- Social and comparative skills
- Physical skills
- Work and study skills

All the essential skills are important if students are to achieve their potential and to participate fully in society, including the world of work. In planning learning programmes, schools need to ensure that all students have the opportunity to develop the full range of the essential skills to the best of their ability. The categories are simply convenient labels for grouping the essential skills and attributes which all students need to develop. These skills cannot be developed in isolation. They will be developed through the essential learning areas and in different contexts across the curriculum. By relating the development of skills to the contexts in which they are used, both in the classroom and in the wider world, school programmes will provide learning which students can see to be relevant, meaningful and useful to them. A number of the essential skills may be developed through group activities. Furthermore, many of the skills will enable individuals to operate more effectively in group situations. Students will learn to work in co-operative ways and to participate confidently in a competitive environment.

## Attitudes and values in the New Zealand curriculum

Attitudes and values, along with knowledge and skills, are an integral part of the New Zealand curriculum. Attitudes consist of the feelings or dispositions towards things, ideas, or people which incline a person to certain types of action.

Attitudes to learning strongly influence the process, quality and outcomes of both learning and assessment. Teachers' expectations, the support of parents and the community, and students' motivation are all significant factors.

The school curriculum will encourage positive attitudes towards all areas of learning. It will provide challenging learning activities which are relevant to students' experiences and appropriate to their levels of achievement. Schools will give students ongoing constructive feedback about their learning and progress.

Values are internalised sets of beliefs or principles of behaviour held by individuals or groups. They are expressed in the ways in which people think and act. Values are mostly learned through students' experience of the total environment, rather than through direct instruction.

## **Appendix VIII : Format and presentation in the New Zealand curriculum**

### **Format and presentation of science in the New Zealand curriculum**

The purpose of the science in the New Zealand curriculum is to provide direction for learning in science for all students. The following statements are from Science in the curriculum documents.

The curriculum in science is designed to encourage all students to continue their participation in science education beyond the years in which it is required school subject. Many students with ability and interest in science will further their science education in the senior school. Some will continue to study science as an integrated subject, some will study specialist science subjects and others do both.

(Ministry of Education, 1993, p. 8)

Science is a way of investigating, understanding, and explaining our natural, physical world and the wider universe. It involves generating and testing ideas, gathering evidence – including by making observations, carrying out investigations and modelling, and communicating and debating with others – in order to develop scientific knowledge, understanding, and explanations. Scientific progress comes from logical, systematic work and from creative insight, built on a foundation of respect for evidence. Different cultures and periods of history have contributed to the development of science.

(Ministry of Education, 2008)

Further the new science curriculum describes that science is able to inform problem solving and decision making in many areas of life. Many of the major challenges and opportunities that confront our world need to be approached from a scientific perspective, taking into account social and ethical considerations.

By studying science, students:

- develop an understanding of the world, built on current scientific theories
- learn that science involves particular processes and ways of developing and organising knowledge and that these continue to evolve

- use their current scientific knowledge and skills for problem solving and developing further knowledge
- use scientific knowledge and skills to make informed decisions about the communication, application and implications of science as these relate to their own lives and cultures and to the sustainability of the environment.

To fulfil the above goal the science curriculum document has been organised into five learning strands. Within each of these strands four unifying aims have been identified and then elaborated into achievement objectives at eight levels.

### **Learning strands**

- Nature of Science
- Living world
- Planet Earth and Beyond
- Physical world
- Material world

This division into five strands is a convenient way of categorizing the outcomes for science education in schools.

### **Achievement aims, achievement objectives and levels**

Achievement aims of each strand demonstrate the key areas of each category of subject matter. The achievement aims set the goals for each learning strand and each strand is divided into eight levels.

This structure provides the themes that link the achievement objectives and the level which describes the progression of the science curriculum from junior primary to senior secondary. This thematic structure provides an idea to organise lesson plans.

## **The New Zealand curriculum (2007) describes:**

### **Nature of science**

*Students will:*

### **Understanding about science**

- Learn about science as a knowledge system: the features of scientific knowledge and the processes by which it is developed; and learn about the ways in which the work of scientists interacts with society.

### **Investigating in science**

- Carry out science investigations using a variety of approaches: classifying and identifying, pattern seeking, exploring, investigating models, fair testing, making things, or developing systems.

### **Communicating in science**

- Develop knowledge of the vocabulary, numeric and symbol systems, and conventions of science and use this knowledge to communicate about their own and others' ideas.

### **Participating and contributing**

- Bring a scientific perspective to decisions and actions as appropriate.

### **Living world**

*Students will:*

### **Life processes**

- Understand the processes of life and appreciate the diversity of living things.

### **Ecology**

- Understand how living things interact with each other and with the nonliving environment.

### **Evolution**

- Understand the processes that drive change in groups of living things over long periods of time and be able to discuss the implications of these changes.

### **Planet Earth and beyond**

*Students will:*

## **Earth systems**

- Investigate and understand the spheres of the Earth system: geosphere (land), hydrosphere (water), atmosphere (air), and biosphere (life).

## **Interacting systems**

- Investigate and understand that the geosphere, hydrosphere, atmosphere, and biosphere are connected via a complex web of processes.

## **Astronomical systems**

- Investigate and understand relationships between the Earth, Moon, Sun, solar system, and other systems in the universe.

## **Physical world**

*Students will:*

### **Physical inquiry and physics concepts**

- Explore and investigate physical phenomena in everyday situations.

### **Physical concepts**

- Gain an understanding of the interactions that take place between different parts of the physical world and the ways in which these interactions can be represented.

### **Using physics**

- Apply their understanding of physics to various applications.

## **Material world**

*Students will:*

### **Properties and changes of matter**

- Investigate the properties of materials.

### **The structure of matter**

- Interpret their observations in terms of the particles (atoms, molecules, ions, and sub-atomic particles), structures, and interactions present.
- Understand and use fundamental concepts of chemistry.

## **Chemistry and society**

- Make connections between the concepts of chemistry and their applications and show an understanding of the role chemistry plays in the world around them.

### **A comparison between science education in New Zealand's science curriculum and international literature on key aims of science education**

The New Zealand science curriculum strands map with the following key ideas of aims for science education

They focus on developing an understanding of science that closely matches with the science education literature, as follows:

- Acquire a broad general understanding of the important ideas and explanatory framework of science. .... So that students can acquire further knowledge (Millar and Osborne, 1998)
- Learning science – acquiring and developing and theoretical knowledge (Hodson, 1998)
- An understanding the basic concepts of science (Hodson, 1998)
- Understanding of fundamental concepts, laws, principles and facts in the basic sciences (Mathews, 1994)
- Scientific methods of investigation for problem-solving, as well as an appreciation of the nature of science (Holbrook & Rannikmar, 2001)
- Sustain and develop the curiosity of young people about the natural world around them and foster a sense of wonder, enthusiasm and interest in science (Millar & Osborne, 1998).
- Doing science – engaging in, and developing expertise in, scientific enquiry and problem solving (Hodson, 1998).
- Understanding the scientific approach to enquiry: empirical enquiry procedures ... and the role theoretical and conceptual ideas in framing any empirical enquiry and interpreting its outcomes (Driver, Leach, Millar and Scott, 1996).
- Appreciate the variety of scientific methods, attitudes and dispositions and appropriately utilise them (Mathews, 1994).
- Scientific methods of investigation (Bybee, 1993).

- Understand how science is made by being engaged in doing it To be able use the many skills which go to make up the scientific method; such skills as observation, measurement, making generalisations, inventing hypotheses, devising fair tests, designing experiments, analyzing data and interpreting results should all be included (Black, 1993).
- Train routine scientists and to be frontier scientists (Claxton, 1991).
- The process of science – the methods employed in collection, analysis, synthesis and evaluation of evidence. It is important to stress that the processes of science include both manipulative and cognitive processes (Duschl, 1990).
- Social values and responsibility, thus promoting the aspirations of society in the manner in which science knowledge and skills enhances cultural traditions and sustainable development needs (Holbrook and Rannikmar, 2001).
- The utilitarian argument: that learners might benefit in a practical sense from learning science.
- The economic argument: that an advanced technological society needs a constant number of scientists to sustain its economic base and international competitiveness.
- The cultural argument: that science is one of the great cultural achievements of our culture – the shared heritage that forms the backdrop to the language discourse that permeates our media, conversations and daily life
- The democratic argument: that (because) many of the issues facing our society are of a socio-scientific nature ... the healthy democratic society requires the participation and involvement of all its citizens (Osborne, 2000).
- Learning about science – developing an understanding of the nature and method of science, and an appreciation of its history and developing an awareness of the complex interactions among science, technology and environment (Hudson, 1998).
- Understanding science as a social enterprise: ‘science in society and science as society’ (Driver, Leach, Millar and Scott, 1996).

- Connect scientific theory to everyday life and recognise chemical, physical and biological processes in the world around them.(Matthews, 1994).

Theoretically, the New Zealand science curriculum accommodates 45 aims from the international Literature. It is important to know whether this structure could accommodate these international strands in practice in classrooms.

The previous and the existing documents clearly state that the curriculum statement in science provides the framework for planning and making decisions about a school's science programme. Teachers, with the support of their school community, will use it to develop their school science scheme. It will be the school scheme that sets the specific learning outcomes- derived from the achievement objectives and the structures the learning experiences of classes and individuals.

### **Science in the New Zealand curriculum document ( 1993)**

The above curriculum document (previous)describes that there are sample learning contexts, possible learning experiences and the assessment examples provided give ideas for schools and teachers, which they may or may not incorporate into their own science schemes. The purpose of that is to indicate the scope and depth of learning.

There are no definite facts to be learnt and the actual outcomes will depend on the teacher's ability and there is a considerable variability in the content learning outcomes in primary science (Ministry of Education, 1993).

These objectives sketch a very broad conceptual understanding of key ideas within each of the four subject areas. This curriculum is mainly focused on leaning outcomes and there is a flexibility to allow teachers to meet the particular needs of their mix of students. Therefore, there seems to be definite variations between the intended curriculum and the actual achieved curriculum.

Science in the New Zealand science curriculum (p. 21) states that the implementation of this science curriculum requires a number of school based decisions and actions. In making these decisions schools and teachers should make full use of the flexibility that exists in how the aims and objectives may be approached. This will result in each school providing a unique science programme that recognises the particular character of their student population that makes effective use of local resources and that fits in with other decisions relating to the whole of the school curriculum.

Science teachers at all levels have varied interpretations of SNZC. Several key dimensions of debates in science education (Ministry of Education, 2000) are:

- The relative emphasis given to each sub-discipline (physical, material, living world and earth science)
- The depth to which conceptual ideas are developed within each of these areas, including the degree to which content should be understood and explained ‘as a scientist would explain it’
- Possible variation in sub-discipline emphases/explanations for one concept
- The extent of linking within and between areas of content –that is, within topic and sub-discipline integration
- How the content is sequenced, within a year group and across levels and within each actual topic
- The extent to which knowledge is to be presented as ‘facts’ and whether or not areas of active scientific inquiry (by working scientists) and genuinely open questions should be introduced into school curricula, and
- The relative emphasis given to the balance of content learning outcomes versus other kinds of outcomes.

The achievement objectives are broad and teachers are expected to derive specific learning outcomes from the achievement objectives and place the

outcomes within the context that are appropriate to the leaning needs of their students.

This curriculum statement in science provides the framework for planning and making decisions about a school's science programme. Teachers, with the support of their school community, will use it to develop their school science scheme. It will be the school scheme that sets the specific learning outcomes- derived from the achievement objectives and the structures the learning experiences of classes and individuals.

(Ministry of Education,  
1993, p 21)

Further, the curriculum document describes that there sample learning contexts, possible learning experiences and assessment examples that provide ideas for schools and teachers which they may or may not incorporate into their own science schemes. The purpose of is to indicate the scope and depth of learning.

Even though, theoretically, it seems that the curriculum document is matched with the international strand there is a lack of pedagogical programming.

For instance, in making sense of the living world, there are eight levels of achievement objectives specified with each level having up to four sub-levels. These objectives specify the different levels of students that are approximately related to the school grade levels.

It is important to recognise students as individuals who learn at different rates and in different ways. It is not expected that all students of the same age will be achieving at the same level at the same time, nor that any student will necessarily be achieving at the same level in all strands of the science curriculum.

(Ministry of Education, 1993, p  
17)

Teachers are expected to understand the student levels and identify the correct learning experiences. The document gives possible learning experiences and possible assessment examples.

There are two integrated strands and contextual strands given in the document. For instance making sense of the nature of science and its relation to technology: Level 1 Achievement objectives are:

1. Share and compare their emerging science ideas
2. Explore and suggest what simple items of technology do
3. Investigate the uses of familiar technology.

Few possible learning experiences are demonstrated in the document:

Students could be learning by

- Listening to others describe how they think plants grow ( L1.3)
- Talking about the activities people do in different seasons ( E1.1)
- Exploring how a telephone can be used (P1.4)
- Working in small groups to devise a set of questions to ask a dental therapist about the materials she uses (M1.2)
- Making a big book of the class's ideas about seeds (L1.3)

Assessment examples

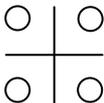
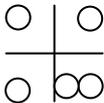
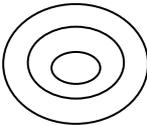
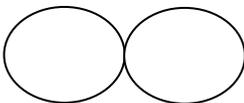
Teachers and students could assess the students

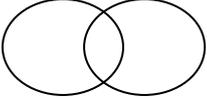
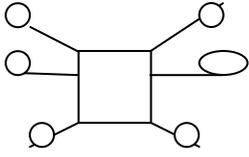
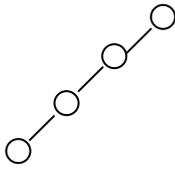
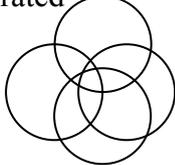
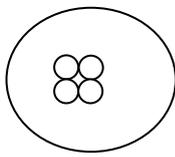
- Ability to suggest ideas when the students explain their understanding about why some people go faster down a slide than other people.
- Ability to observe and share ideas when the students watch the changes in an egg as it poaches or a pikelet as it cooks
- Awareness of the requirements for vehicle movement when the students make a toy car using cardboard boxes, wheels and axles.

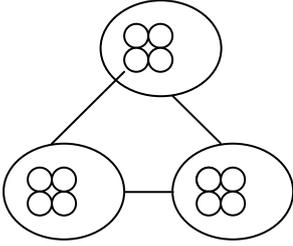
- Awareness of the appropriate simple technology used for cutting different materials when the students choose from a range of pictures of simple cutting instruments.

As mentioned above, there are achievement objectives and possible learning experiences and assessment examples are given in the curriculum document for each of the eight levels.

### Appendix IX : Ten levels of curriculum integration – Fogarty Model

Name	Description	Advantage	Disadvantage
Fragmented  Teacher applies this view in maths, science, social studies	The traditional model of separate discipline	Clear and discrete view of a discipline	Connections are not made clear for students, less transfer of learning
Connected 	Topics within a discipline are connected	Key concepts are connected, leading to the review, reconcept one year's work to the next and relates ideas explicitly.	Disciplines are not related. content focus remains within the discipline
Nested 	Multiple skills (social skills, thinking skills and content-specific skills) are targeted within a subject area	Give attention to several areas at once, leading to enriched and enhanced learning.	Student may be confused and lose sight of the main concepts of the activity or lesson.
Sequenced 	Similarities are taught in concert, although subjects are separate.	Facilitates transfer of learning across content areas.	Requires ongoing collaboration and flexibility as teachers have less autonomy in sequencing curriculum.

<p>Shared</p> 	<p>Team planning and/or teaching that involve two disciplines focus on shared concepts, skills or attitude.</p>	<p>Shared instructional experiences; with two teachers on a team it is less difficult to collaborate.</p>	<p>Requires time, flexibility, commitment and compromise.</p>
<p>Webbed</p> 	<p>Thematic teaching, using a theme as a base for instruction in many disciplines</p>	<p>Motivating for students, help students see connections between ideas</p>	<p>Theme must be carefully and thoughtfully selected to be meaningful, with relevant rigorous content</p>
<p>Threaded</p> 	<p>Thinking skills, social skills, multiple intelligences and studying skills are threaded throughout the disciplines</p>	<p>Students learn how they are learning, facilitating future transfer of learning</p>	<p>Disciplines remain separate</p>
<p>Integrated</p> 	<p>Priorities that overlap multiple disciplines are examined for common skills, concept, and attitudes</p>	<p>Encourages students to see interconnectedness and interrelationship among disciplines, students are motivated as they see these connections</p>	<p>Requires interdepartmental teams with common planning and teaching time</p>
<p>Immersed</p> 	<p>Learner integrates by viewing all learning through the perspective of one area</p>	<p>Integration takes place within the learner</p>	<p>May narrow the focus of the learner</p>

	of interest		
<p>Networked</p> 	<p>Learner directs the integration process through selection of a network of experts and resources.</p>	<p>Pro-active with learner stimulated by new information, skills or concepts</p>	<p>Learner can be spread too thin, efforts become ineffective.</p>

**Appendix X : Suggested programme structure for an alternative programme**

**Suggested course structure and activity schedule for an alternative teacher education programme in Sri Lanka**

Time allocation: 90 hrs.

Term 1

Week	Course element	Assessment	Remark
Weeks 1-3	PBL introduction and the PBL immersion experience (preliminary)	Reflective writing Thinking log	(Only for practice) Group submission
Weeks 4-6	Models of Integration and PBL		Reading resources
Weeks 6-8	PBL immersion experience	Reflective writing/ Thinking log Portfolio	Portfolio consists of all writings and reflective writing
Weeks 8-12	ERA unit plans	Assignment A	Work in groups Individual submission

Term 2

Week 12 - 16	Block teaching	Reflective writing	Remarks (practice)
Weeks 16-20	ERA project Using PBL approach	Assignment B	Submission in Term 3 (After the teaching practice)

	collaborate in groups ( planning stage)		
Weeks 20-24	Block teaching Effectiveness of using PBL	Reflective writing	Add all writings to portfolio

Term 3

Weeks 24- 28	Continue ERA project	Assessment B Presentation	
Weeks 28- 30	Continue project	Project Report and submission	Add all writings to portfolio

### Suggested course structure

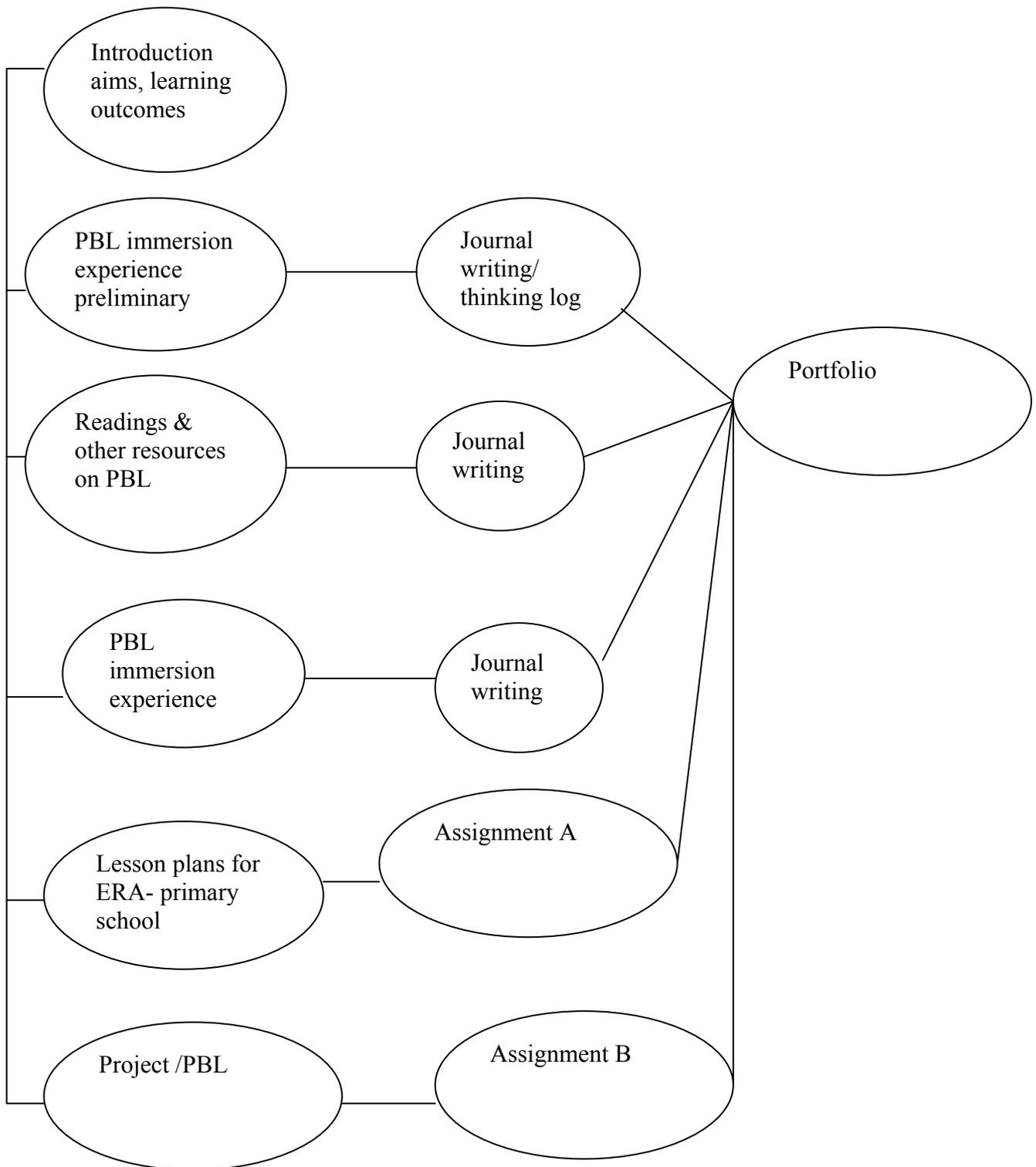


Figure: Course structure

## **Appendix XI :Criteria for assessment**

In this particular teacher education programme for ERA, some of the criteria for self, peer and tutor assessment tasks are suggested. The National Colleges of Education would be able to develop suitable criteria with the expertise knowledge of the curriculum team of the National Institute of Education who are responsible for curriculum preparation of the National Colleges of Education, Sri Lanka.

When the criteria for student assessment the following key objectives of PBL process described by Barrows (1992), Uden and Dix (2004) and Uden and Beaumont (2006), were considered.

- Develop student thinking and reasoning skills
- Help them become independent, self-directed learners (learning to learn, learning management)
- Engage and challenge with initiative and enthusiasm
- Collaborate effectively as a team member
- Monitor and assess own learning to achieve the desired outcome
- Develop skills to identify a problem and design an appropriate solution for it
- Develop the ability to identify issues that warrant further discussions and self study within the context of a problem

### **Criteria to assess PBL immersion experience**

5- Very well developed

4- Well developed

3- Developed

2- To be improved

1- Not developed

	1	2	3	4	5
<p><b>Knowledge building and inquiry skills and self directed learning</b></p> <ul style="list-style-type: none"> <li>• Obtains adequate information about the problem</li> <li>• Identifies learning needs</li> <li>• Sets specific learning objectives</li> <li>• Utilises appropriate search strategies</li> <li>• Interprets the information given in the problem</li> <li>• Identifies deep principles for organizing knowledge</li> <li>• Make efforts to improve</li> <li>• Defines and actions plan to meet learning needs</li> <li>• Shows evidence of accomplishing learning objectives</li> </ul>					
<p><b>Collaborative work</b></p> <ul style="list-style-type: none"> <li>• Shows effective interpersonal abilities</li> <li>• Respects classmates opinions</li> <li>• Gives emotional support to the others</li> <li>• Demonstrate enthusiasm and involvement as a team member</li> <li>• Shows responsibility and commitment in the team's tasks</li> </ul>					
<p><b>Problem solving</b></p> <ul style="list-style-type: none"> <li>• Explores problem statement</li> <li>• Defines the problem and identifies the issues</li> <li>• Develops concept maps to find out problem solving strategies</li> <li>• Develops metacognition skills</li> </ul>					

**Figure: Criteria for PBL assessment of immersion experience (adopted from, International PBL symposium 2007)**

**Lesson plan format for Assignment A**

Class/Stage:

Subject: ERA

Theme:

Sub theme:

Objectives:

- 1.
- 2.
- 3.
- 4.

Development of the lesson:

- Introduction
  
- Development of lesson activities
  - Phase 1
  - Phase 2
  - Phase 3
  
- Assessment

### Assessment rubrics for Assignment A

Element	Very well developed	Well developed	Developed	To be improved	Mark s
Completion of lesson plan format	All elements are appropriate and objectives stated clearly and match the ERA curriculum	Elements are appropriate and objectives match the ERA curriculum	Elements are appropriate and some objectives match the ERA curriculum	Objectives are not clear and some of the elements in the format are missing	
Development of lesson plan and teaching strategies	Demonstrate appropriate teaching strategies classroom management strategies concepts and learning experiences match the stage level and ERA curriculum objectives	Demonstrate appropriate teaching strategies and classroom management strategies and learning experiences match to some extent	Demonstrate appropriate teaching strategies and classroom management in some extent and learning experiences match to some extent	Teaching strategies are not appropriate and learning experiences are not clearly stated	
List of resources/aid e	Listed resources relevant to ERA curriculum and match the selected teaching strategies very well	Listed resources relevant to ERA curriculum	Listed resources match in some extent	Listed resources are inappropriate	
Assessment task	Assessment tasks clearly match the ERA curriculum	Assessment tasks are appropriate	Assessment tasks match to some extent	Assessment tasks are not appropriate	

	objectives and the planned lesson				
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**Assessment rubric for Assignment B**

	Exceptional	Proficient	Fair	poor
Inquiry skills	Identifies learning needs and sets learning goals. Always evaluates inquiry by assessing reliability and appropriateness of sources. Uses meta cognitive questions to engage in active learning	Utilise appropriate search strategies. Evaluate inquiry by assessing reliability and appropriateness of sources	Occasionally ask questions. Occasionally claims areas of inquiry but takes mostly what is left	Fails to recognise limits of understanding. Fails to assess the reliability or appropriateness of sources. Demonstrate unsystematic search strategies
Knowledge building	Thoroughly digests findings and effectively communicate findings to the others. Consistently identifies deep principles for organizing knowledge. Constructs an extensive and thorough knowledge base in all problem aspects	Usually identifies deep principles for organizing knowledge as evidence. Construct knowledge in most problem aspects.	Learns own area of inquiry but not those of others.	Fails to understand or be able to communicate inquiry findings
Exploring the situation	Understand the patterns and relationships and build concept maps	Understand the relationships and show the links to some sort of extent	Begin to see patterns and understand the relationship	Tries to understand relationships

	and project procedures	and explain how it relate to ERA curriculum areas	s	only
Link to ERA curriculum	Identifies and explain all key aspects in the project that link to ERA curriculum	Identifies all key aspects in the project that link to ERA curriculum.	Identifies some aspects in the project that link to ERA curriculum	Recalls some aspects in the project that could link to ERA curriculum
Higher order thinking and problem solving	Define the problem and the problem goals. Demonstrate synthesis skills and explore key features of the process inquiry	Explore the problem goals. Use inquiry to problem solve Occasionally develop models or framework	Need help to identify critical features. Sometimes apply inquiry to problem	Fails to define the problem. Fails to apply inquiry to problem
Self reflection and evaluation skills	Demonstrate consistent reflection on the process of working towards a solution and the learning involved in the process	Demonstrate consistent reflection on the learning involved in the process	Demonstrate some evidence on reflection in the learning process	Demonstrate little evidence on reflection in the PBL process
Using ICT	To be developed. Depends on available facilities in the college	To be developed. Depends on available facilities in the college	To be developed. Depends on available facilities in the college	To be developed. Depends on available facilities in the college

## Appendix XII : Description- Problem Scenario

### Problem Scenario - Water Contamination

<u>Causes</u>	<u>Impact of contamination/evidence</u>	<u>Solutions</u>
Waste up	Polluted Water	Clean
Mismanagement Sewage system of waste	Health risks Disease	Get rid
..... Programmes .....	.....	Awareness .....
Attitudes		

Using this concept map students could construct a concept map that will help them as follows:

- Discover the themes they want to emphasise
- Helps students to identify concepts that are keys in more than one discipline, which helps them move beyond traditional disciplinary boundaries.
- Support a holistic style of learning.
- Construct multiple ways of meaning for students.

Facilitators understand how students may see or organise knowledge differently from the facilitator, which will help her/him better relate to the students and to challenge their ways of thinking.

- Mapping concepts can increase the ability to provide meaningfulness to students by integrating concepts.

### Appendix XIII – Sample Interview transcript

Interview text	notes	code
<p>Answer Q1:            We were told in 2003 that we have to teach two integrated paper one in technology and science and one in language. So we had semester 2 which was about six weeks and which to plan this paper in 2003. We had to teach both face to face and online and February 2004 and that.....big ask. Most Universities have a 2 to 3 running time may research paper and then plan it produce it and teach it            We didn't have that luxury; we had to do it straight away.            Semester one in 2004 spent time with the rest of the team            Evaluating the semester 2 but I didn't teach in semester 2 of 2004. In 2005 "I'm not associated with the paper. Although I do attend the odd evaluation meeting and I monitor its progress and I am asked to input into it from time to time. So still I have another acquaintance with the paper.</p> <p>Q2:            Well I think to look at the goals. You need to have a look at the course admin booklet. One of the key goals of this paper is to model appropriate technology. You can see this stated on page 3 of the course administration book. We want to actually show students how to plan and teach an integrated science and technology course by doing it ourselves. So that we teach it an integrated way and students learn it an integrated way. They will find it very easy to do it where it comes to the classroom. Our key goals can be found in page 5 of the course hand book. They are listed under the learning intension they are 6 of them The main thing is we model ourselves as lecturers everything that we want our students to be able to do. It's important that in this particular paper is that we have criteria So that the students know they have actually achieved the behavioral outcomes or learning intentions or how ever else you wanna describe it and you can find that on page 6 under the heading called success criteria. Notice we use</p>	<p>Involvement            plan</p> <p>teach</p> <p>Goals            Integration            Science and            Technology</p>	<p>Major goals</p>

<p>phrase like that they have to demonstrate an ability and we say what we want them to be able to do and one of them is plan an integrated science and technology units that an appropriate to use We want them to demonstrate certain types of knowledge and you notice that we define the knowledge specific scientific phenomena technical knowledge and understanding technological capability and links to the society.</p> <p>So that it just isn't a theoretical curriculum or theoretical paper and it has to be embedded into the social.....of Nz curriculum as well both of them not just ....other thing we want them to do is develop resources as they go through this paper, both for science and technology every other paper that is taught is that are expect them to demonstrate an ability to use new educational technologies .Some of them are coming in with a very low level of computer literacy and we expect them to raise that to a quite a high degree in this paper and so we force them to do work electronically and they have to submit it and they are forced to use a bit of software that we put out on line or in class we set up action environments that between external and internal students. Then they have to work incorporate learning terms. We take them away from the individualism .than most university papers.</p> <p>I want to put back this on to Q2. Our major goal is problem Based Learning.</p>	<p>Success criteria</p> <p>Integrated science and technology</p> <p>Ability to use new technology</p>	<p>PBL approach and successful learning</p>
<p>Modeling appropriate pedagogy. Other major goal is in process how do you get on to integrated learning process is used to be is PBL .we consciously set out what PBL is? Our major goal is to give them very good background research literature and all the quite different models been proposed. So that at the end of the course in actual fact appropriate for the school</p> <p>We think our students are leaders they should be in a position to make really important decisions by the time they done this course.</p>	<p>PBLapproach</p> <p>Different models</p>	
<p>Q3</p> <p>I think goals are very adorable First I taught in semester1I have doubts about achieving them. Now I know that we can achieWe make some really good improvements .....lot of</p>	<p>Achieving goals</p> <p>Improvements</p> <p>Satisfy</p>	<p>Achieving goals</p>

<p>them satisfied..</p> <p>Q4:</p> <p>It suits very well. If we lecturers choose the right problems for the basis of the learning. If we don't choose the correct scenario we don't get a balance in the technology and the science. It takes such amazing effort to select right problems and analyse them and predict to how they going with students. We did quite well. We chose 10 and five for the first and 5 for the second. Among those five for the first semester Only one proved unbalanced. The degree of learning. We required at the end of the year.</p> <p>Constantly we modify them and looking at them. This is early days We will try to build up a pool of problem based learning situations.</p>	<p>Suits Correct scenario Modify Pool of PBL situation</p>	<p>Appropriate scenarios</p>
<p>Q5:</p> <p>Major teaching approaches. Well. A mixture. It depends on what we have to do. It depends on the semester. Sometimes we have lectures That are rare. Bring them as whole together. Lecture them demonstrate what they want. Other time we will give them structured activities. Work together in groups and get reports back. Other time we give them little cards. Again individual or small groups. Then they can pick up certain skills. Then we know they got these skills. Then we give them open ended problems. Allow choice. Lot of choice. Conferencing scaffolding that we make sure whether they understand what the process going through.. We give them practice exercises. Lot of formative assessment. A lot of feed back. Lot of practice and self evaluation.</p> <p>Practical example.</p> <p>Yes we do.</p> <p>We give them course handbook. They should look at the problems and scenarios. There four scenarios and choose 1. There is an open problem and students. We give them some scaffolding. We give them templates. One of our favorite one is need to know one in appendix 1 page 42. we teach them how to use it. Three column one What do we know What do we need to know How can we find out That is the foundation. They work on that under supervision, in class in the first week. It's quite interesting. That sets whole progress. They constantly use that.</p> <p>Q6.</p>	<p>Teaching approaches Choices Practical experience Feedback Open ended problems</p> <p>Templates</p>	<p>Diversity of teaching approaches</p>

<p>major differences  Traditional courses lecture centered.  Course like this is student centered.  Students have freedom.  They have freedom to inquire  They have freedom to plan They have freedom to research.  They have to follow the conventional problem solving methods of Science and Technology.  Because we want to see can they behave or think like a scientist or a technologist  Science and technologist does they go ahead doing research.  They are allowed to research and define it. They know that we expect them to be thinking and questioning in very high level. We do use blooms taxonomy. They know the taxonomy levels of cognitive thought.  Quite different. We are constantly assessing them.  Traditional papers assessed very conventional manner. Paper and pencil tests.</p> <p>We do diagnostic tests. We do constantly monitoring. Diary or logs some other assessments  Electronically they have to power point presentations. Online /cdroms.</p> <p>Q6 b.  It's made me think  What I choose to teach how I choose to teach it. Its theoretical doesn't develop thinking of the student.  It's theoretical and irrelevant. Doesn't develop thinking of our students at all. The other thing this paper very clearly planned to  Make students are responsible for their own learning. And also responsible to others.  How to work in teams. Objectives of teach science and technology. Actually develop all levels of cognitive learning. Have to learn respect other people's point of view. Other people's contribution etc. As well as evaluate on their own. It also carefully about assessment. How assess students.  What Carry out problem solving process is very very important.</p> <p>It changes where you teaching  You become a questioner you become a facilitator  You become a modeler</p> <p>Traditional way of transmission knowledge. That</p>	<p>Student centered  Freedom  Plan  Research</p> <p>Blooms  Taxonomy</p> <p>Diagnostic test  Continuous assessment</p> <p>Developing thinking  Responsible for own learning  Changes of teaching</p>	<p>Traditional vs integrated papers</p> <p>Responsibility of own learning</p> <p>Changes of teacher preparation</p>
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<p>is not your function. Your function is to motivate focus them to help them think and to make them investigate the questions. how could they find answers.</p> <p>Q7.</p> <p>Very few. We had to do an enormous literature search We have to find out literature.find out what was happening in other countries. Was anyone in Nz doing or has anyone in NZ.we got everything we had to know. We had to do lot of readings. We eventually got 10 readings. We just concern in to improve it. We wrote whole series of resources. We use them in class. See how it works. When we found that students have difficulties we set meetings how can we make it better. How can we design it better. Now we have pretty good things.</p> <p>b. we utilize some of them in class. We found that this paper works well. Expecting students work well together on line as well. Where we structure tasks. We can use this as well to the other papers.</p>	<p>Enormous literature</p>	<p>Resources</p>
<p>Q8.</p> <p>It's a hard question to answer. Actually we don't know whether it is more effective. Nobody actually research it yet. It's too early. All we got at the moment is feedback from students. How do you use in planning And How do you use in class room.</p> <p>One thing we know is anecdotal feedback from students. We surveyed them at the end of each semester and final assessments.</p> <p>We know students really like this approach.</p> <p>We know that</p> <p>Unless do a follow up study to say what was happening</p> <p>Too early yet. Another thing is We don't have a developed anecdote post graduate paper where could introduce some of these ideas to experienced teachers. Then we see the difference between graduate paper and the undergraduate paper.</p>	<p>None of the research</p> <p>Feedback from the student assessment</p> <p>No post Grad paper</p>	<p>Future research area</p> <p>Introduce PBL approach to a post graduate paper</p>

<p>Q 9. The answer is probably yes. It's too early</p> <p>Constantly we use scenarios. At the end of semester we can look what student produced. We do know we done well on that. We put a lot of to that. We still working on finding out the process. Traditional papers do not encourage thinking. It is passive learning When students suddenly come to do a paper like this they are responsible for learning. They are expected to produce outcomes of learning. The other thing is two technologists going to work this paper next. It may have an effect.</p>	<p>Further changes Student production</p>	<p>Areas to be improved</p>
<p>Q10. This integration It is needed to think our colleagues to think. before go in to other areas It's harder to teach You have to have holistic world. The paper like this depends of the successful teamwork. We have only four lecturers to write it teach it and evaluate it. Need very transparent. Everything should be very transparent.</p>	<p>Team work Holistic approach Transparent</p>	<p>Necessity of successful team work and transparency</p>

## Appendix XIV : Student Questionnaire Responses

.....  
 I enjoyed the extreme student centered strategies.  
 b) If 'no' in why not?  
 .....

11. Do the assignments and evaluation procedure of this paper support the stated learning outcomes of the paper?  
 They do very much the evaluation process was extremely practical.

12. How would you compare the workload of this paper with that of other papers?  
 It was very demanding but my group and I found that the assignments were not a huge burden the workload wasn't a real issue for us.

13. What kind of learning support is provided for you in this paper?  
 Well, we had an extremely motivating lecture we were given an assignment on a busy day, also we had the teaching support of our fellow peers, was invaluable.

14. How have you benefited from the collaborative group activities incorporated in this paper?  
 Went to work in a group, learnt a lot and my social skills.

15. In your opinion how does this integrated curriculum fulfill the objectives stated in the national primary school science and technology curricula?  
 .....

14. How have you benefited from the collaborative group activities incorporated in this paper?  
 Yes.

15. In your opinion how does this integrated curriculum fulfill the objectives stated in the national primary school science and technology curricula?  
 Fulfills them as we are providing real world integrated learning.

16. What beginning teacher characteristics does this paper aim to encourage?  
 Problem based learning, integration, collaborative learning.

17. How confident do you think you will be upon completion of this paper to teach Science and Technology in the primary classroom?  
 Very confident.

under 20yrs

20-24yrs

30-34yrs

25-30 ✓

35-39 yrs

40-44yrs

over45yrs

What are your expectations from taking the paper 210.210?

A practical way by which science & tech can be successfully integrated

How does this paper contribute to your preparation as a teacher?

It gave me an insight to how the papers (curriculum) are similar (investigation wise) but different (?)

In what ways is this paper meeting your expectations?

It actually went beyond my expectations and clarified the subjects (sci & tech) as individual areas.

In what ways is the paper not meeting your expectations?

~~.....~~

How well does this paper model/enhance real classroom practice?

Yeah it would be possible to do this in a classroom. I have never actually seen science or tech taught in a classroom. It has shown me that Problem based learning is a great way to do it.

Were you introduced to different teaching approaches in this paper?

Yes. Very much so. Having the lecturer as a facilitator of learning & someone to bounce ideas off was incredible. You appreciate what you learn so much more.

..... and it came clearer

How well does this paper model/enhance real classroom practice?

Practice can be adapted easily

Were you introduced to different teaching approaches in this paper?

Yes PBL