Science and Mathematics Education Centre

Towards Quality Teacher Education: Productive Pedagogies

as a Framework for Saudi Pre-service Teachers' Training in

Mathematics Education

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DECLARATION

To the best of my knowledge and belief this thesis contains no material previously published by any other person except where due acknowledgment has been made.

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university.

Signature:

Date: 27. 11. 2011

The following publications and presentations have resulted from the research described in this thesis:

Journal Article

Alsharif, K. & Atweh, B. Productive Pedagogies as a framework to improve preservice teachers' practices. *The International Journal of Learning.* In press.

Conference Proceeding and presentations

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Alsharif, K. & Atweh, B. (2011). *Productive Pedagogies as framework to improve preservice teachers' practices.* Paper presented at the Eighteenth International Conference on Learning. Mauritius

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ABSTRACT

Reforming pedagogy in mathematics education has been the focus of numerous educational reforms around the world. Productive Pedagogies is a framework for reflection on teaching that aims at improving students' intellectual reasoning, making school teaching and learning more connected to students' everyday lives, and addresses the concerns of equity support. There has been no research on this novel teaching framework in the Saudi Arabian context.

The focus of this study was the incorporation of the Productive Pedagogies framework in teacher education. In particular, this study aimed to investigate the incorporation of the Productive Pedagogies framework within a teachers' pre-service unit in mathematics education in Saudi Arabia. In addition, it aimed to investigate the pre-service teachers' ability to implement the framework in their field experiences. Socio-cultural factors related to the incorporation of Productive Pedagogies in a Saudi Arabian context were also examined.

This research is a qualitative study informed by practical action research methodology and aims to introduce the Productive Pedagogies framework to a group of final year pre-service teachers at a teacher education college in Saudi Arabia. This study took place during the last two semesters of the course and was conceptualised to consist of two phases. In phase I, eighteen pre-service teachers were introduced to the Productive Pedagogies framework in the unit of Mathematics Teaching Methods. In other words, the framework constituted part of the content of the unit and was used as an overall organizer to integrate the other content usually covered in the subject. At the same time, the framework was used by the researcher in his teaching of the subject, thus modeling the principles of the framework in the classroom. In phase II, six pre-service teachers were followed into their field experience at two participating primary schools. Each pre-service teacher was observed five times during their field experience to ascertain his level of

understanding and use of the framework. This study gathered data from focus groups, interviews, observations and reflective journals.

The study revealed that, overwhelmingly, pre-service teachers found the framework very useful, helping them to integrate their new knowledge developed in the unit, Mathematics Teaching Methods, into their practice; they also attempted to use it in planning, conducting and reflecting on their teaching practice during their field experience. In particular, the pre-service teachers demonstrated a shift towards student-centred teaching. In addition, the findings indicated that while the pre-service teachers faced challenges in using Productive Pedagogies in their practice and some of the main dimensions were not implemented a great deal, there was clear evidence of an increase in the implementation of each dimension by pre-service teachers over the duration of the observation period. Reflecting on some of the problems that were observed, this study makes some recommendations for teacher training programs in general.

In the name of Allah, the Most Beneficent, the most Merciful

DEDICATION

This thesis is dedicated to my mother, for her unconditional love,

to my father, for his encouragement,

to my grandmother, for her overall inspiration,

to my brothers and sisters, for their patience in waiting my journey to
finish,

to my lovely wife, for her endless love, support and continued
encouragement,

to all my friends and colleagues.

Lastly, this thesis is dedicated to all educators and teachers who
endeavour to make a difference.

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CHAPTER 1

INTRODUCTION

1.1 Statement of the Problem

Historically, over the last two centuries, the field of mathematics education has developed as mathematicians and educators have turned their attention to what mathematics is, and how it might be taught in schools (Kilpatrick, 1992). Arguably, there are two problems that face people involved in mathematics education around the world, namely, students' lack of achievement in, and disengagement from, the subject. Naturally, these are worrying phenomena to all education systems particularly in the light of the general acknowledgement that mathematics is an important subject in the curriculum and in the current and future lives of students (Atweh & Brady, 2009). In the minds of many, such importance is given to the subject due to the increasing importance of technology and science in most societies – two essential areas for problem solving and raising living standards. Mathematics, like science, is often associated with the economic development of a country (Kuku, 1995). At the personal level of the student, the study of mathematics is often justified as a means of opening the doors to many careers and courses of further study.

Recently, there is a clear trend of attention in research about different possibilities for improving mathematics teacher education (Hershkowitz & Breen, 2006), due to concerns that a mere focus on issues of the learner neglects the crucial role of the teacher in the educational endeavour. Darling-Hammond (2000) mentioned the quality of teachers as being the most important factor influencing learning in school settings. Teacher education may be considered as a centre of any education system because it helps to the development of the qualified teachers. In the literature, the attention on the pre-service preparation process was a concern of many educators to improve the future of mathematics teachers (Frykholm, 1999). Talking about

teacher education in the 1990s, Mintrop (2001, p. 207) summarised that, "Our challenge as teacher educators and researchers was to design a teacher education program module that centred on an ambitious constructivist teaching model". Arguably, the challenge for mathematics teacher educators to develop a constructivist framework for teaching to help student teachers to develop their understanding and its application to classroom practices remains a challenge today in many countries, including Saudi Arabia.

According to Richardson (1997) there are two ways in which constructivism has been implemented in teacher education. Some programs focus on the development of specific pedagogies informed by constructivism. Other programs focus on enabling the student teachers to reflect on their own learning and practices and thus develop effective pedagogies in their field of experience. Arguably, the approaches that depend on the pre-service teacher using reflection on their practice based on their theories are more effectual for achieving flexibility in adapting pedagogies to the local context of the school and the student. Llinares and Krainer, (2006) stressed that student teachers integrate theory and practice better when they are explicitly taught how to reflect on their teaching practice. According to many studies, teacher education programmes should help student teachers to reflect on and analyse their own teaching practices in order to improve their skills of teaching (Artzt, 1999; Ebby, 2000; Morris, 2006). Professional development programs that involve reflection by pre-service teachers on their learning and enable them to share their experience with their colleagues have great impact on pre-service teachers' knowledge and beliefs (Llinares & Krainer, 2006). There is a shift in focus in this approach from beliefs to practices; a shift from student learning to pedagogy.

In light of the previous discussion, the study reported here has focused on assisting pre-service teachers to reflect on their practices using the Productive Pedagogies framework (Lingard, et al. 2001). "Productive Pedagogies is a balanced theoretical framework enabling teachers to reflect critically on their work" (Education Queensland, 2002, p. 2). The framework

is a comprehensive tool for thinking about teaching that is consistent with constructivist theory of learning development, however it takes into consideration research from other areas of knowledge about effective teaching. According to Lingard, Hayes, and Mills (2003) the concept of Productive Pedagogies "was developed after considering a broad range of relevant and cognate literatures, including the sociology of education, sociolinguistic ethnographies of classroom, school effectiveness and school improvement literatures, sociocultural and constructivist research on pedagogies" (p. 403).

1.2 The Context of the Study

I began teaching in the Riyadh Teachers' College in 2000 and my main roles were teaching the mathematics teaching methods unit as well as supervising mathematics students in their field experience. The College was one of eighteen teachers' colleges in Saudi Arabia. In the past ten years, the Riyadh Teachers' College has attempted to focus on the quality of pedagogy in its courses as well as train its students to become better teachers. Part of the reason for these foci was the national initiative to renew teaching and learning. A report prepared by a team of educator supervisors in the Ministry of Education (2000) stated that the teaching methods used within the Saudi classrooms often were based on traditional teaching that focused on memorization of facts and the development of routine techniques and failed to assist students to develop deep understandings and higher order thinking. For the advancement of the educational process, the report recommended that teacher colleges focus on new methods of teaching. The focus was on the teacher as the primary person involved in the improvement and development of teaching. With this major concern, teachers' colleges in the country began focusing on teacher development and searching for the best strategies to be implemented during the years of study and training in the college programs. Consequently, Riyadh Teachers' College supported the reform, advocating change from the traditional teacher-centred approach towards a more student-centred or constructivist-based pedagogy.

Interestingly, in the last ten years in Saudi Arabia, there has been a surge in the amount of education research conducted in the field of teacher education. Notable areas of research focused on improving teachers' pedagogies. That was because many mathematics teachers still used teacher-centred approaches in teaching mathematics in Saudi classrooms and did not help students to engage in higher order thinking (Bader, 2004; Alfarhod, 2009). Albalawi (2010) identified eight main areas of research in teaching and learning mathematics in Saudi Arabia in order to help researchers to direct their research to the most critically needed areas of research. He pointed out that, currently, mathematics teachers' preparation and training were the highest priority areas for research. Almoathm (2008) stressed that there was, however, less emphasis on research related to mathematics teacher preparation programs in Saudi Arabia. According to Felban (2003) teacher education programs should provide pre-service teachers with new strategies and skills to prepare them to become better teachers. A search for an effective model for training for effective strategies to be implemented during the last year of study and training at Riyadh Teachers' College led to the adoption of Productive Pedagogies as a reflective framework for pre-service teachers in mathematics education in order to improve their teaching practices. Gore, Griffiths and Ladwig (2001) suggest that Productive Pedagogies could provide a framework with potential for enhancing the quality of teaching for pre-service teachers. Zingier (2005) agrees that Productive Pedagogies framework is useful in the development of pre-service teachers' understanding of the effective pedagogical practices.

1.3 Productive Pedagogies Framework

Increasing learning outcomes, both academic and social, has been the focus of numerous educational reforms. Productive Pedagogies is a framework for teaching which has a focus on the improvement of student intellectual reasoning, while making teaching and learning in schools more applicable to the students' everyday lives. Also, Productive Pedagogies builds a supportive classroom environment which positively recognises difference. Productive Pedagogies framework was developed in Queensland as a part

from the Queensland School Reform Longitudinal Study (Education Queensland, 2001). In their description of the new framework, the QSLRS (2002, p. 2) highlighted "Productive Pedagogies is a balanced theoretical framework enabling teachers to reflect critically on their work". The rationale for developing Productive Pedagogies was to provide a tool for teachers to use to increase learning outcomes both academic and social (Lingard et al., 2001). Moreover, Productive Pedagogies made a more obvious attempt to link teaching and learning with the diverse range of cultures represented in the Australian classroom (Lingard, Hayes, & Mills, 2003). The developers of Productive Pedagogy postulated that there were four dimensions, Intellectual Quality, Connectedness, Supportive Classroom Environment, and the Recognition of Difference (Education Queensland, 2001). Each of these dimensions were further divided into several elements. The next section presents each dimension with its explanation and interpretation. The attention of developing a comprehensive framework rather than focusing on particular strategies for teaching came from the strong belief that the classroom practices should make a difference not only to the academic but also to the social learning of students. "We cannot emphasise enough the importance of intellectual quality for all students, but we would argue that it is not sufficient. The other three dimensions are also necessary – especially for those students who struggle with schooling" (Hayes, Mills, Christie & Lingard, 2006, p. 78). The definition of each dimension and its elements was taken from (Education Queensland, 2001) and presented below.

1.3.1 Intellectual Quality

Intellectual Quality seeks to ensure that students manipulate information and ideas in ways which transform their meaning and implications, understand that knowledge is not a fixed body of information, and can coherently communicate ideas, concepts, arguments and explanations with rich detail (Education Queensland, 2001). Intellectual quality was further divided into six elements - higher order thinking, deep knowledge, deep understanding, substantive conversation, knowledge as problematic, and metalanguage.

Higher-order thinking requires students to manipulate and combine facts and ideas in order to synthesise, generalise, explain, hypothesise or arrive at some conclusion or interpretation. Manipulating information and ideas through these processes allows students to solve problems and discover new meanings and understandings.

Deep knowledge occurs when it concerns the central ideas of a topic or discipline and when relatively complex connections are established to central concepts.

Deep understanding occurs when students develop relatively complex understandings of these central concepts. Instead of being able to recite only fragmented pieces of information, students develop relatively systematic, integrated or holistic understandings. Mastery is demonstrated by their success in producing new knowledge by discovering relationships, solving problems, constructing explanations, and drawing conclusions**.**

Substantive conversation seen when there is considerable teacher-students and student-student interaction about the ideas of a substantive topic; the interaction is reciprocal, and it promotes coherent shared understanding.

Knowledge as problematic involves an understanding of knowledge not as a fixed body of information, but rather as being constructed, and hence subject to political, social and cultural influences and implications. Multiple, contrasting, and potentially conflicting forms of knowledge are represented.

Metalanguage instruction has high levels of discussion about talking and writing conventions. Mainly, metalanguage is about how written and spoken texts work, about specific technical vocabulary and words (vocabulary), about how sentences work or don't work (syntax/grammar), about meaning structures and text structures (semantics/genre), about issues how discourses and ideologies work in speech and writing. Teachers tend to do a

good deal of pulling back from activities, assignments, readings, lessons, and foregrounding particular words, sentences, text features, and discourse.

1.3.2 Connectedness

The dimension of connectedness in the productive pedagogies framework seeks to ensure that students engage with real, practical or hypothetical problems which connect to the world beyond the classroom, which are not restricted by subject boundaries and which are linked to their prior knowledge. Connectedness is divided into four areas – knowledge integration, background knowledge, connectedness to the world, and problem-based curriculum.

Knowledge integration is identifiable when either; a) explicit attempts are made to connect two or more sets of subject area knowledge, or b) when no subject area boundaries are readily seen.

Background knowledge occurs when lessons provide students with opportunities to make connections between their linguistic, cultural, world knowledge and experience and the topics, skills and competencies at hand. Background knowledge may include community knowledge, local knowledge, personal experience, media and popular culture sources.

Connectedness to the world describes the extent to which the lesson has value and meaning beyond the instructional context, making a connection to the larger social context within which students live.

Problem-based curriculum is identified by lessons in which students are presented with a specific practical, real, or hypothetical problem (or set of problems) to solve.

1.3.3 Supportive Classroom Environment

Supportive classroom environment, the third dimension, seeks to ensure that students influence the nature of the activities they undertake, engage seriously in their study, regulate their behaviour, and know of the explicit criteria and high expectations of what they are to achieve. Supportive classroom environment contains five elements – student direction, social support, academic engagement, explicit quality performance criteria, and self-regulation.

Student direction sees students influence what specific activities or tasks they will do in the period, or how these will be realised. Such activities are likely to be student-centred, as in group work or individual research or investigative projects. In this way the students assume responsibility for the activities with which they engage, or how students complete them.

Social support is presented in classes when the teacher supports students by conveying high expectations for all students. These expectations include: that it is necessary to take risks and try hard to master challenging academic work, that all members of the class can learn important knowledge and skills, and that a climate of mutual respect among all members of the class contributes to achievement by all. Mutual respect means that students with less skill or proficiency in a subject are treated in ways that continue to encourage them and make their presence valued. If disagreement or conflict develops in the classroom, the teacher helps students resolve it in a constructive way for all concerned.

Academic engagement is identified by on-task behaviours that signal a serious psychological investment in class work; these include attentiveness, doing the assigned work, and showing enthusiasm for this work by taking initiative to raise questions, contribute to group activities and help peers.

Explicit quality performance criteria are frequent, detailed and specific statements about what it is students are to do, to achieve. This may involve

overall statements regarding tasks or assignments, or about performance at different stages in a lesson.

Self-regulation was evident in a classroom where teachers did not make or did not have to make statements that aim to discipline students' behaviour (e.g., 'you're not being good today, put your pens away') or to regulate students' bodily movements and dispositions (e.g., 'sit down', 'stop talking', 'eyes this way').

1.3.4 Recognition of Difference

The recognition of difference seeks to ensure that students know about and value a range of cultures, create positive human relationships, respect individuals, and help to create a sense of community. The fourth category contains cultural knowledge, inclusivity, narrative, group identity, and active citizenship.

Cultural knowledge is valued when there is explicit valuing of their identity represented in such things as beliefs, languages, practices, and ways of knowing. Valuing all cultural knowledges requires more than one culture being present, and given status, within the curriculum. Cultural groups are distinguished by social characteristics such as gender, ethnicity, race, religion, economic status, or age. Thus, their valuing means legitimating these cultures for all students, through the inclusion, recognition and transmission of this cultural knowledge.

Inclusivity describes the degree to which non-dominant groups are represented in classroom practices by participation. Non-dominant groups are identified in relation to broad societal-level dimensions of social inclusion/exclusion.

 Narrative is identified as a sequence of events chained together. The use of narrative in lessons is identified by an emphasis in teaching and in student

responses on structures and forms. These may include the use of personal stories, biographies, historical accounts, literary and cultural texts.

Group identity in contemporary social theory emphasises the need for schools to create learning communities in which difference and group identities are positively recognised and developed within a collaborative and supportive classroom community. This requires going beyond a simple politics of tolerance. A classroom, which manifests this ideal, is one where differences and group identities are positively developed and recognised while at the same time a sense of community is created.

Active citizenship acknowledges that in a democratic society all individuals and groups have the right to engage in the creation and re-creation of that democratic society; have the right to participate in all of the democratic practices and institutions within that society; have the responsibility to ensure that no groups or individuals are excluded from these practices and institutions; have the responsibility to ensure a broad definition of the political includes all relationships and structures throughout the social arrangement.

1.4 Research Aims

There are four main aims of this research.

Aim 1: To investigate the incorporation of Productive Pedagogies framework within a teachers' pre-service unit in mathematics education in Saudi Arabia.

Aim 2: To investigate the pre-service teachers' engagement with Productive Pedagogies.

Aim 3: To investigate the pre-service teachers' ability to implement the Productive Pedagogies.

Aim 4: To investigate socio-cultural factors related to the incorporation of Productive Pedagogies in a Saudi Arabian context.

1.5 Apply Productive Pedagogies in a Saudi Context

The development of Productive Pedagogy comes at a time where the Saudi Arabian education system is strongly advocating a student-centred approach to teaching and learning. The advantage of Productive Pedagogy is that it provides a more tangible means of promoting teacher understanding about student-centred learning and intellectual quality. Moreover, the framework might provide more authentic and relevant standards for Saudi mathematics teachers to focus on. Gore, Griffiths, and Ladwig (2002) commented that Productive Pedagogy, as the name suggests, demands a high level of productivity from students through placing high level expectations on both the teacher and students. There has been no research on this novel teaching framework in the Saudi Arabian context. It is hoped Saudi Arabian mathematics classes can benefit from this reflective instructional approach. This research project concentrates on a sample of eighteen pre-service teachers in Riyadh Teachers' College. Practical action research was used to integrate the Productive Pedagogy framework within the official unit in mathematics education in Riyadh Teachers' College, and to determine the level of pre-service teachers' understanding and ability to apply its central principles.

In this study the application of Productive Pedagogies is not taken as unproblematic; investigating its usefulness in the Saudi context is one of the research aims. While the education system in Saudi Arabia was built on the Islamic philosophy and its objectives, the Productive Pedagogies framework was developed in western countries and reflected their values and traditions, and research conducted in those countries. This study aims to provide a comparison between the principles of education in Saudi Arabia and the principles of education reflected in the Productive Pedagogies. The first official document that represents the educational policy of Saudi Arabia was created in 1970 and is still in force. Al-Esia (2009) stressed that the Ministry of Education should create and update the vision and policy of education to reflect the present time and needs. This study aims to identify existing policies in Saudi Arabia that seem to support certain principles of Productive

Pedagogies, as well as highlight some of the objectives and articles of the educational policy that need to be re-examined in order to contribute to the corpus of educational training knowledge in Saudi Arabia. However, as discussed in the conclusion Chapter below, this discussion is necessarily limited as a full discussion of the socio-cultural aspects of education in Saudi Arabia, albeit is important to conduct, falls beyond the scope of this particular study.

1.6 Significance

The Ministry of Education in Saudi Arabia strives for and expects to offer its students the best possible curriculum and teaching methodology in order to enhance the quality of the student learning outcomes in the classrooms for the betterment of the society as a whole. As "the responsibility of education lies in its role in preparing human resources that are capable of creating and achieving comprehensive social development for the community in the various aspects of its social and economic life" (Ministry of Education, 2005, p. 5). Mathematics education is no exception; and thus, the core importance of this research project lies in its contribution to the body of knowledge on contemporary teaching approaches as well as providing support for a new theoretical background for teacher trainers in the Saudi Arabia.

For mathematics students, Productive Pedagogies is an opportunity to focus on more applicable mathematics. This means students will be able to make more useful links with the material studied in school and their lives beyond the school. For mathematics teachers, Productive Pedagogies offers more worthwhile teaching strategies. Teachers are more able to teach content which is related to the students' interests. Productive Pedagogy enables teachers to "reflect critically on their work" and "make intelligent decisions about individual students' needs" (Education Queensland, 2002, p. 2).

Personally, studying the implementation of Productive Pedagogies at the doctoral level will enable me to obtain a significant personal understanding of

the determining factors in high quality instruction, as implemented in Queensland Education. Also, there is a professional benefit from the study of approaches to teaching as applied in different settings in order to draw the most useful and relevant components from these paradigms. Thus, my personal and professional development and a heighten self-awareness are all expected to be benefits of this study.

1.7 Project Overview

Prospective teachers of mathematics at the Riyadh Teachers' College undertake a four year Bachelor of Education course. They study a unit called "Mathematics Teaching Methods" in their seventh semester. The unit contact time is two hours each week for 14 weeks. In this unit, the students consider various mathematics teaching methods and their application. During the following final semester, the students are engaged in fulltime field experience which includes teaching mathematics for a minimum of eight lessons per week for the full semester. This study took place during both final semesters of the course and was conceptualised to consist of two phases.

In *Phase I*, pre-service teachers were introduced to the Productive Pedagogies framework in the unit of Mathematics Teaching Methods. In other words, the framework constituted part of the content of the unit and was used as an overall organizer to integrate the other content usually covered in the subject. At the same time, the framework was used by the lecturer in his teaching of the subject, thus modeling the principles of the framework in the classroom. The aims of this phase were to investigate, the incorporation of Productive Pedagogies framework within the unit, and the pre-service teachers' engagement with the framework. The data collection for this phase consisted of the lecturer-researcher and pre-service teachers own reflective journals and three focus groups with selected pre-service teachers.

In *Phase II*, six pre-service teachers were followed into their field experience at two participating primary schools in order to investigate their ability to implement the Productive Pedagogies. Each pre-service teacher was observed by the lecturer researcher five times during semester as part of the college requirement. However, in each observation, evidence of implementation of the four dimensions of the framework was ascertained by using the QSRLS Productive Pedagogies Classroom Observation Manual (Education Queensland, 2001) which formed the basis for the usual feedback from the lecture on their observed teaching. In addition, semi-structured individual interviews were conducted with each of three participants to investigate their understanding and views about the implementation of the Productive Pedagogies in their practice. One focus group was also conducted with all six pre-service teachers at the end of their field experience.

1.8 Overview of Data Analysis

I followed the suggested steps commonly used in analysing qualitative data by Creswell (2005). These steps were firstly transcribed from the audiotapes from the interviews and focus groups. Field notes during the thirteen observations were written. I then developed a general sense of the data and commenced coding descriptions and themes about the central phenomenon. The process involved a simultaneous process of analysing while data were being collected. This practice helps the researchers to come up with major ideas or concepts (Creswell, 2005). Merriam (1988) states that simultaneous analysis and data collection helps direct the data collection phase productively, and develops a database at the same time. Constant comparative analysis was then used to compare themes with all others that may be similar or different in order to develop more conceptualisations of various pieces of data. NVivo software was used to store, organise, code and retrieve data for analysis.

1.9 Overview of the Thesis

The structure of the thesis is illustrated in Figure 1.1.
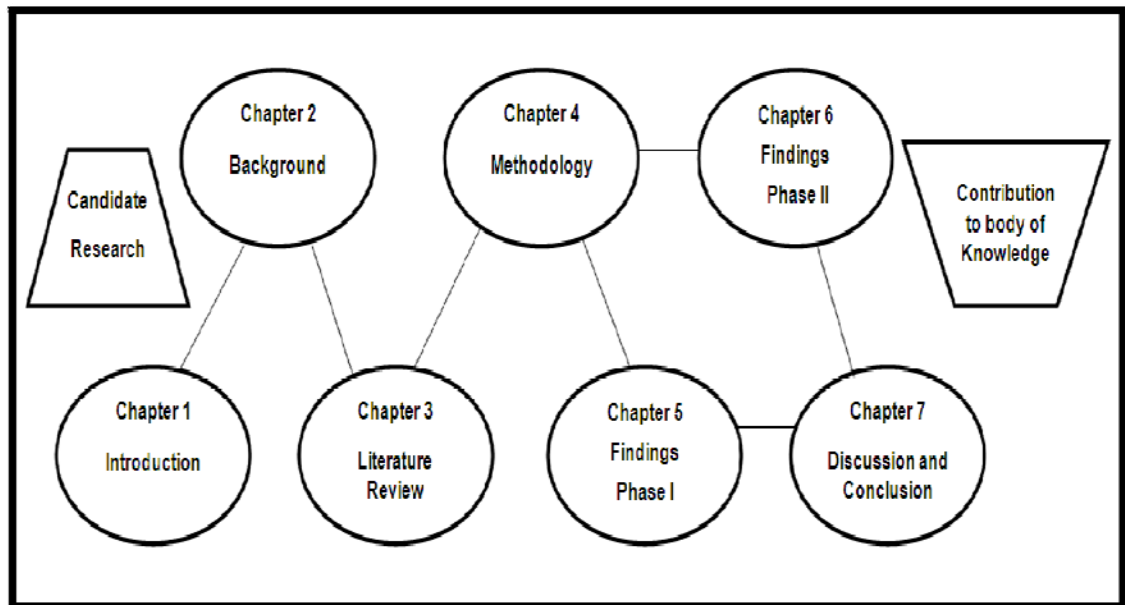
Figure 1.1. Thesis organization roadmap

In more detail, the thesis is organized as follows:

Chapter 1 is an introduction of the study. It provides the background to this study explains the research problem and highlights the research aims. It also discusses the context and the significance of this study. The Productive Pedagogies and its dimensions are described in this chapter. From this, the reader gains an understanding of this research study.

Chapter 2 describes the background and context of this study. This includes an introduction of Saudi Arabia and its location, people and culture. It provides overviews of the education system in the country and its policy. It also discusses the development of mathematics education in Saudi Arabia.

Chapter 3 provides the literature review for this study. This includes a relevance summary of general learning theories and research to the learning and teaching of mathematics. It also discusses a full review of the literature about the theoretical framework of this study.

Chapter 4 describes the research design and methodology employed in this study. It presents an explanation of practical action research, the application of action research in education settings and the discussion of the two phases employed in this study. It provides details of the observation instrument and the data analysis of this study. The chapter concludes with discussion of the ethics and validity issues of the research.

Chapter 5 describes the instructions and pedagogies used in the study, including the official unit aims and content. It presents details on the teaching through the Productive Pedagogies framework and details on teaching about the Productive Pedagogies framework to pre-service teachers. It also provides the two teacher trainers' views on the alignment of the teaching process with the Productive Pedagogies framework. At the end, a reflection on the research process was documented.

Chapter 6 continues presenting the findings of this study; it presents data concerning the pre-service teacher reactions the framework, provides data critiquing the application of the Productive Pedagogies by the pre-service teachers in their teaching practice and highlights student teachers' improvement in implementing Productive Pedagogies over the observation periods.

Chapter 7 discusses the findings in relation to the relevant literature and describes the results that have been achieved. It also concludes this study by discussing the limitations, reviewing the contributions of the thesis to the practice of teacher training, and possible directions of future research in Saudi Arabia.

CHAPTER 2

BACKGROUND OF THE STUDY

The previous chapter explained the research background, research aims and the significance of this study. This chapter presents the background and the context of the study by addressing five areas. Section 2.1 presents an overview of the Kingdom of Saudi Arabia, its geographical location, people and cultures. Section 2.2 describes the development of the education system in Saudi Arabia. Section 2.3 illustrates the philosophy and policy of education. Section 2.4 explains the education administration in Saudi Arabia. Section 2.5 gives an overview of mathematics education in the country.

2.1 An overview of Saudi Arabia

Figure 2.1. Map of Saudi Arabia

The Kingdom of Saudi Arabia is located in the southwest corner of Asia, between Africa, Asia and Europe. Saudi Arabia occupies about four-fifths of

the Arabian Peninsula, with total size of more than 2.2 million square kilometres. Saudi Arabia is bordered by the Red Sea on the west, by Kuwait, Iraq and Jordan on the north, Yemen and Oman on the south and the Arab Gulf, Qatar, Bahrain and United Arab Emirates on the east. The country is divided into 13 provinces, each with a capital city. Each province has its own council that advises the governor and deals with the development of the province.

The Kingdom of Saudi Arabia is a country of great global significance. For millions of Muslims it is the Holy Land and pilgrimage destination. For many expatriates from Asia, Europe and the United States it is a land of opportunities. For the rest of the world, Saudi Arabia's oil is an economic lifeline. Saudi Arabia is now entering a new phase of its development.

The climate in Saudi Arabia varies because of its large area and topographical structure. For instance, in the southwest, the average temperature is only 19 °C, because of its high altitude; in the centre, surrounded by desert, it is 29 °C. In general, the climate is very hot in summer and very cold in winter. Saudi Arabia is a dry country; more than half of the total area is desert. There is less than 127 millimetres of rainfall in the winter. There are no lakes or permanent rivers.

2.1.1 People

According to the 1975 census, the population of Saudi Arabia was about 7.32 million. By 2010, the population was about 27 million (Central Department of Statistic and Information, 2011). There are about 18.70 million Saudis, accounting for 67.9% or two-thirds of the total population. The remaining 31.1% are resident foreigners. The population is 50.9% male and 49.1 female (Central Department of Statistic and Information, 2011). Most of the people in Saudi Arabia are ethnic Arabs. The other ethnic groups are Turks, Iranians, Indonesians, Indians and Africans who immigrated as pilgrims and reside in the western region.

2.1.2 Religion and Culture

Saudi Arabia is an absolute Islamic monarchy with the Qur'an as its constitution. The government is based on the principles of justice, consultation, and equality in accordance with Islamic laws. All Saudi citizens are Muslims. However, people from other countries can practice their religions freely at their compounds and in their homes. In Saudi Arabia, Islam influences nearly all aspects of daily life such as family and social relationships.

The Arabic language is the national and official language, used in government, the courts, the media and the schools. English is used in international business, trade, diplomacy and tourism. The Saudi culture has been influenced by Islamic and Arabic traditions as well as by the diverse input of the Bedouin people. These traditions have evolved over the years and are highly regarded by Saudi people. Hospitality and generosity are famous traditions, which many Saudi family offers to strangers and friends. The Saudi people have adapted their ancient traditions and behaviours to the modern world.

2.1.3 Riyadh City

Riyadh city is the capital city of the Kingdom of Saudi Arabia. Located in the centre of the country at 600m above sea level, the Riyadh province occupies 17% of Saudi Arabia's total area. Riyadh is so named because the meaning of the word in Arabic is a place of oasis and gardens. This is due to the gathering of flood water causing the area to become a green oasis. A hundred years ago, Riyadh was a small settlement inhabited by a few thousand people, whose main occupations were farming and local trading. Nowadays, Riyadh has become one of the fastest growing cities in the world, progressing and developing in education fields. The population of Riyadh has increased rapidly and is currently more than five million (The Central Department of Statistic and Information, 2010). Riyadh's education system and school buildings are part of this national growth. Riyadh city sees

obvious development in the educational field and today Riyadh city has several governmental and private universities, institutes, and colleges in various specializations as well as a large number of schools.

2.2 Overview of the Education System in Saudi Arabia

Saudi Arabia's education system has gone through an astonishing transformation. Its roots go back to the Prophet Mohamed in Mecca, the holy city in the west of Saudi Arabia. Since then, education has been based in the mosques, then in the Qur'anic Schools or *Kuttab* where students learn to read and write Arabic and to recite the Qur'an (Al-Salloom, 1995). Since the Kingdom of Saudi Arabia was founded in 1932, education has been a priority for the government. The Directorate of Education was established in 1925 as the country's first organised educational system. In addition to overseeing all schools in the kingdom, the Directorate of Education opened education offices and new schools across the country. Since then, primary education has been compulsory and free for males (Al-Salloom, 1995). The first public primary schools in Saudi Arabia opened in 1930, and girls were not formally enrolled (Wiseman, 2010).

In 1953, The Directorate of Education became the Ministry of Education. The Ministry of Education developed five-year plans to advance the Saudi education system and a large campaign was started to create different types of schools and institutes and to improve the existing schools. The General Presidency of Girls' Education was established in 1960. Both girls and boys follow the same curriculum. "Yet in spite of this early differentiation, rapid progress toward gender parity in schooling has occurred" (Wiseman, 2010, p. 16). Wiseman (2010) demonstrated the gender parity in Saudi Arabia from two key areas. Firstly, the evidence occurred related the enrolment equity. Girls' enrolment has increased considerably from only 25% of the total student enrolment in schools in 1970 to almost 50% in 2010. Secondly, the evidence occurred related to achievement equity. For example, in international tests such as TIMSS, girls achieved better than boys in science

and there was no significant difference between girls' and boys' achievement in mathematics.

With the rapid development of its infrastructure in the early 1970s, Saudi Arabia paid greater attention to higher education. The Ministry of Higher Education was established in 1975 with a long term plan to support the Saudi educational system to provide the highly skilled individuals needed to develop the country. At this stage the development in all types of education, from general to higher education, has been horizontal (Al-Salloom, 1995). Today's educational system is designed to ensure that students are prepared to deal positively with global economic changes while maintaining Saudi values and principles.

Saudi Arabia offers free education from kindergarten through university to all citizens. One of the characteristics of Saudi Arabia's system is that the genders are segregated at all levels. Saudi Arabia is the only country in the world with a 100% single-sex schooling system and no coeducational institutions. This is due to the social, cultural, and religious traditions (Wiseman, 2010). The Ministry of Education has become one of the most important ministries in the Kingdom (Alsinbl, Alkhateb, Metwali & Abdalgawad, 1996).

The Saudi government has demonstrated a substantial commitment to the educational sector. According to Table 2.1, the government allocated US$13.14 billion for education and human resources in 2000. Ten years later, the amount allocated for education was nearly 25 per cent of the total Saudi budget, totalling US$ 36.65 billion (Ministry of Finance, 2011).

In all, the government of Saudi Arabia is responsible for providing free public education to all citizens and residents. The government also supplies schools with equipment and textbooks.

Table 2.1

The Saudi annual budget from 2000 to 2010 (in billions of US $)

Years	2000	2002	2004	2006	2008	2010
Total budget	49.3	55.7	61.3	89.3	120	146
Education	13.2	15	17	23.2	28	36.7

2.3 Policy of Education in Saudi Arabia

The educational policy in the Kingdom of Saudi Arabia derives from the religion of Islam. The Ministry of Education has formulated from this policy some general principles. These general principles are:

1. Foster a holistic Islamic concept of the universe, man and life, in which the laws of God enable each creature to fulfil its duty.
2. Emphasize that life on earth is a stage of work and production during which an individual invests his or her capacities, with full faith, in eternal life in the other world. Today is work without judgment and tomorrow is judgment without work
3. Engender faiths in human dignity as decreed in the Quran and cooperation with other nations in order to attain justice, peace and humanitarian progress.
4. Reinforce that it is an Islamic duty for every individual to seek an education and that the state's duty is to provide educational resources.
5. Use an Islamic orientation to judge the theories and applications of science and knowledge in all forms, curricula, writing, and teaching so that this knowledge is in harmony with Islamic thinking.
6. Give students the opportunity to participate in the growth and development of their own communities and therefore profit from their efforts.
7. Make profit from all kinds of useful human knowledge and experiences.
8. Reinforce that females have the right to an education.

9. Show students how to profit from all kinds of knowledge and raise the nation's standard of living.

10. Promote harmonious between religion and science and technology since they are the most important means of cultural, social, economic, and physical development

11. Promote prudent interaction with the developments of other civilizations in science, education, and liberal arts, following the developments in these fields and contributing to them and therefore the progress of society and mankind.

12. Use Arabic as the language of all stages of education except when special circumstances dictate otherwise (Ministry of Education, 1980).

From these previous principles, the Ministry of Education has made general goals and objectives for the education system. These state that the purpose of education is to:

1. Demonstrate the harmony between science and religion in Islamic law.

2. Educate faithful citizens to feel their responsibility to serve and defend their country.

3. Provide students with the skills and knowledge necessary for being an active member of society.

4. Sharpen students' understanding of the cultural, social, and economic problems of society, and prepare them to participate in constructive solutions.

5. Stress the dignity of the individual and offer equal opportunities for education.

6. Teach scientific skills and applied sciences, and provide opportunities for students to participate in craft activities, construction works, farm work, and laboratory research.

7. Encourage the spirit of scientific thinking and research, and strengthen students' observational skills.

8. Develop mathematical thinking and arithmetical skills and train the student on the use of the language of numbers and how to make use of them in scientific and practical fields.

9. Develop good reading skills and habits and strengthen students' organizational and language skills, and their use in speech and writing.

10. Understand the environment and natural resources, and the significance of the kingdom's geographical location, economic position, and political role in safeguarding and promoting Islam.

11. Be responsive to the individual differences between students and cultivate each individual's abilities and inclinations

12. Promote appreciation for Arabic language and expression (Ministry of Education, 1980).

2.4 Education Administration in Saudi Arabia

Education in Saudi Arabia is under the administration of three main authorities: Ministry of Education, Ministry of Higher Education, and Technical and Vocational Training Corporation.

2.4.1 Ministry of Education

The Ministry of Education was established, as mentioned above in 1953 to be responsible for the general education of boys and girls in the country. The Ministry of Education has about 42 educational departments that are distributed on all the regions of Saudi Arabia to perform the supervision of schools and link them with the Ministry of Education.

According to the Ministry of Planning, the enrolment in general education institutions increased sharply from about 536 thousand students in 1970 to 4.99 million in 2009, an average annual growth rate of 5.9%. The number of schools under the Ministry of Education increased from 3,098 in 1970 to 31,782 schools in 2009. In terms of the male and female teachers, the

number has increased due to the rapid expansion of the education system from 22,300 in 1970 to 426,800 in 2009, equally divided between male and female teachers (Ministry of Planning, 2011). The Ministry of Education provides the general education in the Kingdom of Saudi Arabia that includes four stages; pre-primary, primary, intermediate and secondary education as well as being responsible for the private education sector. The next figure shows the stages of the education system in Saudi Arabia.
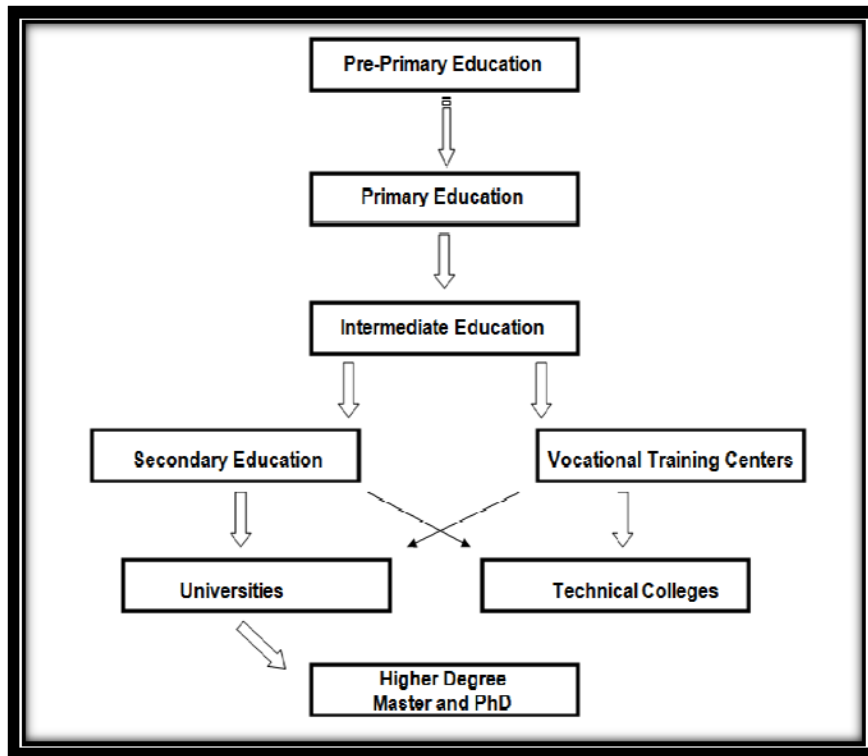
Figure 2.2. The stages of the Education System in Saudi Arabia.

Pre Primary Education (3-5 yrs)

Children age 3 to 5 are enrolled in pre-primary education as an optional choice as attending. Pre-primary is not required in order to enrol in primary school. The main objectives of the education policy at this level are the following:

- nurture the instincts of the children and look after their moral, mental and physical growth in a natural environment similar to that provided by their family;

- familiarize children with the school atmosphere and assist their socialization into school life;
- teach the children fundamental knowledge and skills that are related to their surroundings;
- encourage children's imaginative thinking and guide their development;
- protect children against dangers, treats the early signs of bad conduct and control childhood problems in an adequate manner (cited in Alsalloom,1995).

Pre-primary have their own separated buildings with their special staff and teachers. In pre-primary, boys and girls study together in same classes and are taught by female teachers. According to government data, 103,145 children are in pre-primary education in 2009 and taught by 9,818 teachers (Ministry of Education, 2009).

Primary Education (6-12 years old)

Primary school is the first compulsory stage of education for children who are over the age of six. The main objectives of primary education are to:

- cultivate the correct Islamic creed in the spirit of the children and provide them with comprehensive moral and intellectual education shaped by Islamic values;
- develop children's basic skills, especially language, mathematics and physical education;
- develop children's understanding of the rights and duties of citizenship;
- cultivate a love for learning and the value of work, and train children to make constructive use of their leisure time (cited in Alsalloom,1995).

From this stage through to university schools are segregated by gender. The period of study in primary education is six years where a student is provided with the necessary knowledge and tools to develop their personality,

spirituality, social communication and, physical health. In the last grade (Year 6) students obtain the certificate of completion of the primary stage which qualifies them to enrol in intermediate education.

The school year has two semesters, each with fourteen weeks of classes and a two-week exam period. The primary school program has six daily class periods which are each forty-five minutes long. Students in this stage study subjects including Arabic, art education, religious studies, science and mathematics. They study five lessons of mathematics every week, one lesson every day. According to government data, the number of students in primary education is about 2.47 million in 2009 (Ministry of Education, 2009).

Intermediate Education (13-15 years old)

This stage in Saudi Arabia consists of three grades. The main objectives of the intermediate education are to:

- teach students the skills and knowledge that suit their age of development, enabling them to learn the general principles and fundamental rules of education and sciences;
- stimulate students to seek knowledge through meditation and scientific reasoning;
- develop, orient and refine students' intellectual skills;
- stimulate students to restore the glory of the Islamic nation to which they belong and resume the march on the path of dignity and glory;
- prepare students for the next stage of life (cited in Alsalloom,1995).

Beside the main subjects stated above, students in this stage start studying new subjects such as English and computer science. In terms of mathematics, they take six lessons every week. According to government data, the number of students in Intermediate education is about 1.2 million in 2009 (Ministry of Education, 2009).

Secondary Education (16-18 years old)

This stage lasts three years and this is the final stage of general education in the Saudi educational system. The main objectives of secondary education are to:

- strengthening all aspects of Islamic faith and compliance with Islamic principles in all deeds;
- looking after the students' gifts and various capabilities which unfold at this stage and direct them appropriately, thus achieving the objectives of Islamic education in its general sense;
- developing the students' scientific thinking and the spirit of research, systematic analysis and sound academic methods;
- open opportunities to capable students and enable them to continue their studies in higher institutes and universities of all specialties;
- impart in the students useful reading habits and the desire to broaden their scope of knowledge and to use their leisure time in activities that improve their personality and the conditions of their community (cited in Alsalloom,1995).

After the first year of senior education, (Year 10) students select between a science or arts academic program to study in their two final years. Chemistry, physics, geology and mathematics are studied in the science program; while the arts program focuses on religious studies, literature, and social studies. Table 2.2 shows the number of schools, students, and teachers in all different levels of education under the supervision of the Ministry of Education in 2009.

Table 2.2

The number of schools, students, and teachers

Levels	Gender	Schools	Students	Teachers
Pre-primary	Co-Education	1,521	106,301	10,337
Primary	Males	6,767	1,265,426	110,850
	Females	6,835	1,227,699	112,661
Intermediate	Males	4,130	634,927	58,989
	Females	3,780	553,415	58,381
Secondary	Males	2,469	606,062	47,353
	Females	2440	490,112	52,400
Special education	Males	1,064	17,393	5,383
	Females	487	8,932	2,419
Adult education	Males	768	12,671	0 *
	Females	3,156	70,100	13,319
Total		33,417	4,993,038	472,092

* Taught by secondary school teachers. (Ministry of Education, 2009)

2.4.2 Ministry of Higher Education

The Ministry of Higher Education was established in 1975 to manage the policy of higher education in Kingdom of Saudi Arabia and provide all types of education which follow the secondary stage. The Ministry of Higher Education is responsible for supervision, coordination and observation between programs of higher education and the programs of national development in different fields in order to provide the general and private sectors with the technical and administrative staff. Currently, Saudi Arabia has 24 public universities and 8 private universities.

In addition, the Ministry of Higher Education offers scholarships to many Saudi students who graduate from universities to complete their specialty fields abroad. In 2005, the Ministry of Higher Education established the King Scholarship Program in order to send thousands of students to study in the best universities in various countries around the world each year.

Teacher Education

Teacher education programs were run by both the Ministry of Education and the Ministry of Higher Education until 2007, when a decision was made to join teacher colleges to the various universities resulting in teacher education

becoming the sole responsibility of the Ministry of Higher Education. Students in teacher education programs study for four years, with eight semesters. In Riyadh College, the mathematics education program has two strands, one to prepare students to become teachers in primary schools and the other to become teachers in intermediate and secondary schools. In the first semester of the last year, students from both strands undertake a unit called mathematics-teaching methods in their first semester and field experience practice in their final semester. During their field experience, students are required to teach mathematics for a minimum of eight lessons per week for the whole semester and they are expected to spend the whole school day at the schools and to perform as official teachers.

2.4.3 Technical and Vocational Training Corporation

The Technical and Vocational Training Corporation is responsible for developing technical and vocational programmes in response to national manpower requirements. It has 36 technological colleges for males, 9 technical institutes for females and 98 vocational training centres.

2.5 Overview of Mathematics Education in Saudi Arabia

Mathematics has been part of education in Saudi Arabia since education in the early Qur'anic Schools where students learned to recite the Qur'an and learn some basics arithmetic skills. When the first education system was established in 1952, mathematics was well developed and became a compulsory subject in all stages of general education. Since then, major reforms have been made to mathematics education in Saudi Arabia to improve its teaching and learning. Most of these reforms have focused on the content of mathematics textbooks. In 2001, the Saudi education policymakers formulated several objectives for mathematics education for each stage. The general objectives are the following:

1. To employ mathematical thinking to solving problems.

2. To understand concepts, rules, relationships and patterns of mathematics.
3. To develop the ability to communicate and express mathematics by using the language of mathematics.
4. To develop positive tendencies and attitudes towards mathematics.
5. To appreciate the contributions and developments of mathematicians
6. To use modern technology to develop mathematics applications (Ministry of Education, 2001).

The weekly lesson plan of mathematics for the all grade levels (1-12) is shown in table 2.3. From this table we observe the importance of mathematics in Saudi classroom teaching plans.

Table 2.3

Mathematics weekly plan for the general education

	Grade Levels	Periods per week	
		First semester	Second semester
Primary	1	-	2
	2	4	4
	3	4	4
	4	5	5
	5	5	5
	6	5	5
Intermediate	7	5	5
	8	5	5
	9	5	5
Secondary Science strands	10	6	6
	11	6	6
	12	6	6

Students in each grade study two mathematics textbooks one for the first semester and the other for the second. For the primary stages each book contains 36–50 lessons. These lessons cover different areas of mathematics such as numbers, operations, fractions, geometry and shapes. In the

intermediate and secondary stages each book contains four units. Each unit has several lessons to address different topics of mathematics such as congruence of triangles, polynomial, and differential equations.

In the past decade, there was a national initiative to renew teaching and learning in Saudi Arabian schools. This initiative arose because of the findings of a variety of studies and reports which highlighted the importance of improving the quality of teaching and learning in schools. For example, a team of educators in the Ministry of Education studied reports of the teachers' supervisors from all the departments of education and found that the teaching methods used within the Saudi classrooms often focused on memorization and did not help students to develop clear understandings of the concepts taught (Ministry of Education, 2000). The report therefore recommended greater attention to the quality of teaching. In response to this report, the Ministry of Education funded a project to improve teaching strategies in classrooms. The overall goal of the project was to train teachers on new teaching strategies which include cooperative learning, critical thinking and creative thinking in order to obtain good learning outcomes. However, the comparatively low performance by Saudi students in the international exams such as Trends in International Mathematics and Science Study (TIMSS), led to a rethink about mathematics learning and teaching methods in schools. In TIMSS 2003 and 2007, Saudi students' mathematics achievements were among the lowest of all the participating countries and below the low benchmark (Martin, Mullis, & Chrostowski, 2004; Olson, Martin & Mullis, 2008).

With these major concerns, the Riyadh Teachers' College engaged in the implementation of major reform to improve teaching practices in all its courses. This focus on improving teaching is, arguably, parallel to the international concerns that a mere focus on issues of the learner neglects the crucial role of the teacher in the educational endeavour (Atweh, 2007; Darling-Hammond, 2000). Alghamdi (2002) in his discussion about the future vision of teachers' colleges in Saudi Arabia stressed that colleges should keep up with the global changes towards student-centred approaches. This

challenge was adopted in the reforms at the Riyadh Teachers' College along the lines of pervious mathematics education reforms around the world which advocated a shift from the traditional teacher-centred approach towards more active involvement of the learners (Australian Education Council, 1991; NCTM, 1989).

CHAPTER 3

LITERATURE REVIEW

The previous chapter described the development of the education system in Saudi Arabia and especially its mathematics education. This chapter presents the literature review by addressing six areas. Section 3.1 summarises the relevance of general learning theories and research to the learning and teaching of mathematics. Section 3.2 explores the link between constructivism and mathematics teacher education. Section 3.3 provides the theoretical background of the research study with reference to Authentic Pedagogy. Section 3.4 explains the Productive Pedagogies framework. Section 3.5 discusses the implications of Productive Pedagogies in educational settings. Section 3.6 summarises the chapter.

3.1 Constructivism

The constructivist view of learning has been receiving a great deal of attention (Ariasian & Walsh, 1997), because of its impact on science and mathematics education. Treagust, Duit, and Fraser (1996, p. 3) wrote, "the constructivist view has become a most powerful driving force in science and mathematics education, particularly during the past decade". Herscovics (1996) cited in (Goodell, 2006) stressed that the application of constructivism to mathematics teaching began in the 1980s, and has remained a topic of extensive discussion ever since. According to Kroll (2005), constructivism is a theory about learning and about how people acquire knowledge. Much of the popularity of constructivism in the last 20 or 30 years has come from the dissatisfaction with the results of teachers and the traditional education system, mainly because students are not graduating with satisfactory skills in reading, writing or mathematics (von Glasersfeld, 1995). Constructivist theory seems to be a refreshing way to perceive how people learn and understand (von Glasersfeld, 1995).

Hiebert and Grouws (2007) noted that within mathematics, theories of teaching have been less clearly articulated than theories of learning. "Although theories of learning provide some guidance for research on teaching, they do not translate directly into theories of teaching" (Hiebert & Grouws, 2007, p. 373). Richardson (1997) stressed that there is a difficulty in translating a constructivist theory of learning into the practice of teaching. However, while constructivism is not a theory of teaching, it helps inform teaching and reminds educators that the learner must be at the centre of pedagogies (Kroll, 2005). Constructivism therefore seems to be a powerful alternative to direct instruction (Confrey, 1990). Ariasian and Walsh (1997) identified three reasons for the popularity of constructivism in teaching. First, it enables schools to promote higher-level learning outcomes by encouraging their students to construct their own meanings and interpretations. Second, it assumes that all students can and will learn as they acquire and build their own personal knowledge. Third, it gives teachers more discretion to construct their own meanings and interpretations in order to improve classroom teaching and learning.

Bodner (1986) explained the difference between the traditional view of knowledge and the constructivist model. The traditional view of knowledge is based on the common sense belief in the existence of a real world whether we notice it or not. In addition, the constructivist model assumes that knowledge is constructed in the mind of the learner. This difference in perception towards knowledge led to a change in teaching strategies in classroom. Teachers do not need to feed students information; teachers should encourage students to use their own thought processes to construct knowledge and solve problems. The key to learning, in a constructivist model, is for the learner to find multiple ways to link new knowledge or meaning to previous cognitive experiences. Tobin and Tippins (1993) point out that in shifting the teaching approaches from teacher-centered to be more student-centred the learners construct knowledge depending on their experience. Richardson (2003) listed several differences between the constructivist and transmission models of teaching. The constructivist pedagogy has the following characteristics:

1.   The focus is on the students' background knowledge and on the development of their understandings and beliefs;
2.   The dialogue between teachers and students and among students led to the creation and shared understanding of a topic;
3.   Tasks that require students to challenge, change or add to existing beliefs and understanding;
4.   The construction of an awareness of students' understanding and learning process.

Several studies have focused on constructivist theory-based teaching (Wheatley, 1991; Yager 1991). Many of these studies have shown the effectiveness of constructivist models of teaching to achieve learning. The centre of attention moved from the theory of learning to considering pedagogical practice. It is clear that there is a shift to a focus on how students learn how teachers teach. For most teachers, their knowledge of constructivism is limited to the saying "students construct their own knowledge" (Cobb, 1994, p. 4). However, there is more to constructivism than a simple change of words from learn to construct. The central belief of constructivism is the facilitation of a student-centred classroom with a focus on the prior conceptions and values of the student. Constructivism stresses the contextualised nature of learning and understanding, and advocates that all student answers are somewhat valid (Selley, 2000). The attention should go to the thinking process, not right answers. Airasian and Walsh (1997) pointed out the difference between the theory of constructivism and its practical application. They advise teachers who attempt to implement constructivism in their teaching practices that there is no single instruction of constructivism that can be readily applied in classrooms. Teachers should not fall into the trap of believing that students construct meanings by only constructivist instruction techniques (Airasian & Walsh, 1997). Different learning goals therefore, need different teaching methods (Hiebert & Grouws, 2007).

3.2 Constructivism in Teacher Education

The main role of teacher education programs is to provide learners with different theories and knowledge of teaching so that they can apply this knowledge in the classroom. Darling-Hammond (2010) stressed that over the past two decades many teacher educators have developed successful approaches to preparing and supporting teachers to make a difference. However, helping student teachers to make a link between theory and practice seems to be a major concern for many educators. Korthagen, Loughran and Russell (2006) asserted that teacher education finds itself in a hard position for three reasons. Firstly, criticism from teachers, parents and politicians about the value of teacher preparation programs for the reality of everyday practice in schools. Secondly, several researches have pointed out evidence that teacher education has failed to address these complaints. Third, with new conceptions of learning and teaching development such as constructivist views, teacher education needs more effort to train teachers in this manner.

In the last two decades, teacher education programs have become student-centred. According to Confrey and Kazak (2006), teacher education has been dramatically affected by the theory of constructivism. "Constructivist ideas have spawned hundreds of books and articles and currently influence classroom teaching practices and teacher education techniques (Oxford, 1997, p36). Richardson (1997) pointed out that there are two forms of constructivist teacher education. One form teaches student teachers how to teach in a particular constructivist approach. The other enables student teachers to understand their own learning and its effects on their practices.

Many studies have adopted different constructivist approaches in teacher education programs. Mayer-Smith and Mitchell (1997) examined whether teaching about constructivism using teaching methods informed by constructivism in a general science method course can be used to promote conceptual change in pre-service science teachers' views of teaching and learning. The course is a part of one-year post-graduate secondary teacher

education program at the University of British Columbia. All students who enter this program were science graduate students with no pre-service teacher training. In this program students study general methods and theory courses in the first semester which is followed by a long practicum experience in the second semester. The researchers design and instruct the general science methods courses and collected their data from pre-service teachers during the course and practicum. They found that a conceptual change in pre-service teachers is possible and that some of them acquire a deep understanding of constructivist pedagogy. The importance of constructivism was also highlighted in mathematics courses (Klein, 1999; Ebby, 2000; McDuffie, 2004; Goodell, 2006). Andrew (2007) examined the teaching methods that were used in mathematics courses for pre-service elementary teachers and how these methods are linked with constructivist theory. Four mathematics educators participated in this study; they were observed in the classroom and interviewed. He concluded that all of the participants had used constructivist-based teaching strategies such as cooperative group learning, small group questioning and whole class questioning, and that their students had benefited from them. Students were actively involved and put in charge of their own learning experience. Simon and Schifter (1993) discussed the impact of a teacher education program, which helped teachers to adopt constructivism, on students. The participants of this program were experienced teachers of mathematics (K-12). They were involved in a two-week intensive summer institutes and weekly classroom follow-up during one academic year. They concluded that teachers who had been involved in the program found that their students' beliefs about learning mathematics changed and that their attitudes toward mathematics improved.

While the constructivism seems to direct the view of learning articulated in the educational literature of teacher education (Fox, 2001), many critics argue that constructivism has lost its power as a meaningful concept (Sjoberg, 2008). According to Windschitl (2002) the reason that constructivist teaching is difficult to characterize is that constructivist learning was influenced by different views of theorists. Several varieties of constructivism

such as individual or cognitive constructivism with reference to Jean Piaget, social constructivism with reference to Lev Vygostsky, and radical constructivism with reference to Ernest von Glasersfeld might have misleading implications for teaching in classroom. Depending on which constructivism a teacher prefers, the goals, learning activities, and even the culture of the classroom can differ dramatically (Windschitl, 2002). With cognitive constructivism, there is a focus on personal construction of knowledge while social constructivism emphases the importance of the meaningful activity and social interaction.

Constructivism has been critically reviewed by many educators (O'Loughlin 1992; Phillips, 1995; Fosnot, 1996; Fox, 2001; Hyslop-Margison & Strobel, 2008). For example, Phillips (1995) in his article "The good, the bad, and the ugly: The many faces of constructivism", asserted that "because there are so many versions of constructivism, with important overlaps but also with major differences, it is difficult to see the forest for the trees – it is a matter of pressing concern to find some way of categorizing them so that the overall picture does not get lost (p. 7). Fox (2001) argued that the claims of a variety of constructivist theories provide incomplete views of human learning. He, for example, questioned the claim that knowledge is constructed rather than innate or passively absorbed by saying that "our ability to perceive, to learn, to speak and to reason are all based on the innate capacities of the evolved human nervous system" (p. 26). Again, he warns that even although constructivism is seen as the most favoured view of learning and teaching in the teacher education literature, it needs to be examined and developed.

As stated earlier, constructivism is a theory of learning, and has its limitations in practices. Airasian and Walsh (1997) argued that implementing constructivism in the classroom is more challenging than might be expected from the simple slogans that advocates repeat. Therefore, many teachers in schools are still using the traditional teaching approach. Several studies highlighted that pre-service teachers rely on transmission approaches of teaching. Brown, Cooney and Jones (1990) suggested, "pre-service and beginning teachers' reversion to teaching styles similar to those their own

teachers used is legendary" (p. 649). Andrew (2007) referred this to the lack of teachers' professional development stating that many pre-service teachers are graduated without ever having been in constructivist classrooms during their entire academic life. Andrew (2007) suggested that to bridge this gap, teacher educators need to incorporate more student-centred instructional techniques in their teaching. Goodell (2006) stressed that mathematics teacher educators need to consider the implications of constructivist theory for the teaching of mathematics and incorporate these ideas into methods courses. Klein (1996) embraced constructivist pedagogy with his pre-service teachers in mathematics methods unit. She concluded that while students understand some useful mathematics concepts, they tend to rely on transmission approaches of teaching when they teach their students in schools. Similar results were observed by Foss and Kleinsasser (1996) who analysed pre-service teachers' beliefs and practices about mathematics teaching. They found that although pre-service teachers had been exposed to constructivism during their study, their beliefs and practices about mathematics teaching had not changed. Hyslop-Margison and Strobel (2008) warned that while teacher educators should add constructivism pedagogies to their teaching, they must ensure that pre-service teachers fully understand the epistemological limitations of constructivist theory. They should understand that "the claims that all knowledge is constructed is not very helpful if the assertion limits the application of more traditional teaching approaches, such as lecturing, that are equally effective within certain teaching and learning context" (Hyslop-Margison & Strobel, 2008, p 85). Frid (2000) noted that despite the evidence that pre-service teachers tend to teach mathematics using transmission approaches even when they had been exposed to constructivism in teacher education programs, teacher educators must not abandon constructivism "as a failure, but instead consider if we [i.e. teacher educators] ourselves have in fact succeeded in implementing constructivist pedagogy" (p. 31).

The challenge for mathematics teacher educators is to help pre-service teachers to master and apply what they learn in practice – to help them to find a link between theory and practice. This challenge drives mathematics

teacher educators to research in order to change student teachers' beliefs about learning and teaching mathematics (Ebby, 2000; Stuart & Thurlow, 2000; Grootenboer, 2008; Lavy & Shriki, 2008). Teacher's beliefs play an important role in classroom practices (Kagan, 1992). Oxford (1997) discussed several ways in which teacher education programs can apply elements of constructivism and stressed that teacher education should not just be the presentation of new information to students, but should challenge beliefs and engage the pre-existing ideas. Many studies have shown that a teacher's practice in the classroom is a reflection of his or her beliefs about learning theories and styles. Teachers' views on learning theories are therefore an important influence on classroom practice. If the teachers believe that knowledge can be transmitted, then their class instructions might involve the directed one-way flow of information to students. However, if teachers subscribe to the constructivist view of learning, they will design activities to help students to build knowledge. Applefield, Huber and Moallem (2000) stated, "teachers' personal theories of learning have long been viewed as having considerable influence on virtually all aspects of teachers' decisions about instruction" (p. 1).

The value of a reflective practitioner approach has received significant attention since it was introduced by Schon in the 1980s. Teacher education should help students to reflect on their learning experience as "the reflectiveness seems to be a key terms of how people learn from experience or fail to learn from it" (Oxford, 1997, p. 47). Chapman (2008) reviewed studies from 1998 to 2008 that involve the learning of mathematics teacher educators based on research they conducted on their instructional practices. He summarised three themes that are representative in the finding of the studies. First, all the studies demonstrated that the instructional approaches resulted in changes in pre-service teachers' pedagogical knowledge. Second, the studies supported the importance of reflection in order to improve teaching practices for both educators and pre-service teachers. Finally, some of the studies suggested guidelines for instruction that educators should be aware of when they start developing their courses. Dangel and Guyton (2004) who reviewed the literature of constructivist

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teacher education from 1990 to 2004, stressed that "reflection is evident in a majority of the programmatic efforts and is seen by many constructivist teacher educators as a sort of adhesive that connects and cements the various components or tasks within a teacher education program" (p. 6).

According to Llinares and Krainer, (2006) pre-service teachers will have a better opportunity to integrate theory and practice when they are introduced to reflection on teaching practice. According to many studies, teacher education programmes should help pre-service teachers to reflect on and analyse their own teaching practices in order to improve their skills of teaching (Artzt, 1999; Ebby, 2000; Morris, 2006). Risko, Vukelich and Roskos (2002) critically reviewed 36 empirical studies on pre-service teacher reflection and pointed out that the research highlighted reflection as a cognitive process that can produce reasoned thinking about instructional decisions, but failed to provide guidance for students on how to reflect effectively. Murray, Nuttall and Mitchel (2008) reviewed research which is concerned with initial teacher preparation during the period 1995 to 2004 in Australia, and found that one of the major topic areas of these studies was reflection and reflective practice. Goodell (2006) designed a mathematics education course in teacher education based on the principles of constructivism and reflective thinking. She wants her course to be not only about constructivism as a theory of learning, but also constructivist in nature itself. She concluded that teacher education programs must include opportunities for their pre-service teachers to learn how to reflect critically on their teaching practices. McDuffie (2004) examined the reflective practices of two elementary pre-service teachers during their teaching internship. He concluded that the long-term reflection exhibited by the pre-service teachers was an important part of their reflective practice for future teaching.

Since there is an abundance of articles which stress the importance of reflective thinking in teaching and learning and considering the student-centred learning, this study has employed the Productive Pedagogies framework (Lingard et al., 2001) in mathematics education during the last year of the pre-service teachers' course in Saudi Arabia. This course uses

the Productive Pedagogies framework to help pre-service teachers to reflect on their teaching and learning experience. "Productive Pedagogies is a balanced theoretical framework enabling teachers to reflect critically on their work" (Education Queensland, 2002, p. 2). Hill (2002) asserted that Productive Pedagogies is a useful tool for reflection on teaching practices. In a sense, the Productive Pedagogies framework was an adaptation and extension of Newman and associates' Authentic Pedagogies. The following sections discuss the background and development of both frameworks

3.3 Authentic Pedagogy

The body of teaching literature is one of the strongest threads is the move from teacher-centred to student-centred teaching and learning. One of the main reasons cited for this shift has been an increasing focus on different learning styles and strategies commonly applied by students. The majority of scholars agree that learners add new experiences to their pre-existing ones. More importantly, these prior ideas generate new knowledge for the learner. Newmann, Marks and Gamoran (1996) have fittingly commented that rather than regurgitating knowledge from subject-matter fields, students should construct meaning that is grounded in their own experience. Newmann, Marks and Gamoran (1996) referred to this construction of knowledge from personal experience as active learning. Students need to be engaged in enriching activities beyond simply listening. In active learning, students read, write, discuss, and participate in their own reasoning. Chickering and Gamson (1991) commented that, to be actively involved, higher-order thinking tasks, such as analysis, synthesis, and evaluation, must be part of the students' learning experiences.

However, Newmann, Marks and Gamoran (1996) warned that even highly active students may produce intellectually shallow work. Such work may mean a student has not been able to apply his or her understanding. Further, there may be a difference between what the student understands and what is accepted in the discipline. Therefore, there is a call to focus on the intellectual quality of student reasoning. *Authentic Pedagogy* is the term

coined by Newmann, Marks, and Gamoran (1996) to refer to a framework of teaching which introduces higher standards for intellectual quality. Authentic Pedagogy is based on a tripartite definition, which holds that teaching and learning is only authentic when (1) knowledge is constructed and not transmitted; (2) when the work builds on existing knowledge on the topic and is expressed in socially accepted terms; (3) and when the knowledge has value beyond the school (Newmann, Marks, and Gamoran, 1996). In order to understand how these tenets are applied in practice, there is a need for a more detailed examination of their components.

3.3.1 Tenet I: Knowledge is constructed

Newmann, Marks, and Gamoran (1996) argued that learning is a complex active mental process, one that is not achieved by transmitting information to a student. Nevertheless, students have to make some processes, interpret and negotiate the meaning of the information encountered. A great deal of evidence has indicated that direct instruction may not provide an adequate base for students' development and for their use of higher cognitive skills (Confrey, 1990). Resnick (1989, p. 1) described three interrelated aspects of learning as follows: "First, learning is a process of knowledge *construction*, not of knowledge recording or absorption. Second, learning is *knowledge-dependent*; people use current knowledge to construct new knowledge. Third, learning is highly tuned to the *situation* in which it takes place" (emphasis original). However, learning embraces different point of view, learning as an individual activity and learning as social construction.

Learning as individual activity

Learning must be an individual activity. One of the pillars of Gunstone's paper (1995) is that students' prior knowledge and beliefs are used when the students construct new knowledge. Gunstone wrote, "The nature of an individual's personally constructed meaning is strongly influenced by his or her existing ideas and beliefs" (p. 9). From this point, Gunstone stated that students' constructions are influenced by their own views of the discipline being studied and by the nature of learning and teaching. Piaget spent

almost 60 years developing the basis for this theory, wrote "Intelligence organizes the world by organizing itself" (cited in Driver, Asoko, Leach, Mortimer, & Scott, 1994). Jean Piaget identified four stages of cognitive development:

- Sensor motor stage (birth – 2 years). In this period, the mental structures are mainly concerned with the mastery of concrete objects. In other words, babies organise their physical action scheme, such as sucking, grasping, and hitting, for dealing with the immediate world.
- Pre-operational stage (2 – 7 years). In this period, children learn to think and to use symbols and internal images but their thinking is unsystematic and illogical.
- Concrete operations stage (7 – 11 years). In this period, children develop the capacity to think systematically, but only when they can refer to concrete objects and activities.
- Formal operational stage (11 years and older). In this period, young people develop the capacity to think systematically on a purely abstract and hypothetical plane.

According to Piaget, the intelligent organise their own worlds. Learning, understanding, and knowledge are personal and internal. Piaget claimed that personal schemes develop as people experience more complicated events. Oxford (1997, p. 39) explains "Piaget's concern was for the individual child, not the child in social context. He portrayed the child as a lone scientist, creating his or her own sense of the world". Piaget sees the meaning making possess as individualistic and students must be actively engaged in reconstructing their existing understandings by restructuring their cognitive maps (Richardson, 1997). Therefore, the role of teachers is facilitating an environment where students challenge their concepts and thinking process (Richardson, 1997). This view is also found in Dewey's work. Prawat (2000) summarised Dewey's theory of education by saying that children bring certain interests and needs to the learning situation, and an established set

of habits and routines for dealing with those interests and needs. Therefore, the teacher's role, as a facilitator and provider of assistance, is to create a problematic situation that challenges habits and appeals to the child's interests (Prawat, 2000). A part of the learning as an individual activity is that one's schemata, or prior knowledge, only changes when experiences create disequilibrium. In other words, people change their ideas, or reorganise their knowledge internally (Driver, Asoko, Leach, Mortimer, & Scott, 1994).

Learning as social construction

With learning as an individual activity, there is a focus on personal construction and meaning making; however, learning as social construction places a greater emphasis on a dialogic process involving person-in-conversation (Driver, Asoko, Leach, Mortimer, & Scott, 1994). Lev Vygotsky's social development theory says that cognitive development is directly related to social development. Our culture influences our social and cognitive development. Vygotsky claimed that an individual's cognitive system is a result of social interaction and cannot be separated from social life (Vygotsky, 1978). Richardson (1997) asserted that the direction of cognitive development in Piaget's work moves from the individual to the social; Vygotsky's work is moves from the social to the individual. For Vygotsky, the teacher becomes a facilitator or guide and provides learners with scaffolding to ensure that the learners' constructs will grow stronger and more complex (Oxford, 1997). This view sees students as trainees who are eager to learn the societal knowledge of their teachers, tutors, and mentors. Learning as social construction signifies that students need to understand by knowing what society believes.

However, these two views of learning depend on each other. Students need to internalise the knowledge for it to have meaning for them, but they also need to be engaged in a social conversation to aid the way they form schemes (Driver, Asoko, Leach, Mortimer, & Scott, 1994). Learning as an individual activity stresses the importance of physical experiences; however, the students also need the concepts and models of modern language, mathematics, and science for their experiences to be transferable and

indeed useful for life. It has long been thought that practical activities supported by group discussions are good methodologies for promoting learning as social construction (Driver, Asoko, Leach, Mortimer, & Scott, 1994). However, others such as Rogoff (1990, cited in Cobb, 1994) argue that learning as an individual activity is an oversimplification because learners must know social rules if they are to participate in the classroom in the first place.

Thus, Newmann and his colleagues insist that teaching and learning are only authentic when knowledge is constructed as individuals and as social construction and not transmitted. Newmann, Marks, and Gamoran (1996) connected their first criterion of authentic pedagogy to constructivism by saying that "construction of knowledge is consistent with the constructivist perspective of the student as a meaning-making person continuously integrating prior experience with new information" (p. 286). Nevertheless, their vision stresses that authentic performance occurs when learners analyse or interpret information to solve complex problems.

3.3.2 Tenet II: Builds on existing knowledge

The second consideration of authentic pedagogy emphasises that knowledge must be linked with the previous knowledge gathered in the same field. By considering the learner's prior knowledge, the construction of knowledge related to teaching provide teacher with opportunity to help students to build upon their existing understanding. Prior knowledge is defined by Jonassen and Gabrowski (1993) as "the knowledge, skills, or ability that students bring to the learning process" (p. 417). According to Ausubel (1968, cited in Bauersfeld, 1995, p. 139), "if I had to reduce all educational psychology to just one principle, I would say this: The most important single factor influencing learning is what the learner already knows". A large body of research on student learning in science and mathematics focuses on the ideas that students bring to the classroom, and how these prior ideas affect how and what the students learn.

In the Victorian Science in Schools Research Project cited in Tytler (2002), the main tenets of this research can be distilled into four key points: 1) prior ideas and conceptions of the world are brought into the science class by students; 2) these ideas and conceptions often differ greatly from the "accepted scientific" corpus of knowledge; 3) similar prior ideas and conceptions are held by students with similar backgrounds, thus, leading to a common set of alternative ideas and conceptions about the world; and 4) the teacher can use these ideas and conceptions as stepping stones to future ideas and conceptions. Using classroom instructions that considered student's prior ideas can play a major role to enhance students' mathematical understanding. Clements and Battista (1990) wrote about students' prior knowledge by listing the tenets of constructivism. Clements and Battista argue that constructivism makes students more active in the class. The first tenet is that children create their own knowing. The second is that this new mathematical knowledge is created by children by their reflections on their physical and mental actions. The third belief is that only internal interpretations of the world exist, not external references of knowledge of the world. Fourthly and fifthly, learning is social, and that in terms of mathematics, students need to be able to make sense of the activity with less interference from the teacher.

The implication of this on teachers is that effective teachers focus on pedagogies that consider students' prior knowledge and experiences. Many studies have highlighted the importance of teachers' recognition and value for student's previous knowledge (O'Tool, 2006; Davies & Walker, 2007). Therefore, prior ideas and conceptions play a large role in determining the new ideas and conceptions that students take away from the mathematic classroom. It is clear that the construction of knowledge and learners' prior ideas have a strong effect on the Authentic Pedagogy model in particular and on the teaching literature in general. This suggests the need to acknowledge the influence of students' prior ideas and conceptions on learning, and to recognise that students construct their own meanings and understanding.

3.3.3 Tenet III: Value beyond school

The third consideration of authentic pedagogy is that products or performance have tangible value beyond the school. Providing students with work that is of high intellectual quality and that is linked with students' prior knowledge cannot alone improve students' learning outcomes. Students must be able to connect the new information with their experience in a way which has value in their lives (Newmann, Marks, & Gamoran, 1996). In most schools, achievement is designed simply to record the students' answers, not their application. Communication, productivity, and flexibility are the skills that students will need in their adult lives (Newmann & Associates, 1996). Hayes et al. (2006) commented that when teachers make the subject matter relevant, they connect classroom learning with the real world processes, and thus make learning more enjoyable.

The importance of linking what students learn in school and their life out of school has been a topic of educational research for nearly a century. Newmann, Marks, and Gamoran (1996) referred to historical education philosophy, when Dewey strongly articulated the case for aiming education toward achievement that has value beyond school. The details and implications of this link will be discussed later in this chapter.

The three criteria, the construction of knowledge using prior knowledge base, creating deeper understanding, and the production of achievement that has value beyond school are the mainstays of authentic academic achievement. Newmann and his colleagues found that these three criteria, translated as standards to guide classroom practice greatly improved student achievement. Table 3.1 shows the standards for Authentic Pedagogy and student academic performance.

While there is no clear agreement about how to define and measure quality pedagogy because of the difficulty of separating the effects of a specific teaching technique, Authentic Pedagogy criteria and standards can be used to judge the quality of assessment tasks, classroom lessons, and student

performance (Newmann, Marks, & Gamoran, 1996). Newmann et al. (1996) offered evidence, based on their study of 24 restructured schools, that Authentic Pedagogy pays off in improved student performance, and can improve student performance regardless of gender, race, ethnicity or socioeconomic status.

The study built on the large studies conducted by the Centre on Organization and Restructuring of Schools (CORS) from 1991 to 1995. Newmann and his colleagues reported their research in 24 restructuring elementary, middle, and high school in 16 states and 22 districts in the US. Mathematics and social studies classes were observed four times during one year and students were given important assessment tasks. Each class in this study received a score based on Authentic Pedagogy standards for instruction and assessments. In examining the levels of authentic pedagogy, and its connection to student performance in restructured schools, they posed three questions:

1. Quality and variability: How much authentic pedagogy is taking place in these schools? How much variation in the delivery of authentic pedagogy is there among teachers, schools, grade levels and subjects?
2. Link to student achievement: To what extent does authentic pedagogy contribute to authentic student performance?
3. Equity: To what extent are students from certain social and academic backgrounds more likely to receive authentic pedagogy?

The research team found that when schools and teachers provide authentic instruction, the students' academic achievement improved remarkably.

Authentic pedagogy appears to improve student performance in all three levels and in both mathematics and social studies. In this study, Newmann and his colleagues developed a set of teaching standards that measure the extent to which students are challenged to think, to develop in-depth understanding, and to apply academic learning to important real-world

problems. These standards are called "Authentic Pedagogy." Their research showed that students who receive more authentic pedagogy learn more than students who do not. Newmann explains how educators can benefit from the result of authentic pedagogies studies by saying that

> *We think our guide to authentic instruction and assessment can be used to build professional community aimed at high standards. Educators can use our findings to redirect attention from the managerial/logistical issues raised by new practices, new procedures, and new structures. Our research can help them focus instead on what's really important: defining standards for high-quality student learning, and building a professional community that supports intellectual quality (Brandt, 1995, p. 73).*

Table 3.1

Standards for Authentic Pedagogy and student academic performance (Newmann, Marks, & Gamoran, 1996)

Authentic Pedagogy

A. Assessment Tasks

Standard 1: Organization of Information: The task asks students to organize, synthesize, interpret, explain, or evaluate complex information in addressing a concept, problem, or issue.

Standard 2: Consideration of Alternatives: The task asks students to consider alternative solutions, strategies, perspectives, or points of view as they address a concept, problem, or issue.

Standard 3: Disciplinary Content: The task asks students to show understanding and/or use of ideas, theories, or perspectives considered central to an academic or professional discipline.

Standard 4: Disciplinary Process: The task asks students to use methods of inquiry, research, or communication characteristic of an academic or professional discipline.

Standard 5: Elaborated Written Communication: The task asks students to elaborate their understanding, explanations, or conclusions through extended writing.

Standard 6: Problem Connected to the World: The task asks students to address a concept, problem, or issue that is similar to one that they have encountered, or are likely to encounter, in life beyond the classroom.

Standard 7: Audience Beyond the School: The task asks students to communicate their knowledge, present a product or performance, or take some action for an audience beyond

the teacher, classroom, and school building.

B. Classroom Instruction

Standard 1: Higher Order Thinking: Instruction involves students in manipulating information and ideas by synthesizing, generalizing, explaining, hypothesizing, or arriving at conclusions that produce new meanings and understandings for them.

Standard 2: Substantive Conversation: Students engage in extended conversational exchanges with the teacher and/or with their peers about subject matter in a way that builds an improved and shared understanding of ideas or topics.

Standard 3: Deep Knowledge: Instruction addresses central ideas of a topic or discipline with enough thoroughness to explore connections and relationships and to produce relatively complex understandings.

Standard 4: Connections to the World Beyond the Classroom: Students make connections between substantive knowledge and either public problems or personal experiences.

Authentic Academic Performance

Standard 1. Analysis

Mathematical Analysis: Student performance demonstrates and explains their thinking with mathematical content by organizing, synthesizing, interpreting, hypothesizing, describing patterns, making models or simulations, constructing mathematical arguments, or inventing procedures.

Social Studies Analysis: Student performance demonstrates higher order thinking with social studies content by organizing, synthesizing, interpreting, evaluating, and hypothesizing to produce comparisons/contrasts, arguments, application of information to new contexts, and consideration of different ideas or points of view.

Standard 2. Disciplinary Concepts

Mathematics: Student performance demonstrates an understanding of important mathematical ideas that goes beyond application of algorithms by elaborating definitions, making connections to other mathematical concepts, or making connections to other disciplines.

Social Studies: Student performance demonstrates an understanding of ideas, concepts, theories, and principles from the social disciplines and civic life by using them to interpret and explain specific, concrete information or events.

Standard 3. Elaborated Written Communication

Mathematics: Student performance demonstrates a concise, logical, and well-articulated explanation or argument that justifies mathematical work.

Social Studies: Student performance demonstrates an elaborated account that is clear, coherent, and provides richness in details, qualifications and argument.

Since this study in 1996, numerous studies have built on the vision of authentic pedagogy. Newmann, Lopez and Bryk (1998) examined the intellectual quality work of students in 12 schools for the Chicago Annenberg Research Project. The study asked teachers to provide students with two typical and challenging assignment samples at different times of the semester. After receiving 349 assignments from 74 teachers with total of 3,300 pieces of student work, the research team coded and analysed the data into higher-order thinking, deep knowledge, deep understanding and substantive communication. They found that when teachers assign tasks that demand high intellectually quality, students perform well on them. They also concluded that in classrooms where teachers give more challenging assignments that are based on authentic pedagogy, student performance improved considerably. Bryk, Nagaoka and Newmann (2000) also examined the authentic intellectual work of students' assignments collected in 1996-1997 in the Chicago schools, and the final samples of assignments of students' work in 2000-2001. They found a clear relationship between the intellectual quality work and students' achievement in addition to an improvement in the quality of classroom assignments in the Chicago schools.

Newmann, Bryk and Nagaoka (2001) examined the connection between the quality of teachers' task and student achievement. The team found that authentic intellectual work improved the students' skills and their performance in reading and mathematics on the Iowa Test of Basic Skills. They concluded that in some very disadvantaged Chicago classrooms, high quality assignments were found and that all students in these classes benefited from such instruction. Smith, Lee and Newmann (2001) examined how different forms of instruction and learning in Chicago elementary schools affected students' learning. They found clear and consistent evidence that teachers' pedagogies influence how much students learn in reading and mathematics.

Due to the fact that the Authentic Pedagogy standards have had a great and lasting impact on students' achievement in the US, school reformers around the world began to study these standards. Roelofs and Terwel (1999)

examined how Dutch teachers use teaching strategies that aligned with Authentic Pedagogy standards. They present three questions:

1. According to teachers' and students' perceptions, to what extent were the characteristics of authentic pedagogy found in the first grades of Dutch secondary education one year and three years after the implementation of the national curriculum?
2. To what extent did textbook use reflect authentic pedagogy?
3. To what extent were conditions for authentic pedagogy met?

After multiple case studies of the implementation of authentic pedagogies in three large Dutch secondary schools between 1993 and 1996, they concluded that "in the context of the national curriculum for the first stage of Dutch secondary education, the characteristics of authentic pedagogy were not found to any real extent" (p. 218). However, a comparison of the years 1994 and 1996 shows teachers' increased use of authentic pedagogy practices.

In Queensland, Australia, a large commissioned research project was undertaken by Education Queensland from 1998 to 2001 to improve students' learning outcome, called The New Basics. The New basic is an integrated framework for curriculum, pedagogy, and assessment. The New Basics has designed a curriculum framework around four new curriculum organisers: life pathways and social futures; multiliteracies and communications media; active citizenship; and environment and technology. These four clusters of practices were seen as "essential for survival in the worlds that students have to deal with" (Education Queensland, 2001, p3). With this new curriculum, a significant form of assessment called Rich Tasks was developed. Rich Tasks was designed to help students to engage with the new basics curriculum framework.

Regarding the pedagogy, the Productive Pedagogies developed as pedagogical professional development materials in 2001 and was an adoption and extension of the authentic pedagogy. Further details about this adoption will be discussed below. As a model, Authentic Pedagogy has had mixed acceptance and was a highly theoretical model aimed at high-

achieving student populations. Ladwig (1998) highlighted that Authentic Pedagogy was difficult to use as a teaching framework and did not comprehensively articulate effective teaching. Consequently, it required modification. The classroom practice subsequently became a focus of the Queensland School Reform Longitudinal Study (QSRLS) research team (Ladwig 2004). While they agreed with the tenets of Authentic Pedagogy, the team believed that it needed to be "unpacked" for school teachers (Lingard, Hayes, & Miles, 2003). Later, Gore, Griffiths, and Ladwig (2001) wrote that Authentic Pedagogy did not easily translate into practical modes of pedagogy.

3.4 Productive Pedagogies Literature

Based on the QSRLS, (Education Queensland, 2001), a comprehensive framework known as Productive Pedagogies was developed to describe the essential features of effective teaching. The new approach was "a balanced theoretical framework enabling teachers to reflect critically on their work". Productive Pedagogies was intended for teachers to use to improve academic and social outcomes (Lingard, Hayes, & Miles, 2003). The QSRLS reported by Lingard et al, (2001) investigates 24 classroom practices in years 6,8,11 in four subject areas (English, mathematics, science and social sciences) to examine the link between classroom practices and improved learning. Observations in the classroom were conducted and each class was observed twice. After three years of data collection, 974 observations had been conducted. The Productive Pedagogies model was formulated based on the result of the first year data, and on a classroom observation coding manual. Observation data from the three years was tested to see if it fit the theoretical model's underlying dimensions of classroom practices. At the end of multi-data analysis, the research team found that the emphasis on the intellectual quality outcomes in the Newmann study was thus expanded to incorporate the emphasis on social outcomes of schooling in Australia. The research team redeveloped Newmann's categories into a broader grid that encompassed factors which the Australian and other educational research and curriculum development suggest make a difference in student

achievement. The supporters of Productive Pedagogies postulate that there are four dimensions – Intellectual Quality, Connectedness, Supportive Classroom Environment, and the Recognition of Difference (See Table 3.4, QSRLS, 2001). In this literature, the researcher will explain how these four dimensions are important in classroom practice.

Table 3.2

Productive Pedagogies dimensions and research questions

Dimension	Items	Research question
Intellectual quality	Higher order thinking	To what extent do students use higher order operations?
	Deep knowledge	To what extent is deep knowledge presented?
	Deep understanding	To what extent is deep understanding evident?
	Substantive Conversation	To what extent is classroom discourse devoted to creating or negotiating understandings of subject matter?
	Knowledge as Problematic	To what degree is knowledge presented as constructed?
	Meta-language	To what extent does the teacher (or the students) talk or discuss explicitly how language works, aspects and characteristics of languages, texts and discourses?
Connectedness	Background Knowledge	To what degree are links with students' background knowledge made explicit?
	Connectedness to the world	To what extent is the lesson, activity, or task connected to competencies or concerns beyond the classroom?
	Problem-based Curriculum	To what extent is the lesson based on the solution of a specific problem(s)?
	Knowledge Integration	To what degree is school knowledge integrated across subject boundaries?
Supportive classroom Environment	Student direction	To what degree do students determine the classroom activities?
	Explicit criteria	To what degree are criteria for what counts as high quality student performance made explicit?
	Social support	To what extent is the classroom characterised by an atmosphere of mutual respect and support among teacher and students?
	Academic Engagement	To what extent are students engaged in the lesson?
	Student self regulation	To what degree is classroom behaviour guided by implicit (self) control?
Recognition of difference	Cultural knowledge	To what degree is non-dominant cultural knowledge valued?
	Group identities	To what degree is the class a supportive environment for the production and positive recognition of difference and group identities?
	Representation	To what degree are non-dominant groups represented in classroom activities?
	Narrative	To what extent is narrative used for teaching and learning purposes in the lesson?
	Active citizenship	To what degree is the practice of active citizenship evident?

3.4.1 Intellectual quality

The focus on intellectual quality comes from the fact that intellectual quality has a determining impact on students' achievement. A number of studies have shown that students do not achieve high academic performance because schools do not always require students to complete work of a high intellectual quality (Hayes, Mills, Christie & Lingard, 2006). Intellectual quality requires students to complete intellectual tasks and engage in higher order thinking activities in classroom. Several studies observed a significant trend in students' achievements when they perform intellectually demanding tasks (Newmann, Lopez and Bryk, 1998; Anthony, Bryk, Jenny and Newmann, 2000; Newmann, Bryk and Nagaoka, 2001). Koh and Luke (2009) examined the quality of teacher assignments and student work in Singapore schools. They collected samples of teacher assigned work in English, social studies, mathematics and science from a random 30 elementary schools and 29 high schools. They found a strong correlation between the quality of teachers' assignment tasks and student work. Where teachers provide students with more intellectually demanding tasks, students were more likely to produce high quality work.

Students' think about, develop, use and make sense of mathematics influenced by teachers' assignment tasks and their associated activities (Anthony &, Walshaw, 2008). Students give longer responses and demonstrate higher levels of performance on mathematical assessments when they have been required to engage with higher order tasks (Hiebert & Wearne, 1993). Zevenbergen and Niesche (2008) stressed the importance of intellectual quality in mathematics tasks and that tasks should enable and foster deep mathematical learning. That can occur when the task is built for connections among mathematical ideas, collaborate and share knowledge, test findings, and challenge mathematical ideas (Zevenbergen & Niesche, 2008). In short, these are the key selections of tasks that help students to work mathematically (Burton, 2004). However, engaging in higher order thinking tasks requires more effort and work from students than routine

activities. Henningsen and Stein (1997) suggested that supportive actions by teachers, such as scaffolding and consistently pressing students to give meaningful explanations is important as well as allocating adequate time for the students to engage at a high order thinking. According to Grootenboer (2009, p697) "Extended engagement not only allows for richer mathematical outcomes for the students, but it also promotes the development of personal qualities such resilience and perseverance".

Although performing intellectual tasks is important in schooling, teachers' instructions, which enable students to engage in higher order thinking activities and substantive conversation in classrooms, also play a major role in students' achievements (Smith, Lee and Newmann, 2001; Avery, 1999). Hayes, Mills, Christie and Lingard (2006) confirmed that the QSRL study found that "all students benefit from being provided with activities that require them to be actively engaged in construction of knowledge" (p. 46). This means students should be engaged in higher-order thinking activities to demonstrate a deep understanding of the concept being taught and to discuss that understanding with their teachers and peers (Hayes, Mills, Christie & Lingard, 2006). Rule (2006) reviewed 45 journal articles addressing authentic learning in different contexts in order to identify the main ideas concerning what exemplified authentic learning in the context of discipline. He pointed out that one of the themes supporting authentic learning is to ensure that students must exercise higher levels of thinking as they learn. He asserts, "Authentic mathematics tasks provide realistic and complex mathematical data, address a wide range of background knowledge and skills, and often require solvers to use different representations in their solutions (p. 4).

Teacher instructions that support intellectual quality should involve higher order thinking activities such as asking high order knowledge based questions, which require high levels of mathematical thinking and reasoning. Way (2008) highlighted the importance of teachers' questions to guide children through investigations and to stimulate their mathematical thinking. She acknowledged that all children benefit from developing higher order

thinking skills and she posed a list of questions that can be used to guide students through a mathematical investigation, and at the same time prompt higher levels of thinking. Sullivan and Liburn cited in Zevenbergen, Dole & Wright (2004, p. 92) defined good questions as having three aspects:

1. They require more than remembering a fact or reproducing a skill;
2. Pupils can learn by answering the question, and the teacher learns about each pupil from the attempts; [and]
3. There may be several acceptable answers.

Intellectual quality is also related to the use of instructional activities that engage students in substantive conversation in order to develop their mathematics thinking and understanding. In classes with substantive conversation, there is an extensive student-student and teacher-student interaction about the ideas of a substantive topic in order to share better understanding (Education Queensland, 2001). Encouraging teachers to use small and large group settings in their mathematics instruction to help students to discuss and share their mathematics thinking was raised as a concern in many curriculum documents around the world (e.g. Australian Educational Council, 1991; NCTM, 1989). Many researchers have shown that student participation in peer and small or large groups can help to develop mathematical thinking and solve problems as well as provide the context for social and cognitive engagement (Anthony & Walshaw, 2008; Horne, 2004; Goos, 2004). "Numerous scholars have identified and illustrated ways that students' learning is enhanced by participation in classroom discourse that focuses on investigating and sharing mathematical ideas" (Lloyd, 2008, p. 166). Effective group work allows students to discuss and develop deep understanding through substantive conversations (Grootenboer, 2009). Hershkowitz, Hadas, Dreyfus, and Schwarz (2007) set up the learning environment where a small group of individual students construct shared mathematics knowledge and consolidate it. The research focused on the constructing process of these small groups of three students each. They found that all students have benefited from the interactions and shared knowledge. A study undertaken by Lloyd (2008) described a high

school mathematics teacher's decisions about classroom organisation and interactions using a new curriculum intended to support teachers to develop student-centred approaches. In this study, the teacher interacted with students in small groups and whole class discussion. Both instructions contribute in positive ways to students' understanding of mathematics content.

3.4.2 Connectedness

In spite of decades of attempted reform in both curriculum and pedagogy in mathematics education, the subject remains a mystery or an ordeal for many students. One of the main reasons for this is the lack of ability of students, and often of the teachers, to see a direct connection between the mathematics studied in school and their concerns outside the classroom. Research shows that students are more likely to continue to study mathematics and put in greater effort to succeed in it based on their perceived value of mathematics and its relevance to their life aspirations as much as on their ability in and enjoyment of it (Luttrell, Callen, Allen, Wood, Deeds & Richard, 2010). As the authors argue, educational reform is not likely to have long term impact if students do not value mathematics. According to previous studies, "the perceived value was more important than expectations for success in keeping students cognitively engaged" (p. 144).

When teachers argue for the value of mathematics with their students, they tend to insist that their students will need mathematics for jobs or for their future studies. Very rarely do mathematics classroom activities touch on the current concerns and experiences of the students. Hence, mathematics is presented in what students view as a decontextualised, abstract and meaningless way. Similarly, mathematics is often presented in isolation from capacities and knowledge developed in other subject areas. Christie (2005) argued that "current times require the consideration of both universalistic, abstract knowledge and particularistic, contextualised knowledge" (p. 244).

The notion of connectedness in terms of the Productive Pedagogies framework concerns the link between classroom information and the rest of the world. It is important connectedness occurs without the limits of the subject. The concept of connectedness links new knowledge with students' background knowledge and with the world outside the classroom by identifying and solving intellectual and/or real world problems (Education Queensland, 2002), thus allowing learning to occur more easily and meaningfully (Moulds, 1998). Many researchers believe that classroom content can have value beyond the school and students achievements. Newmann and Wehlage (1993) demonstrated that pedagogy can reveal some degree of connectedness when students deal with real world public problems or use personal experience for the application of their knowledge. In this situation, Darling-Hammond (1998) added that teachers need to see how ideas and knowledge connect across fields and to everyday life.

The focus on connectedness in Productive Pedagogies stemmed from concerns about trying to explain how and why students from disadvantaged backgrounds do not perform well in school when compared with their more socially advantaged counterparts. Pedagogies that connect classroom learning with the real world might motivate all students to engage with the learning process - a link which is often absent when the curriculum is divorced from the lives of students (Hayes, Mills, Christie & Lingard, 2006). A positive impact on students' achievement was found when the classroom instruction focused on both intellectual quality and connectedness to the world beyond the school (Newmann & Associates, 1996). Zyngier (2003, p. 3) stressed that "As a focus of curriculum development, connectedness is not new and has been defended as a valuable pedagogic strategy at least since the early twentieth century by progressive educators".

Reviews of studies of the effective of connectedness pedagogies in mathematics classrooms have generally yielded positive findings. Sawyer (2008) contended that research has shown that helping students learn to make connections between various forms of mathematics knowledge as well as between mathematics and real life experience enhance mathematics

learning and teaching. Zevenbergen, Dole and Wright (2004, p. 116) stressed that for students to see why they need to study mathematics and that mathematics is not an irrelevant area of study, teachers should make the connection on three levels:

- Within mathematics, where links are made between the various strands of the curriculum.
- With other discipline areas, where connections are made with other curriculum such as science health and physical education
- In worlds beyond schools, where mathematics is placed in realistic contexts.

De Lange (1996) stressed that linking mathematics to real world situations helps enhance students' understanding of mathematics concepts and strengthens their understanding. Gainsburg (2008) looked at why teachers connect mathematics to the real world in their classroom practices. Sixty-two mathematics teachers participated in this study and took a written survey. Five of them were selected for classroom observations. The observations were to record any connections being made by the teachers. The research indicated that motivating students and helping them understand mathematical concepts were more often cited as reasons for making connections in mathematics classrooms. In a study undertaken by Lovejoy (2008) to investigate mathematics teachers' views about the use of real world connections in the algebra classrooms, the results indicated that all teachers believe in the benefit of real life applications for their students and confirm that they incorporate real life connections into their classrooms.

3.4.3 Supportive classroom environment

Educators around the world have focused on the quality learning environment. Fraser (2001) asserted that for many educational researchers, student academic outcomes have been strongly influenced by the quality of learning environments. Webster and Fisher (2003) stressed that for many

years, the education literature has linked student achievement with a good school environment. Fraser (2001) highlighted "The research shows that attention to the classroom environment is likely to pay off in terms of improving student achievement" (p. 4). Hayes, Mills, Christie and Lingard (2006) stressed that teachers and students most often identify the supportive classroom environment as an important aspect of a good classroom. Marks, Doane and Secada (1996) found a positive impact on students' achievement when school and teachers offer a supportive learning environment.

Classroom environment considers social support as a quality of classroom practices. Social support is present in class when teachers build a good relationship with students by conveying high expectations for all students and that all members of the class can learn important skills and knowledge in an atmosphere of mutual respect (Education Queensland, 2001). Many researchers have highlighted the importance of a supportive classroom build on teacher-student relationships (Wubbels, 1993; Rawnsley, 1997; Roeser et al, 1996; Wentzel, 1997). Wubbels and Brekelmans (2005) reviewed different studies investigating teacher-student relationship and affective outcomes. They noted that, "from the studies reviewed with respect to student outcomes, appropriate teacher-student relationships are characterized by a rather high degree of teacher influence and proximity towards students" (p. 15).

Like social support, educators would universally consider academic engagement as a part of the quality of classroom practice (QRLS, 2001). The link between supportive classroom and students' engagement has been recognised in a wide variety of studies (NSW, 2003). Anthony and Walshaw, (2008) stressed that mathematics teachers who produce effective classroom environments care about student engagement. Wentzel (1997) explored the effects of teacher care toward students' academic effort. He concluded that perceived caring from teachers was significantly and positively related to students' academic effort.

3.4.4 Recognition of Difference

The recognition of difference is an important aspect of productive pedagogies as it deals with the substantial difference in the learning outcomes of students from different backgrounds (Hayes, Mills, Christie & Lingard, 2006). According to Cary, Fennema, Carpenter and Franke (1995) many studies during the last two decades have noted a clear difference in mathematics achievements among different groups of students. Students such as females, members of ethnic minorities and those from lower socioeconomic groups tend not to participate effectively in mathematics classroom activities (Cary, Fennema, Carpenter and Franke, 1995). Therefore, there is a need for a new pedagogical framework to help all students to learn and achieve equity. In the original standards document by the National Council of Teachers of Mathematics (NCTM) in 1989, there are clear principles to help all students to achieve in mathematics (NCTM, 1989). Later in 2000 the new standards stress that

> *Teachers need help to understand the strengths and needs of students who come from diverse linguistic and cultural backgrounds, who have specific disabilities, or who possess a special talent and interest in mathematics. To accommodate differences among students effectively and sensitively, teachers also need to understand and confront their own beliefs and biases.* (NCTM, 2000, p. 14)

Since then, several studies support pedagogies that value diversity in the classrooms. Lingard and Mills (2007) referred this to as issues of social justice and inclusion. They argue that pedagogies can make some difference; however research-based models of pedagogy should only provide a framework, not an order or instruction. In the Productive Pedagogies framework, Recognition of Difference elements are *cultural knowledge*, *inclusivity*, *narrative*, *group identity* and *active citizenship* (Education Queensland, 2001). Moreover, Productive Pedagogies made a more obvious attempt to link teaching and learning with the diverse range of cultures in the

Australian classroom and to incorporate citizenship into mainstream teaching (Lingard, Hayes, & Mills, 2003). The research team believes that Productive Pedagogies should contain explicit pedagogy, recognising non-dominant cultural knowledge and the use of narrative that affect student achievement. Focusing on the recognition of difference in Productive Pedagogies comes from the great amount of thought that has gone into trying to explain how and why students from disadvantaged backgrounds do not do as well in school as their more socially advantaged counterparts (Education Queensland, 2002).

Several scholars have contended that knowledge represents the culture of the dominant society (Lee, 2003). Lee suggested that teachers need to provide explicit instruction about the dominant culture's rules and norms for students who are not from the culture of power. However, Hayes, Mills, Christie and Lingard (2006) argued that knowledge should be presented in the classroom from different cultures' beliefs, languages, practices and ways of knowing. According to Cary, Fennema, Carpenter and Franke (1995) diverse cultures should be represented in all curricula in order to achieve multicultural education. They suggest that instructional activities should be centred on multicultural contexts so each student can relate his or her personal background to what is to be learned. While there are some concerns as to whose diversities are and are not worthy of support (Mills & Goos, 2007), the literature supports the views that differences should be positively and included in the classroom culture (QSRLS, 2001).

Students come to school with a range of cultural backgrounds, experiences and dispositions. These differences create different learning experiences (Zevenbergen, Dole & Wright, 2004). Students need a setting in which they feel comfortable sharing and discussing their attitudes and beliefs. The cultural worldview of the student has a great influence on classroom teaching and learning (Fisher, Waldrip & den Den Brok, 2005). There has been considerable attention in the literature to the connection between respect for diversity in the classroom and academic performance. White and Lippitt (1960 cited in Hayes, Mills, Christie & Lingard, 2006) found that in

classrooms with inclusion and with respect for differences, academic outcomes were equal. Lee (2003) stresses that "when these students are provided with equitable learning opportunities, they can capitalize on their linguistic and cultural experiences as intellectual resources for new learning in science classrooms" (p. 465).

Teachers need to value diversity in their classrooms, and should understand and acknowledge the critical role of culture in teaching and learning (Sheets, 2009). According to Sheets, teachers need to observe students' cultural behavioural patterns to recognise individual and group cultural competencies and skills in order to use this knowledge to guide their teaching decisions. Taylor and Fox (1996, p. 90) suggest several principles that teachers could use to value the differences in their classrooms. Teachers need to:

1- Recognise the rich body of knowledge that students bring with them to the classroom.
2- Begin with the personal in order to honour all voices and to value everyone's perspectives.
3- Encourage a safe environment in which students feel comfortable.
4- Realise that culture is not static, but a dynamic, highly contextualised entity.

Consequently, there is a need for a pedagogical framework that can be organised around the recognition of difference and help teachers to work with and value the difference in their classrooms.

The theoretical arguments for the development of the Productive Pedagogies framework have been summarised in this literature review. The framework has focused on the improvement of students' intellectual reasoning and makes teaching and learning in schools more applicable to the students' everyday lives, in addition to creating supportive environments which accommodate diversity in the classroom and achieve educational equity (Luke, 1999). The next section will describe the implications of the framework in educational setting.

3.5 Using Productive Pedagogies in Educational Settings

Productive Pedagogies has become a central focus of research and academic interest over the last decade. Zyngier (2005, p. 4) stressed that "variations of the Productive Pedagogies framework have been adopted in New South Wales, Tasmania, South Australia and Victoria". A new model of pedagogy has been taken by the department of education and the training research team in New South Wales to improve the quality of teaching in schools in 2003. The NSW model has been built on Newman's work (1996) and Productive Pedagogies (2001) to improve the pedagogical practice that improve students' learning outcome. The model contains three dimensions: intellectual quality, quality learning environment and significance. This model became a standard for teacher practice in NSW schools.

An enormous body of research supports the frameworks that improve students' achievement. This led research educators to introduce the Productive Pedagogies framework to the teacher education program to enhance the teaching of pre-service teachers. Several studies highlight Productive Pedagogies in teacher education and training. A number of studies have modelled Productive Pedagogies in pre-service teachers programs to 1) change pedagogic practice, 2) increase students' awareness of teaching pedagogy, 3) implement critical reflection for their understanding of the framework and 4) prepare a series of professional development activities focussed on Productive Pedagogies to train pre-service teachers (Wilson& Klein, 2000; Sorin & Klein, 2002; Zyngier, 2005; Gore, Griffiths & Ladwig, 2001; Aveling & Hatchell, 2007).

Wilson and Klein (2000) have introduced the Productive Pedagogies to make teacher education more appropriate in the 21st century. Wilson and Klein's study was conducted with students in their final year (fourth year) at teachers' college. The students undertook a core education subject that was based on addressing issues in order to prepare teachers who are soon to enter their own classrooms for first time. The content for study in the subject

drew from a focus on researchers teaching practice and the Productive Pedagogies work. After one semester working on the study, the researchers found the Productive Pedagogies model helped them as teacher educators as well as their students to critically reflect on pedagogical issues. They found themselves moving from a teacher-directed to a student-centred approach. When comparing this study with this current investigation we can see clearly that this study goes beyond introducing the Productive Pedagogies framework to pre-service teachers to following them in their teaching practices in order to investigate their ability to implement the framework in their practices.

Gore, Griffiths and Ladwig (2001) examined whether Productive Pedagogies can improve the quality of teaching. The study involves 30 students who take an elective subject, "Teaching Better" in their final year of a four-year teacher education program. The researchers introduced the concept of productive pedagogies to pre-service teachers and followed ten of them in their internship. After analysing the data the researchers suggest that

> *Productive Pedagogies need to come early in the teacher education program in order to be more fully integrated into students' knowledge base for teaching…. if students are to treat PP as foundational to all of their efforts in teaching, it needs to be: (1) clearly positioned in that way from the beginning of the teacher education program; (2) used as a device to guide all aspects of the teacher education curriculum; and (3) modelled in the pedagogy of teacher educators. (Gore, Griffiths & Ladwig, 2001, p. 10)*

Gore, Griffiths and Ladwig's study design is comparable to the investigation reported here. However, the context is different in terms of the culture, language and school settings. In addition, the current study also incorporates the Productive Pedagogies framework into a core unit called Mathematics Teaching Methods in order to investigate how the official unit content can be integrated within a Productive Pedagogies framework.

Sorin and Klein (2002) developed a framework for their pre-service course based on the Productive Pedagogies framework. They expected that this gave their students spaces to develop their own understanding of the quality of pedagogical practices. Zyngier (2005) examined the productive pedagogies principles as a metalanguage for developing pre-service teachers' knowledge and understanding of teaching. The study was conducted in the first-year primary and early childhood pre-service teaching program at Monash University in 2002. The study presented the four dimensions of the productive pedagogies framework to eight students. Substantive conversations focused on the language of the 20 elements of the framework during their 10-week course and included practice observation using video of real classroom practice. Critical reflections and observation of real classrooms were done to ensure that students thoroughly understood the model. The researcher concluded that the early introduction of the language of productive pedagogies to pre-service teachers could help them to use the common vocabulary and language to describe what good teachers have always done. He stressed that the main value of Productive Pedagogies is its use by teachers as a language to talk about their practice. Again, in the above two studies the researchers did not follow their students in their field experiences.

Not only does Productive Pedagogies have valuable implications in pre-service teachers' education, it also has a great impact on in-service teacher education. One of these was to train in-service teachers to develop their teaching practices. Gore, Griffiths and Ladwig (2002) prepared a series of professional development activities in Productive Pedagogies to train in-service teachers. This study involved 26 teachers from a small rural primary school and a large urban secondary school. The research team concluded that teachers could change their practices to incorporate Productive Pedagogies. Another use of the Productive Pedagogies was to enhance the teaching and learning environment and link them with the technology in the classroom (Kent & Holdway, 2009; Kapitzke and Pendergast, 2005; Chinnappan, 2006). Social justice was also affected by the Productive Pedagogies framework. Some researchers have used the framework to

develop a particular understanding of social justice (Mills & Keddie, 2007; Atweh & Bland, 2005; Atweh & Brady, 2009). The Productive Pedagogies framework also found to help raise awareness of the equity for students with disabilities. When students with disabilities were challenged and supported to produce high intellectual quality work, their work quality was comparable to that of their nondisabled peers (Barden, 2004). Fields (2006) studied the effect of the Productive Pedagogies framework on teachers' behaviour management. He concluded that while there is some evidence of a paradigm shift in both teaching and behaviour management by the majority of teachers, a significant number of teachers remained teacher directed in their practice and controlling in their perspective on behaviour management in spite of their agreement with Productive Pedagogies.

While some of these studies involved mathematics as a part of the reflection and discussion regarding Productive Pedagogies, generally, there has been less attention to Productive Pedagogies in mathematics education. There have been few research studies that clearly link mathematics with Productive Pedagogies. One example is a study by Cronin and Yelland (2004) which demonstrated how a focus on Productive Pedagogies has led to positive outcomes in numeracy for young indigenous Australian students. Productive Pedagogies has likewise been used with a networked online learning environment in mathematics to establish a powerful learning environment (Chinnappan, 2006). Atweh (2007) explained how the two dimensions of the Productive Pedagogies--intellectual quality and connectedness--supported the development of a Socially Response-able Mathematics Education. Sawyer (2008) described the practices of mathematics teachers who help students make connections between forms of disciplinary knowledge and between disciplinary knowledge and real-life experiences. Finally, Mills and Goos (2011) conducted research in classrooms using Productive Pedagogies to emphasise the importance of pedagogies for delivering a socially-just mathematics curriculum.

This study was conducted in a mathematics teacher education program and used Productive Pedagogies to teach a unit called Mathematics Teaching

Methods to pre-service teachers. Pre-service teachers also used Productive Pedagogies to teach mathematics in primary schools.

3.6 Summary

The perspectives on research and pedagogical practice have different approaches and methods; moreover, they differ in the nature of the evidence on which their theories are based. Recently, constructivism has become a centre of teaching and learning in mathematics teacher education. One reason is to give student teachers a space to develop their own understanding and beliefs about classroom pedagogies. More recently, researchers have identified general characteristics of pedagogy that have meaning in real classrooms, and have demonstrated effects on learning outcomes for all students. Authentic Pedagogy was developed by Newmann and his colleagues to raise the standards for intellectual quality (Newmann, Marks & Gamoran, 1996). Using the widespread acceptance of Authentic Pedagogy, a team of researchers in Queensland developed Productive Pedagogies for teachers to use to improve students' academic and social outcomes (Lingard et al. 2001). Each section of the literature review highlighted important points that are linked with the theoretical development of the four dimensions of the Productive Pedagogies framework. The next chapter describes the details of the methodology.

CHAPTER 4

RESEARCH METHDOLOGY

The previous chapter reviewed the literature pertaining to the present study and its theoretical framework. This chapter outlines the research methodology used in introducing the Productive Pedagogies framework to pre-service teachers in Riyadh in Saudi Arabia and provides information about how the research was conducted. This study had two phases. The first phase examined the incorporation of the Productive Pedagogies framework within a teachers' pre-service unit in mathematics education. In particular, this phase of study examined the teaching processes necessary for the incorporation of Productive Pedagogies in the unit. The second phase investigated the pre-service teachers' ability to implement the Productive Pedagogies framework in their field experience. This chapter is divided into nine sections. Section 4.1 outlines the research aims and questions. Section 4.2 describes the research methodology. Section 4.3 presents details on research design and participants. Section 4.4 describes the data-gathering instruments. Section 4.5 describes the data collection and procedures. Methods used in data analysis are discussed in section 4.6. The research quality standards and the ethical considerations are described in sections 4.7 and 4.8 respectively. Section 4.9 summarizes the chapter.

4.1 Research Aims and Questions

In chapter 1 the aims of this study were identified. In this chapter the aims were elaborated in order to identify specific research questions under each aim. There are four main aims of this study.

Aim 1, to investigate the incorporation of the Productive Pedagogies framework within a teachers' pre-service unit in mathematics education in Saudi Arabia. In particular, this project aims to investigate:

1.1 How might the official unit content be integrated within a Productive Pedagogies framework?

1.2 How can the teaching processes in the unit incorporate Productive Pedagogies?

Aim 2, to investigate the pre-service teachers' engagement with Productive Pedagogies. In particular, this project aims to investigate:

2.1 To what degree do the pre-service teachers' appreciate and have a favourable attitude towards Productive Pedagogies?

Aim 3, to investigate the pre-service teachers' ability to implement Productive Pedagogies during their study of the unit.

Aim 4, to investigate socio-cultural factors related to the incorporation of Productive Pedagogies in a Saudi Arabian context.

4.2 The Research Methodology

This research is a qualitative study informed by Practical Action Research methodology (Schmuck, 1997). Shank (2006) defined qualitative research as "systematic empirical inquiry into meaning" (p. 6). Denzin and Lincoln (2000) explained the role of the qualitative researchers by saying that they "study things in their natural settings, attempting to make sense of, or interpret, phenomena in terms of the meanings people bring to them (,p. 3). Atkinson, Coffey, and Delamont (2001 cited in Shank, 2006) mentioned, "in terms of methodologies, perspective, and strategies, qualitative research is an umbrella term which encompasses many approaches" (p.6). Data collection based on qualitative methods can be used in action research which addresses practical problem in schools and classrooms (Creswell, 2005).

There are many versions of action research in the literature. Action research is defined as any systematic inquiry conducted by teachers or educators to collect information about, and subsequently improve their teaching

processes, and how students learn (Mills, 2007). Action research was defined by Johnson (2005, p.21) as the "process of studying a real school or classroom situation to understand and improve the quality of actions or instruction". Action research provides a framework that guides the energies of teachers toward a better understanding of why, when, and how students become better learners (Mills, 2007). The term action research has been used since the 1930s. Kurt Lewin viewed action research as a cyclical approach of planning, acting and reflecting to address social issues. The cyclical nature of action research is often described as spiral of self-reflection cycle of planning, action with observation, reflection and re-planning (Kemmis & Wilkinson, 1998). This spiral of planning, acting and reflecting is a dynamic process of action research inquiries (Creswell, 2005). Creswell (2005) showed that there are two designing types of action research in the literature. One is a participatory action research which emphasis on research that contributes to emancipation or change in the society. The other one, which is adopted in this study, is a practical action research with emphasis on research that is conducted by teachers on research problem in their own classroom in order to improve their students' learning and their practices.

Action research has become a useful tool for researchers in education. Stephen Corey and others at teachers college of Columbia University introduced the term action research to the educational community in 1949 (Johnson, 1993). Corey (1953 cited in Johnson, 1993) defined action research as the process by which practitioners study their own practice in order to guide and evaluate their actions. Action research is reported to be a highly practical and organized method for educational inquiry (Tomal, 2003). Atweh (2007) asserted that action research, which is known for its cyclic plan, is now accepted by most research communities as a valid research method and a useful attempt to bridge the gap between theory and practice. The rationale behind action research in the educational setting is to enable educational practitioners to understand and improve educational practices (Stringer, 2008). This model of inquiry has been used to encourage researchers to reflect on their own practice in order to improve their students' performance (McNiff, 1988). Similarly, Mills (2007) believed that action

research encourages teacher to reflect on and subsequently improve their practice. It is a distinctive and effective approach that can help teachers and teacher educators build their own knowledge base (Hui & Grossman, 2008).

Some critics, however, argue that action research is still uncommon when compared to more traditional forms of conducting research (Mertler, 2006). It has been described as the least precise of educational research methodologies and the one that is most subject to errors of bias, generalization and validation (Hui & Grossman, 2008). However, action research is different from other research inquiries and builds on other criteria. Johnson (2005, p. 24) argued that in an action research project, the intention is not to "prove", but to "understand" and to improve. While proving is not the target of action research, the researcher should produce credible evidence and good explanation for what he or she believes happened (McNiff, 2002). Herr and Anderson (2005) suggested that practitioners might ask their colleagues to act as critical friends in order to reduce the bias and subjectivity in action research. A critical friend is someone "whose opinion you value and who is able to critique your work and help you to see it in a new light" (McNiff, 2002, p 18). Handal (1999) commented that a critical friend at the university level can offer guidance for the researcher on what can be improved and how to make the change. In action research, critical friends can offer continuing support throughout the research process (Pine, 2009).

As a teacher trainer at a teachers' college, I constantly had to reflect on, and improve my students' learning as well as my teaching practice. Practical action research helps make reflection more systematic and defensible. According to Mertler (2009, p. 12) "Action research offers a process by which current practice can be changed toward better practice" With this in mind, I chose practical action research to study the application of the Productive Pedagogies framework. Cohen, Manion and Morrison (2000) suggested that researchers can use action research to adopt and evaluate new learning strategies in their teaching practice. In addition two of my colleagues were

selected to be critical friends from the start of the project to provide useful feedback.

4.3 The Research Design

In this study, two phases were designed for achieving the study objectives. Phase I of this study extended from September 2008 to the mid of January 2009 (semester one in Saudi Arabia, 2008-2009). In this phase, pre-service teachers in their fourth and final year of the teacher education program were introduced to the Productive Pedagogies framework in the unit of Mathematics Teaching Methods. In other words, the framework constituted part of the content of the unit and was used as an overall organizer to integrate the other content usually covered in the subject. At the same time, the framework was used by the lecturer in his teaching of the subject, thus modeling the principles of the framework in the classroom. In the unit, the pre-service teachers learned how to develop some methods of teaching mathematics. The unit was taught with different methods of teaching to enhance pre-service teachers' engagement with the Productive Pedagogies framework. The framework has been elaborated upon and demonstrated to the students through a series of seminars and group-based workshops. The purpose of this phase was to investigate the incorporation of Productive Pedagogies into the Mathematics Teaching Methods Unit and to investigate the pre-service teachers' engagement with the framework. The action research inquiry was compatible with my investigation of introducing the principles and application of Productive Pedagogies and with my ethos of improving teaching and learning. I reflected on my practice by using action research. The data collection for this phase consisted of the lecturer-researcher and student teachers own reflective journals and three focus groups with selected student-teachers. In addition, two colleagues were selected as critical friends through the semester to critique the work and provide feedback. At the end of phase I, the data also were collected from two colleagues' interviews.

Phase II of this study extended from January 2009 to the end of May 2009 (semester two, 2008-2009). In this phase, pre-service teachers were followed throughout their field experience of teaching mathematics in primary schools. Each one was observed in the classroom five times during his teaching practice. The aim of the observations was to investigate the pre-service teachers' ability to apply the Productive Pedagogies framework. Data were collected through observations, reflective journals, semi-structured interviews with the participants and one focus group interview with the entire group.

4.3.1 Research participants

Qualitative inquiries are more likely to have a small sample size than other approaches (Cohen, Manion & Morrison, 2000), because "in qualitative research the issue of sampling has little significance as the main aim of most qualitative inquiries is ether to explore or describe the diversity in a situation, phenomena or issue" (Kumar 2005, p. 164). In action research, the researcher studies a few individuals or cases in order to provide an in-depth picture about the phenomenon (Stringer, 2008). Eighteen pre-service teachers from the Riyadh Teachers' College participated in phase I of this study. The pre-service teachers who entered the teachers' college from secondary school were between 17 and 21 years on average, and all were males. The participants have a mixed socio-economic background and came from both rural and urban areas. Prospective teachers of mathematics at the Riyadh Teachers' College undertake a four-year Bachelor of Education course. They study a unit called "Mathematics Teaching Methods" in their seventh semester. The unit contact time is two hours each week for 14 weeks. In this unit, the students consider various mathematics teaching methods and their application. During the following final semester, the students are engaged in fulltime field experience, which includes teaching mathematics for a minimum of eight lessons per week for the full semester under faculty supervision. In this case and for phase II of this study, a group of six pre-service teachers from the entire group volunteered to participate in this phase.

4.3.2 Research setting

This study was conducted in three different educational places in Riyadh in Saudi Arabia: Riyadh Teacher College, Al-Hidaya Primary School and Al-Taqwa Primary School (the schools' names are pseudonyms).

Riyadh Teachers' College

Riyadh Teachers' College is located in the north-east of the city of Riyadh and serves students in the Riyadh region which occupies 17% of Saudi Arabia's area. Riyadh Teachers' College is one of 18 teachers' colleges in Saudi Arabia. It was established in 1976 with two objectives: to prepare students to become teachers in primary schools and to reform in-service teachers education academically and educationally. The Riyadh Teachers' College becomes one of the educational institutions leading in the field of development and educational reform in Saudi Arabia. The College offers bachelor's degrees in many subjects such as mathematics, science, English language and social studies. In 2007, the decision was made to join each teachers' college in the country to its nearest university. Riyadh Teachers' College then became a college in King Saud University. In the 2008/2009 academic year, the Teachers' College employed-180 full time staff members with approximately 2,400 student enrolments (Riyadh Teachers' College, 2009). Riyadh Teachers' College was the setting of phase I of this study where pre-service teachers were introduced to the Productive Pedagogies framework.

Al-Hidaya Primary School

Al-Hidaya Primary School is located in the north of the city of Riyadh and provides basic education for students in grades 1 through 6. The school has 400 students and employs 27 full-time teachers, including three mathematics teachers. The administrative staff comprises one principal, one assistant principal and one psychology consultant. The school students are Saudi and international students who come from different Arab countries. In phase II of

this study, a group of three pre-service teachers was sent to this school. The first pre-service teacher taught two classes of fifth-grade amounting to five lessons a week. The second participant taught two classes of third-grade amounting to four lessons a week. The third pre-service teacher taught two classes of second-grade amounting to four lessons a week.

Al-Taqwa Primary School

Al-Taqwa Primary School is located in the east of the Riyadh city and provides basic education for students in grade 1 through 6. The school employs 28 full-time teachers, including three mathematics teachers. The administrative staff is composed of the principal, two assistant principals, one psychology counsellor, and one librarian supervisor. There are 420 students distributed through all grade level. Another group of three pre-service teachers was sent to this school for field experience. The first pre-service teacher taught ten lessons per week to fourth-grade students, divided on two classes. The second participant taught ten lessons per week to sixth-grade students divided into two classes. The last pre-service teacher taught ten lessons per week to fifth-grade students divided into two classes. Table 4.1 depicts the pre-service teachers' weekly classes and lessons.

Table 4.1

Pre-service teachers' schools and year levels

Schools	*Participant*	*Year level*	*Lesson/ week*
Al-Hidaya Primary School	PT7	5	10
	PT6	3	8
	PT3	2	8
Al-Taqwa Primary School	PT4	4	10
	PT5	6	10
	PT9	5	10

4.3.3 Mathematics Teaching Methods unit

The Mathematics Teaching Methods Unit is intended to provide pre-service teachers with focused skills and knowledge of teaching mathematics. The body of knowledge consists of effective teaching skills and techniques for primary mathematics teachers. This unit prepares pre-service teachers to

- Expand their knowledge about the nature and goals of mathematics.
- Recognize different stages of mathematics development.
- Identify the teacher competencies applicable in a local context.
- Plan and conduct mathematics lessons for primary school students.
- Implement various teaching strategies in different learning contexts.
- Assess students and provide appropriate feedback.
- Apply microteaching skills in the classroom.

Table 4.2 presents the syllabus and content aims of the unit along with the teaching calendar. Each part of the unit syllabus provides examples from primary school mathematics textbooks to demonstrate the content.

Table 4.2

The syllabus and content aims of the unit along with the teaching calendar

Weeks	Syllabus	Content
Week 1	Orientation	Overview of aims and explicit performance criteria of the learning program. Introduction on the theoretical framework of the productive pedagogies approach.
Week 2	Productive Pedagogies Framework introduction	Demonstrate the four dimensions of the framework.
Week 3	Teacher Competencies	Definitions, teacher skills at primary schools, teacher ethics, and teacher principles.
Week 4	Mathematics History	Old and new mathematics teaching, Arab and Muslim mathematics development.
Week 5	Planning and Conducting teaching	Principles, types, effective factors of planning, and lesson plan preparation. Education aims, its definitions, selection criteria, formulate aims.
Week 6	Teaching Process and Effective Teaching Strategies	Pedagogies, classroom questions, and teaching practice. Teaching implications of cooperative learning and small group working.
Week 7	Teaching Process and Effective Teaching Strategies	Classroom management and teaching implications of problem solving and an investigation approach.

Week 8	Evaluation	Definitions. Types: formative, summative, diagnostic, and continuous assessment; portfolio.
Week 9	Diversity and Difference in the Classroom	Explore the issues pertaining to working with and valuing differences in the classroom.
Week 10	Observation	Viewing videos of teachers in authentic classroom situations and reflecting on the cases.
Week 11	Real Classroom Observation	Opportunity provided to pre-service teachers to observe a real mathematics classroom.
Week 12 -13	Mini Teaching	Each pre-service teacher gets a chance to practice teaching of a chosen lesson from a mathematics primary textbook in front of the class.
Week 14	Reviewing	

The unit content is supported by four Arabic books: *Methods of Teaching Mathematics* (Mufti & Soliman, 2000), *Teaching and Learning of Mathematics in Primary School* (Obed, 1998), *Learning by Work in the Teaching of Mathematics at the Primary Stage* (Monofi, 2005), and *Teaching Principles and Skills* (Yosef, 2008). The unit was a 14-week course which met for two hours each week. The unit had been taught with various methods of teaching to enhance pre-service teachers' engagement with the Productive Pedagogies framework. The framework had been elaborated upon and demonstrated to the sample group through a series of seminars and group-based workshops. In most of the lessons, the two hours session involved presenting information, problem posing, constructing and reconstructing ideas, group discussion around the topic, class discussion and self-reflection. Part of the unit required watching and reviewing videos of teachers in classrooms. The learning program also allowed pre-service teachers to observe real mathematics classrooms. At the end of the course, learners taught a mathematics lesson in small group setting. Details of the content and teaching methods are discussed and analyzed in Chapter 5.

Table 4.3

The time allocation for different activities in a typical classroom

Activity/ Aids	Time (minutes)
Presentation	15
Problem posing	15
Construction	15
Group discussion	20
Class discussion	40
Self- reflection	10
Total	115

4.3.4 Unit assessment

In the past, the unit's assessments were completely based on paper and pen test. They included two midterm exams worth 40% and one final exam worth 60% of the total mark. However, in this study the unit's assessments have been changed to focus on more practical assessments during the course. There were two strong arguments for this focus on more practical assessments. First, the aim of this course was to provide learners with focused skills and knowledge of teaching mathematics. A part of the course involved viewing videos of teachers in authentic classroom situations and reviewing these situations. Other components of the learning program concerned providing opportunities for pre-service teachers to observe real mathematics classrooms at schools. Learners also were able to teach a mathematics lesson in small group practice. These and other similar activities were not considered in the previous assessment system, so it is important to assess students on these skills. The second aim was to give the pre-service teachers the opportunity to discuss the assessments of the course with their instructor during the course. These discussions led to an agreement about how their final grades would be calculated. The practical part of the course would account for 60% of the final grade, based on five components. First, weekly reflective journals where pre-service teachers reflect on their learning process by following guided questions. Second,

participation in group discussions to solve classroom tasks. Third, reading articles and giving individual explanations as well as completing a task on mathematics teaching methods. In this task, pre-service teachers selected one teaching method, such as problem solving, cooperative learning or investigation strategy, and then completed their assignment by linking the theory to practice. Fourth, observing a real mathematics classroom and completing the observation report. Finally, each pre-service teacher performed a mini lesson in front of his colleagues. A written exam, worth 40% of the total mark, makes up the academic component of the unit.

Table 4.4

The assessments and marks of the unit

ASSESSMENT TYPE	PERCENTAGE	TIME
Participation and class attendance	15	Weekly
Reflective journal	10	Weekly
Students research	10	Week 6
Observing a classroom	10	Week 9
Microteaching	15	Week 12-14
Theoretical test	40	Week 15
Total	100	

4.4 Productive Pedagogies Classroom Observation Manual

Having gained permission for translation, pre-service teachers were provided with an Arabic version of the "Productive Pedagogies Classroom Observation Manual" (Education Queensland, 2001). The original booklet was from the Queensland School Reform Longitudinal Study (QSRLS) commissioned by Education Queensland. The 24-page booklet contains explanations and examples of all 20 elements of the Productive Pedagogies along with five standards on a Likert scale. Table 4.5 shows one example of the standards criteria for the framework (see Appendix for all 20 elements of the standards criteria). Translation of the document into Arabic language

enabled pre-service teachers to understand the framework and how their practices would be rated. After the booklet was translated into Arabic, it was sent to two Arabic-speaking doctoral students at Curtin University who checked the accuracy of the translation. Then the researcher discussed the most accurate ways to convey the English expressions. A draft of the final copy of the booklet was given to an Arabic-speaking professor in the Curriculum and Instruction Department at the Teacher College in Riyadh to check the grammar. The Arabic version was 40 pages long as several examples from mathematics were added to illustrate the framework. During the weekly lecture meetings, pre-service teachers used the booklet to understand and clarify the framework as well as to make connections between the framework standards criteria and their classroom tasks. In Week 7, they used the standards criteria to rate the recorded teaching sessions and discuss their report with the class. In Week 9, pre-service teachers also used the standards criteria to direct their observations when they visited different schools to observe mathematics teachers in their classroom. In Week 12-14, pre-service teachers again used standards criteria to rate their colleagues' mini lesson. In Phase II, I used the standards criteria for the framework to direct my observations and rate pre-service teachers' practices.

Table 4.5
Standards criteria for Higher Order Thinking as shown in the original booklet (Education Queensland, 2001)

Are students using higher order thinking operations within a critical framework?				
1	**2**	**3**	**4**	**5**
Students are engaged only in lower-order thinking; i.e. they either receive, or recite, or participate in routine practice and in no other activities during the lesson do students go beyond simple reproduction.	Students are primarily engaged in lower order thinking, but at some point they perform higher order thinking as a minor diversion within the lesson.	Students are primarily engaged in routine lower order thinking a good share of the lesson. There is at least one significant question or activity in which some students perform some higher order thinking.	Students are engaged in at least one major activity during the lesson in which they perform higher order thinking, and this activity occupies a substantial portion of the lesson and many students are engaged in this portion of the lesson.	Almost all students, almost all of the time, are engaged in higher order thinking.

4.5 Data Collection and Procedures

According to Merriam (1988), using multiple methods of data collection is a major strength of qualitative case studies. In action research, there are many ways to collect data. Selecting the right methods is a crucial aspect to ensure acquisition of relevant and valid information (Tomal, 2003). This study gathered data from focus groups, interviews, observations and reflective journals. Table 4.6 summarises the data collection procedures.

Table 4.6

Data collection

Study phase	Time	Data collection	Participants	Aims of data collection
Phase I	Week 1-14	Reflections	Researcher	To provide information about the teaching process using the Productive Pedagogies.
	Week 2-10	Reflections	Pre-service teachers	To provide information about pre-service teachers' engagement with the Productive Pedagogies and their reflection on the teaching process.
	Week 6,9,12	Focus Group	Pre-service teachers	To provide information about pre-service teachers perception and understanding of the framework.
	Week 13	Interviews	Teacher trainers	To provide information about the alignment of the unit content and Productive Pedagogies as well as the teaching process in the class using the framework.
Phase II	Week 1-8	Reflections	Researcher	To offer information related to pre-service teachers' teaching practices
	Week 1-8	Reflections	Pre-service teachers	To provide information on their teaching practices using the Productive Pedagogies.
	Week 2,3,5,6,7	Observations	Pre-service teachers	To provide evidence on teaching practices that use elements of the Productive Pedagogies.
	Week 7	Interviews	Pre-service teachers	To provide information about pre-service teachers implementation of the framework
	Week 8	Focus group	Pre-service teachers	To provide information about pre-service teachers understanding and implementing of the framework.

4.5.1 Focus group interview

A focus group interview is the process of collecting data through interviews with a group of people (Creswell, 2005). Morgan (1996) defined focus groups as a research technique that gathers data on a topic determined by the researcher through group interaction. At first, I considered using a questionnaire to investigate the pre-service teachers' engagement with Productive Pedagogies framework. However, given the sample size and the risk that they would give only superficial answers, focus groups interviews were therefore utilised to provide more details. The other reason for selecting focus group interview as a method of obtaining information from students was that students might hesitate to share their experience in individual interviews. Therefore, focus group interviews were used to encourage participants to freely share their learning experience and encourage each other to express their feelings and opinions. Creswell (2005) stressed that focus groups are useful when the individuals are hesitant to provide information. According to Shank (2006, p. 48) "focus groups are most useful for getting at complex understanding notions in a setting where the sharing of experiences can help guide the other participants to greater awareness and participation". In this study, four focus group interviews were conducted to provide information about pre-service teachers' understanding and implementation of the Productive Pedagogies framework.

Procedure and Implementation

Four focus group interviews were conducted during Phases I and II. In Phase I, three focus group interviews were conducted in Week 6, Week 9 and Week 12. The three focus group interviews were conducted in different weeks to provide information that was useful for the action research cycles of action and reflection. The sample group was divided into three focus groups of six participants each. Macintosh (1993, cited in Gibbs 1997, p. 4) mentioned that "the recommended number of people per group is usually six to ten". Each focus group lasted for about one hour. The first focus group interview was conducted after a six week period to allow time to build and develop relationships with participants. Darlington and Scott (2002) stressed that in

interviews where participants feel connected with the interviewer, they are more likely to share their thoughts freely.

During the interviews, I used the five types of focus group questions cited by Krueger and Casey (2000). First, opening questions were used to get pre-service teachers talking and feeling comfortable. (What do you think was the purpose of the Productive Pedagogies framework? How clear was the purpose of the Productive Pedagogies framework?) Introductory questions directed the group to start thinking about the topic. (How clear were the directions for using the Productive Pedagogies framework? What were the main objectives of the program?) Transition questions linked the introductory questions to the key question. (What were your first impressions of the program? What do you think you were supposed to learn from this program?) Key questions focused on major areas of concern. (Can you describe how the Productive Pedagogies framework has helped you to understand the unit content? What did you like best and least about Productive Pedagogies? How would you improve it? Tell me about any problems you had while using Productive Pedagogies.) Finally, ending questions closed the meeting. (Is there anything we should have talked about, but didn't?). All focus groups interviews were conducted in Arabic followed four steps to make sure that the focus groups were productive. First, all participants were invited to express their thoughts, feelings and opinions. After I posed a question, I encouraged everyone to respond. Stringer (2008) stressed that each participant should have opportunities to express his or her perspective. Second, all participants were asked to give their names at the beginning of the interview and were encouraged to speak one at a time. Third, all focus group interviews were recorded with a high quality audiotape and microphone placed in the middle of the table. "Tape quality is always a concern in qualitative research" (Darlington & Scott, 2002, p. 59). Fourth, all focus group interviews were transcribed by the researcher. Merriam (2009) suggests that the researcher should transcribe the tapes by himself in order to gain a real understanding of the data.

In Phase II, one focus group interview was conducted with the six pre-service teachers at the end of their field experience. The focus group interview was to investigate the pre-service teachers' perceptions on implementing the Productive Pedagogies framework in their teaching practices. Several themes and key questions were used to encourage pre-service teachers to express their views and opinions. For example, what kind of difficulties did you face when implementing the Productive Pedagogies framework in your teaching? Have you encountered problems during the preparations of the lesson plan using the framework? Is there a good way to apply the framework in each lesson? These key questions opened the floor for more discussion about how the pre-service teachers implemented the framework in their field experience.

Strengths and limitations

A focus group, as a method of collecting data, has many advantages. It encourages interaction between the researcher and participants and allows the researcher to obtain participants' perceptions and opinions through conversation. It also offers a relaxed group setting where participants are more likely to express their views and thoughts freely (Anderson, 1998). A focus group allows contributions from participants who may feel that they have nothing to say, but who engage in the discussion generated by other member group (Kitzinger, 1995). Despite its advantages, in some ways a focus group can be limited. For instance, group discussions may go beyond the research aims and goals. Differences in views may lead to disagreements that discourage some people from participating in the discussion. Also, the participants might talk over or interrupt each other. Finally, transcribing and analysing the data from focus groups are time consuming.

4.5.2 Interviews

Anderson (1998, p. 202) defined an interview as "a specialized form of communication between people for a specific purpose associated with some agreed subject matter". The interview is a face-to-face interaction in which

the researcher can obtain rich information from the interviewees (Macintyre, 2000). Tomal (2003) wrote on conducting interviews as an action research technique that interviewing is a great method for collecting data on the feelings of research participants and their interpretations of the world. Semi-structured interviews were used in this study. Fraenkel and Wallen (2003) described semi-structured interviews as "verbal questionnaires. Rather formal, they consist of a series of questions designed to elicit specific answers on the part of respondents" (p. 456). The semi-structured interviews consisted of open-ended questions to give participants the opportunity to offer more information. In this study, two semi-structured interviews were conducted with two teacher trainers and three semi-structured interviews were conducted with three pre-service teachers in Phase II of this study.

Procedure and Implementation

In phase I, two interviews were conducted with two teacher trainers to elicit their perceptions about integrating the official unit content into a Productive Pedagogies framework and how my teaching in the unit could incorporate Productive Pedagogies. During the week prior to the course commencement, I explained Productive Pedagogies to two of my colleagues in the Riyadh Teacher College. I chose the colleagues who had taught the unit before in order to discuss integrating the unit content with the framework. The discussions with the colleagues continued through the semester and the feedback helped to evaluate my plans and my understanding of the content integration with the 20 elements of Productive Pedagogies. At the end of Phase I, the two of my colleagues were interviewed individually. The Interviews lasted from 40 to 60 minutes and were transcribed. I followed Creswell's (2005) general steps to conduct interviews.

1- *Identify the interviewees.* In this case I selected two of my colleagues who had taught the Mathematics Teaching Method Unit before were selected who able to provide rich feedback.

2- *Determine the type of interview you will use.* Semi-structured interviews were chosen to allow me to responses to the various situations by asking other questions to obtain deep information.

3- *Take brief notes during the interview.* This helped me later during the process of transcription.

4- *Locate a quiet, suitable place for conducting the interview.* Each interview was conducted in my colleagues' offices in order to minimise distractions.

5- *Use probes to obtain additional information.* "Probes are sub-questions under each question that the researcher asks to elicit more information" (Creswell, 2005, p. 218). See Appendix for all the question and sub questions of the interview.

In Phase II, three pre-service teachers were interviewed individually at the end of their field experience. The aim of the interviews was to identify pre-service teachers' perceptions of the impact of Productive Pedagogies on their pedagogical practice and on the learning outcomes of their students. Each interview lasted 35 minutes to an hour. Most of the pre-service teachers' interview questions were built upon teachers' observation notes and their teaching practices. For example, What are the elements of Productive Pedagogies that are repeated constantly with you in the lessons? Can you give examples from your teaching to explain which elements of the framework helped or limited you from achieving your lessons' goals? Did you change the type of assessment to fit with the framework? How?

Strengths and limitations

The interview is perhaps one of the most important methods used in qualitative research. It allows researchers to elicit the interviewees' feelings and emotions and enables researchers to obtain specific information from the participants. It also gives researchers an opportunity to verify information obtained by other research tools (Creswell, 2005). It allows researchers to expand on issues or to ask for clarification (Macintyre, 2000). However, there are some limitations to using interviews as a research collecting methods such as respondents possibly giving short answers or hesitating to give some kinds of information (Macintyre, 2000). In addition, participants might not answer candidly, when the interviewer is their instructor (Creswell, 2005).

4.5.3 Observation

Observation is one of the most common methods of data collection in research because it allows the collection of data in a real-life situation (Tomal, 2003). The core strength of observations is the possibility of recording data from the data's natural setting (Creswell, 2005). Mills (2007) demonstrated two types of observation used in action research: active participant observer, and passive observer. Teachers are active observers when engaged in teaching and observing the outcome. As passive observers, the researchers focus on data collection and watch the classroom activities (Mills, 2003). In this study, different types of observations were collected during Phases I and II.

Procedure and Implementation

In Phase I of this study, active participant observation was demonstrated through observing my own teaching and classroom activities. This created a picture of students' understanding of, appreciation of, and attitudes towards the Productive Pedagogies. In some lectures, I observed the class in order to see how students engaged with classroom activities. For example, I watched and took notes for students' reactions while they were viewing videotapes of mathematics lessons or when they were working in groups. These notes later helped with the preparation of the key questions of the focus group interviews. I read the notes and then formulated some questions to obtain more information from the students.

In Phase II, I used passive observation when watching the volunteer pre-service teachers in their field experience. Six pre-service teachers were followed into their field experience at two participating primary schools. Each pre-service teacher was observed five times during their field experience. In each observation, evidence of implementation of the four dimensions of the framework was ascertained by using the QSRLS Productive Pedagogies Classroom Observation Manual (Education Queensland, 2001) which formed the basis for the usual feedback from the lecture on their observed teaching. The coding manual contains each element of the four dimensions, together

with five Likert scale score indicating the level of manifestation of the element in that particular lesson (one being the lowest). For example, in Higher Order Thinking element of the Intellectual Quality dimension, the lesson was rated as one if the students were engaged only in tasks requiring lower order thinking such as receiving or reciting information, or participating in routine practice of acquired skills. However the lesson was rated as five if almost all the students, almost all of the time, are engaged in higher order thinking (Education Queensland, 2001). Each observation took place within a regular 45-minute lesson. Pre-service teachers could review their scores after each observation and discuss their results with the researcher. Each participant was provided with a reflection booklet. This booklet contains a section that includes guided questions to help the students to complete their reflection and a section that explains the QSRLS Productive Pedagogies Classroom Observation Manual.

Strengths and limitations

According to the literature, there are certain advantages to collecting qualitative data through observation. It helps the researcher to gather information about actual student behaviors (Creswell, 2005). It also allows the researcher to see some things that teachers might not be able to report on themselves. Observation allows the researchers to see how attitudes and perceptions change over time (Burns, 2000). However, as many other collecting data methods, observation has its limitations. For example, during the observation there are many details that need to be recorded which may result in some important details being missed or overlooked. Furthermore, during observed lessons teachers and students might possibly change their actions because they are being observed.

4.5.4 Reflective journals

Journals from both teachers and students are a valuable source of qualitative data for action research (Mills, 2007). Hendricks (2006) commented that maintaining a journal throughout an action research study is a highly effective means of recording the strengths and weaknesses of the project as

well as day-to-day change. In this study, reflective journals from both the researcher and pre-service teachers were collected weekly.

Procedure and Implementation

For this study, the data were obtained from pre-service teachers journals. At the end of each lesson, pre-service teachers were asked to write reflective journal. Hendricks (2006) commented that to help students to record their feelings, emotions, learning struggles, and personal growth, they need specific guidelines and prompts for journal writing. Pre-service teachers were provided with guiding questions to direct their writing. For instance, "what happened in the class to help you with learning?" "How did the productive pedagogies elements link with classroom activities?" "What did you like most and least about Productive Pedagogies?" One benefit of the reflective journal was to develop pre-service teachers' understanding of the Productive Pedagogies framework. Beveridge (1997) found that writing reflective journals encouraged students to look more analytically at their learning. In Phase II of this study, each participant was provided with a reflection booklet. This booklet contained a section that included guided questions to help the students to complete their reflection and a section that explains the QSRLS Productive Pedagogies Classroom Observation Manual (see Appendix).

I also kept my own journal writing about my experience of using Productive Pedagogies in my teaching practices. Mootz (2002) commented that teachers should ask questions about their practice in relation with each element of the Productive Pedagogies framework to help them design a variety of activities and actions. My reflections considered issues related to the teaching process such as the kind of activities that provide or links to Productive Pedagogies as well as considering issues related to students' participation such as their satisfaction in the classroom.

Strengths and limitations

Reflective journals have many advantages such as helping teacher researchers to record what is happening in their classrooms and allowing them to analyse, evaluate and change their own practice. Reflective journals

can also help students to record events, thoughts and feelings and assist them to develop their understanding of the concept being taught. However, writing and keeping journals might add more to the workloads for students and in terms of research analysis, reading and analysing the data can be time consuming.

4.6 Data Analysis

Data analysis is the process of making sense out of the data in order to address the research questions (Merriam, 2009). Creswell (2005) listed several steps to analysing and interpreting qualitative data: preparing and organizing the data, exploring and coding the data, describing findings and forming themes, representing and reporting findings, interpreting the meaning for the findings and validating the accuracy of the findings. In this research, these key techniques for analysing and interpreting qualitative data were used. Figure 4.1 shows the qualitative process of the data analysis in this study.

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│         ┌──────────────────────────────────────┐            │
│         │          Data Preparation            │      ┐     │
│         │ (i.e. Transcribes interviews, focus  │      │     │
│         │ groups and field notes;              │      │     │
│         │ Rewrite students' reflective journals│      │     │
│         └──────────────────────────────────────┘      │     │
│                         ⇩                              │     │
│         ┌──────────────────────────────────────┐      │     │
│         │    Data exploration and initial codes│  Simultaneous
│         │  Read the transcripts and constructed│      │     │
│         │  codes                               │      │     │
│         └──────────────────────────────────────┘      │     │
│  Inductive              ⇕                              │     │
│ Deductive ┌──────────────────────────────────────┐    ┘     │
│         │     Building themes and categories     │          │
│         │ Refinement of categories and exploration          │
│         │ of relationship and patterns across cat│          │
│         └──────────────────────────────────────┘            │
│                         ⇩                                    │
│         ┌──────────────────────────────────────┐            │
│         │ Themes and Description for the Research Report     │
│         │ Select several quotations and use different charts │
│         └──────────────────────────────────────┘            │
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Figure 4.1. The qualitative process of the data analysis in this study.

First, the data were prepared and organized from the earliest stage of this research. Audiotapes were transcribed from the interviews and focus groups by myself in order to get intimate familiarity with the data. I also typed pre-service teachers' journals that been hand written in order to prepare them for analysis. Additionally, field notes were taken during the observations. N-VIVO software was used to store, organise, code and retrieve data for analysis. Data were organized into file folders based on their type and time collection. Shank (2006) commented that N-VIVO software is one of the more commonly used programs recently being used for qualitative research analysis.

Second, after preparing the data for analysis, the first step was to explore the data and start the initial coding. I read the transcripts in their entirety several

times trying to get a sense of the whole before breaking them into parts. Merriam (2009) stressed that the researcher, as starting point, needs to read and reread the data, making notes in the margins commenting on the data in order to construct a set of tentative categories or themes. Coding of each document was then commenced. Coding is not just making a list of concepts; it involves interaction with data analysis, by asking questions about the data, and comparisons between data (Corbin &Strauss, 2008). Charmaz (2006, p. 47) suggested that the researchers during the initial coding might ask the following questions:

1- What is this data a study of?
2- What does the data suggest? Pronounce?
3- From whose point of view?
4- What theoretical category does this specific datum indicate?

According to Langdridge (2004) initial codes are not formed and then tested against the data, but the data must be carefully examined for meaning after which codes are constructed that are grounded in the data. Merriam (2009) recommended that the best way of analysing a qualitative study is to do it simultaneously with data collection. This means the commencement of data analysis while data are still being collected. In this case, I started analysing the data from Phase I of this study in order to enable intensive analysis.

Third, the second step, coding, commenced which is focused on building themes and categories. This is the process whereby large amounts of data are examined and the most significant and/or frequent earlier codes are identified (Charmaz, 2006). I listed number of codes and then re-examined the data it an attempt to see whether new codes would emerge. After this step, a constant comparative method was used to look for similarities and then differences between categories. Langdridge (2004) pointed out that constant comparative method is a key process for the development of categories and theory. Thorne (2000, p.69) wrote, "This strategy involves taking one piece of data (one interview, one statement, one theme) and comparing it with all others that may be similar or different in order to develop

conceptualisations of the possible relations between various pieces of data". After that, I reduced the codes to a small number of themes in the data in order to develop a theory and bring the data back together again in a coherent whole. For instance, under the big them of "pre-service teachers' reaction to Productive Pedagogies" there is a sub-theme called "valuable framework". This sub-theme has again several sub-themes such as "guide to teaching practices, useful in their teaching planning and well-organized model of teaching". These sub-themes were supported with different quotations from the data. The overall process of data analysis in this study began with the construction of themes and categories in a highly inductive form and then end with a slightly deductive mode as I re-examined the data to find more evidence to support my findings.

Finally, I reported my findings (see Chapters 5 and 6) using several tables, charts and figures to highlight the main findings. Quotations from pre-service teachers and from colleagues were presented in order to support the findings and personal reflections about the meaning of the data were included.

Data Translation

In this study, all interviews were conducted in Arabic and the findings are presented in English. Arabic is the researcher's and participants' first language; English is the researcher's second language. The data transcription and translation were guided by the following steps.

- All reflection, interviews and focus group were transcribed in Arabic.
- The researcher analysed all data in Arabic.
- Themes and selected quotations were translated into English.

4.7 Research Quality Standards

The traditional criteria such as validity and reliability are essential qualities in quantitative research. Validity is the degree to which studies measure what they purport to measure; while reliability is the consistency of the data (Mertler, 2009). However, in qualitative research, researchers disagree on

the value of validity and reliability to action research (Mills, 2007), "because qualitative methods are essentially subjective in nature and local in scope, procedures of assessing the validity of research are quite different than those used for experimental study" (Stringer, 2008, p. 48). Morgan (1983 cited in Guba & Lincoln, 1989) noted that the traditional criteria, which is rooted in the assumptions of the scientific paradigm, could not be expected to apply in any sense to constructivist studies. Guba and Lincoln (1989) developed the trustworthiness criteria in order to judge the quality of the constructivist or interpretative paradigm. To ensure representation and legitimacy of the study, I adhered to the guidelines on credibility, transferability, dependability and objectivity as outlined by Guba and Lincoln (1989). Merriam (2009) suggested that the trustworthiness and rigor of the researcher's interpretation and findings are concerned in qualitative research.

4.7.1 Credibility

Credibility is a parallel to internal validity used in quantitative research (Guba & Lincoln, 1989). To increase the credibility in this study I followed several techniques listed by (Guba & Lincoln 1989).

1. Prolonged engagement: Spending sufficient time in the field in order to achieve certain purposes and building trust (Guba & Lincoln 1989). I spent about 14 weeks with participants in the first phase and eight weeks in the second phase. This helped to build a good relationship and trust with participants in order to gain rich information around the research inquiry. Merriam (2009) suggested that one important strategy used to enhance credibility was adequate engagement in data collection.

2. Persistent observation: Sufficient observation to enable the researcher to identify and assess relevant factors of the problem being pursued (Guba & Lincoln, 1989). In Phase I, and as stated earlier, active participant observation was demonstrated during the weekly teaching sessions in order to create a picture of students' understanding and appreciation of, and attitudes towards the

Productive Pedagogies. In Phase II, six pre-service teachers were asked to volunteer as participants for observation. They were observed five times each during their field experience. There were meetings and discussions after each observation in school for about 10 minutes so that participants feel confidence to share their feelings and opinions. Further, there was a two-hour meeting each week at the college to discuss pre-service teachers' observations and to share their experiences.

3. Peer examination: Discussions with colleagues as critical friends were used to test the findings and conclusions. A critical friend is someone "whose opinion you value and who is able to critique your work and help you to see it in a new light" (McNiff, 2002, p. 18). Handal (1999) commented that a critical friend at the university level can offer guidance for the researcher on what can be improved and how to make the change. In this study, two of my colleagues were selected to be critical friends from the start of the project to provide feedback about my teaching plans.

4. Member checks: All pre-service teachers who participated in the observations were given frequent opportunities to review their observation results. After each observation, I reviewed and discussed the observation noted with pre-service teachers.

5. Triangulation: Different types of triangulation were used to enhance the credibility of this study as mention below.

4.7.2 Triangulation

Triangulation "involves the careful reviewing of data collection through different methods in order to achieve a more accurate and valid estimate of qualitative result for a particular construct" (Oliver-Hoyo & Allen 2006, p. 42). Merriam (2009) commented that triangulation reinforces reliability and internal validity. According to Johnson (2005), triangulation in action research means looking at something from more than one perspective in order to enable you to see all sides of a situation. In this study, source triangulation such as observations, interviews, focus groups and reflective journals were

used. Comparing and cross checking data from these methods helped to improve the validity of the research. "These multiple sources and methods provide rich resources for building adequate and appropriate accounts and understandings that form the base for working toward the resolution of research problems" (Stringer, 2008, p. 49). This gave the researcher a good understanding of his research and helped him to support his findings and results. Stake (2010) stressed that triangulation makes researchers more confident that he or she has the meaning right or they need to examine differences to see important multiple meanings.

4.7.3 Transferability

Transferability is parallel to the external validity or generalizability used in quantitative research (Guba & Lincoln, 1989). Transferability is the degree to which the findings of the research can be transferred to a different setting, or used with other samples (Shank, 2006). To ensure transferability in constructivist or interpretative studies, the researcher can provide thick descriptions to enable other researchers who are interested in making a transfer to reach a conclusion about whether transfer can be contemplated as a possibility (Lincoln & Guba, 1985). Merriam (2009) mentioned that to transfer the findings of the qualitative research, the researcher should provide thick descriptions of procedures, data and the nature of the context. In this study, sufficient supporting information was provided, so that other researchers would be able to transfer the process of the research. This was achieved also by describing the collection and the interpretation of the data in addition to providing more quotations from the observations.

4.7.4 Dependability

Dependability is parallel to reliability in quantitative research in that it is concerned with the constancy of the data over time (Guba & Lincoln, 1989). According to Merriam (2009) in dependability, the question is whether the results are consistent with the data collected, not whether the findings will be found again. "The key strategy for ensuring dependability is an audit trail"

(Shank, 2006, p. 114). Shank (2006) wrote that dependability is the researcher's ability to know where the data originates from, how it was collected and how it is being used. Merriam (2009) recommended that the researcher should keep a research journals or record memos on the process of research in order to construct an audit trail. A clear trail was drawn up in this study to formalise the methods and rationale for data collection. As outlined in section 3.5, where the data originated from and where it was collected are presented together to clarify the relationship between them. Stringer (2008) explained that dependability is achieved by providing the audiences with details of the research process including collecting and analysing data and constructing reports. As already mentioned, another strategy to increase the dependability of this study was triangulation. More than two methods of collecting data were used in order to better understand the findings. Mills (2007) stressed that overlap methods can be used to confirm the dependability of the data collection. Merriam (2009) suggested that researchers could use triangulation strategies to ensure consistency and dependability.

4.7.5 Confirmability

Confirmability is parallel to objectivity in conventional research and that it refers to the degree to which the outcomes of the study can be confirmed by others (Guba & Lincoln, 1989). "Confirmability is achieved through an audit trail" (Stringer, 2008, p. 51). This chapter reported on the development and use of an audit trail that tracks the details of the data collection process as well as the analysis of the data. The following three chapters will provide rich information which confirms the accuracy of the perspectives presented in this study

4.8 Ethical Consideration

4.8.1 Informed consent

All pre-service teachers were told about the nature and methods of the research, its aims, its risks, benefits, time requirement, and possible outcome (Cohen, Manion, & Morrison, 2000). As a teacher of the mathematics teaching methods unit at teachers' college, I gave students the option not to participate in the research process if they were not comfortable doing so. Participants were informed that if they did not wish to participate, their grades would not be affected. According to Hammack (1997), a researcher needs to inform the participants of what the study will involve so that they can make an informed decision about whether or not to participate. Anderson (1998) suggested that all participants sign an informed consent form before being permitted to participate. In this case, a signed form was requested at the beginning of this study (see Appendix).

4.8.2 Anonymity

While anonymity in action research is not possible, the researcher respected the privacy of the participants. I took the utmost care to give unbiased accounts of the events of the classroom. According to Mills (2007, p. 31), "confidentiality is when the researcher knows the identities of participants but promises not to release them to anyone else". Access to data gathered during the study was only available to the researcher and his supervisor.

4.8.3 Permission

I obtained permission to conduct the study from the head of the teachers' college. I also gave the principals of the schools who involved in the research a letter to explain my research project and got permission. In addition, before this study was carried out, I obtained permission from the department of Education Queensland to translate the five-point scale of the QSRLS code manual into Arabic (see Appendix for these permissions).

4.9 Summary

This chapter has presented the methodologies employed in this study. Action research was used as a framework in this study. The study consisted of two phases as follows:

I.   Introduction of the Productive Pedagogies to pre-service teachers in the unit of mathematics in the first semester.

II. Following pre-service teachers in their teaching practices in the second semester.

The sample of students who participated in the action research process, in Phase I, consisted of 18 pre-service teachers in Mathematics Teaching Methods unit at the teachers' college in Riyadh who were introduced to the Productive Pedagogies framework. In Phase II, 6 pre-service teachers were observed during their field experience to determine their ability to implement the framework in their teaching practices. The chapter has also described the procedures for data collection and data analysis. The next two chapters present the findings of this study.

CHAPTER 5

ANALYSIS OF THE DATA: PHASE I

The previous chapter reported on the methodology, research aims, and data analysis procedures of this study. This chapter commences the data analysis process by describing the pedagogies used in the study, including the official unit aims and content. The purpose of this chapter is to investigate the incorporation of the Productive Pedagogies framework within the official unit content in mathematics education and, more specifically, with the teaching processes of the unit. The data presented here was accumulated during the first phase of this study from my weekly reflective journals, teaching process, pre-service teachers' work and from interviews with two teacher educators who have taught the Mathematics Teaching Methods unit. The interviews focused on their perceptions of the framework, and their views about the incorporation of the unit content and teaching process with Productive Pedagogies elements.

This chapter provides details of the data analysis process as follows: Section 5.1 describes the incorporation of the unit content and teaching process with Productive Pedagogies dimensions. It presents details on teaching about the Productive Pedagogies to pre-service teachers and gives examples of the teaching through the framework. Section 5.2 presents a reflection on the research process. Section 5.3 describes the two teacher educators' views on the incorporation of the teaching process with the Productive Pedagogies framework. Section 5.4 summarises the chapter.

5.1 Integration of the Unit Content with Productive Pedagogies Dimensions

The participants took a unit called "Mathematics Teaching Methods" in the first phase of this study. The purpose of this unit was to provide learners with focused skills and knowledge of teaching mathematics. The body of

knowledge comprises effective teaching skills and techniques of primary mathematics teachers. In this unit, participants learned some mathematics teaching methods and their applications. As a starting point, the unit content was divided into nine topics. Two topics then were added to present the Productive Pedagogies framework, (in bold; see Table 5.1). The unit was delivered in a 14-week course (two hours per week) consisting of theory and practical exercises.

Table 5.1

Alignment between the unit topics and study weeks

Unit Topics		Study week
1	**Productive Pedagogies Framework (introduction)**	**Week 2**
2	Teacher Competencies	Week 3
3	Mathematics History	Week 4
4	Planning and Conducting Mathematics Lessons	Week 5
5	Effective Teaching Strategies (problem solving and cooperative learning)	Week 6
6	Effective Teaching Strategies (small group work and investigation strategy)	Week 7
7	Assessment and Evaluation	Week 8
8	Diversity and Difference in the classroom	Week 9
9	**Productive Pedagogies (evaluation)**	**Week 10**
10	Observation of mathematics teaching	Week 11
11	Microteaching	Week 12-14

One or more dimensions of the Productive Pedagogies were integrated with each topic of the unit in order to discuss and implement their elements when teaching the topic. In other words, by integrating a topic with a Productive Pedagogies dimension, I was utilising elements of that dimension in teaching and therefore I was modelling it for the pre-service teachers. For example, two techniques were used to identify which of the dimensions are appropriate to implement with each topic. These two were from my five years' teaching experience at the college and from discussions with my colleagues.

The first technique was based on my teaching experience, which I have used to determine which Productive Pedagogies dimensions and elements to demonstrate in the teaching of each topic. Lingard, Hayes and Miles (2003)

commented that the Productive Pedagogies model does not recommend presenting each of the 20 elements in each lesson. Teachers should use their professional judgment to determine which elements to use in his or her teaching. Lingard et al. (2001) stressed that while all 20 elements may be needed and should be present in the classroom at all times, some elements might be more suitable than others.

I taught this unit to pre-service teachers for two years and have been an instructor in a teachers' college for five years. These experiences helped me to integrate the course's contents with the framework dimensions. I considered the following questions when making the decision about this process of integration.

- ❖ What outcomes should I be trying to help students achieve, and how might the elements of Productive Pedagogies contribute to students' attainment of those outcomes?
- ❖ What specific things can I do to integrate each of the elements of Productive Pedagogies into my teaching practice?
- ❖ How does the nature of the content affect my ability to apply the elements of Productive Pedagogies?
- ❖ How should I interact with the content so that I can apply the elements of the framework?
- ❖ How should students interact with the content so that they benefit from my use of the elements of the framework?

These questions were adapted from Killen (2006), formulated to help teachers understand the Quality Teaching Model and to enhance students' learning. Teachers use these questions to examine and guide their teaching practice. In this case, these questions helped to determine what elements of Productive Pedagogies would be presented in each lesson.

The second technique was the discussion with critical friends. During the week before the course started, I explained Productive Pedagogies to two of my colleagues and discussed how the four dimensions could be integrated

into my lesson plans. My colleagues' suggestions and feedback helped me to incorporate the Productive Pedagogies elements with the content of each lesson. Table 5.2 shows these incorporations. The table is followed by detail descriptions of teaching about and teaching through the framework.

Table 5.2

Incorporation of Productive Pedagogies dimensions with each lesson

Lesson Topics		Dimension
1	Productive Pedagogies Introduction	Discussion of all dimensions
2	Teacher Competencies	Intellectual Quality Classroom Environment
3	Mathematics History	Recognition of Difference
4	Planning and Conducting Mathematics lessons	Intellectual Quality Connectedness
5-6	Effective teaching strategies (part1 and 2)	Intellectual Quality Classroom Environment
7	Assessment and Evaluation	Intellectual Quality Recognition of Difference
8	Diversity and Difference in the classroom	Recognition of Difference
9	Productive Pedagogies observation	All dimensions
10	Observation of mathematics teaching	Connectedness
11	Micro-lesson	All dimensions

5.2.1 Teaching *about* Productive Pedagogies

Introducing the Productive Pedagogies to pre-service teachers involves introducing the entire framework in one lesson and then incorporating some elements of the framework into the following lessons. This section describes how the framework was introduced in detail as well as the official unit aims and content.

Topic I: Productive Pedagogies Introduction

In this lesson, the Productive Pedagogies framework was introduced and demonstrated to pre-service teachers for a first time. Each pre-service teacher was provided with a copy of the Arabic translation of the Productive

Pedagogies dimensions and examples. The lesson started by describing the four dimensions of the framework: Intellectual Quality, Connectedness, Supportive Classroom Environment and Recognition of Difference. Pre-service teachers worked in groups to study and discuss each dimension. After that, each group was given a printed lesson plan from a first-year mathematics textbook (see figure 5.1) and asked to study the lesson and design activities to implement the first dimension of the framework which is the Intellectual Quality. They needed to understand the mathematics lesson first, and then use their background knowledge to create practical activities to implement the Intellectual Quality elements. Working in groups allowed students to exchange their ideas and understandings as well as explore ideas using concrete examples from their own context. Zevenbergen, Dole and Wright (2004) stressed that, working in groups "enables higher achieving students to practice their control of language and lower achieving students to hear ideas being modelled in a language that is more likely to be in a genre that they can access" (p. 24). Allowing pre-service teachers to use their own language to discuss the elements with their teacher and peers helped to clarify initial misconceptions about the meaning of each element.   Working in groups to perform their task meant that the pre-service teachers produced different activities to implement the six elements of Intellectual Quality. Each group presented its work to the class for discussion and feedback. Feedback and comments on students' vocabulary and words that were used in the presentation was provided.
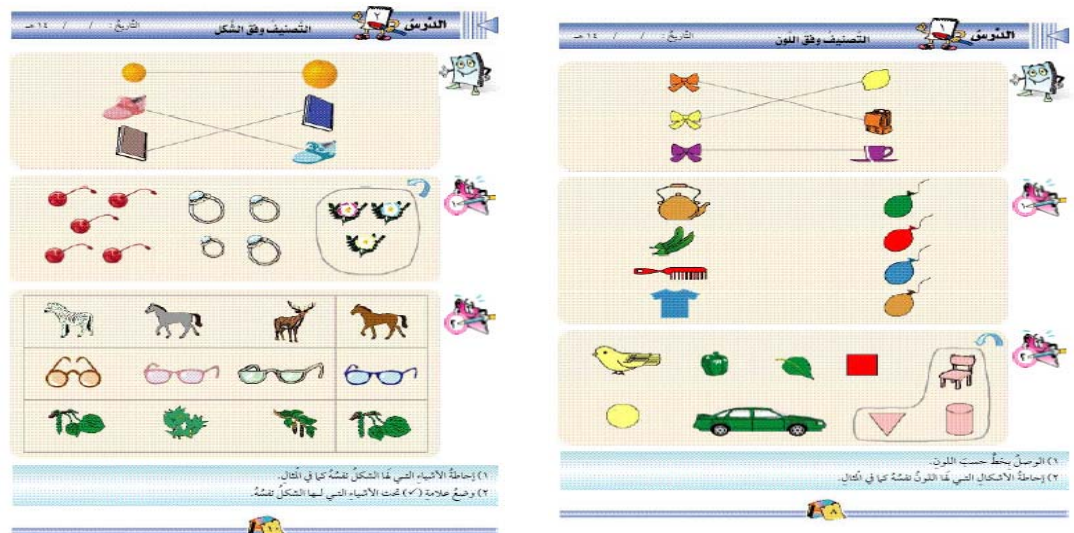
Figure 5.1. Year one lesson, Classification by colour and shape

In the second part of this lesson, the dimensions of Connectedness, Supportive Classroom Environment and Recognition of Difference were introduced. Pre-service teachers were provided with another printed lesson from a mathematics textbook and were asked to create useful activities to make a connections between the content of the lesson and the world beyond the classroom. They had gone through the same process as described in part one to perform their tasks. By the end of this lesson, pre-service teachers had become familiar with the concept of Productive Pedagogies and its dimensions.

Topic II: Teacher Competencies

The Teacher Competencies was the first topic in the unit content and its aim was to provide pre-service teachers with knowledge about teacher standards and competencies. As a result of studying this topic, pre-service teachers had a chance to enhance their understanding of teacher roles and increase their awareness of teacher's ethics. The lesson also described some common problems that teachers might face in the classroom. In this lesson, several elements of Intellectual Quality and Supportive Classroom

Environment were discussed in order to enrich pre-service teachers' understanding of teachers' ethics and principles of teaching and learning mathematics.

Topic *III*: Mathematics History

The purpose of this topic was to provide pre-service teachers with the opportunity to study the history of mathematics and to enrich their general knowledge about its development. They studied mathematical concepts that were being developed over time, and, in particular, the Muslims' and Arabs' contributions to mathematics. The content of this topic was integrated with the Recognition of Difference dimension to raise awareness of the importance of valuing differences in their practices. Discussing a number of elements from the Recognition of Difference dimension in teaching practice helped to address different issues related to the history of mathematics and build a strong environment where pre-service teachers value their culture and heritage.

Topic *IV*: Planning and Conducting Mathematics Lessons

This lesson demonstrated the principles of conducting a teaching plan for primary school classes. Pre-service teachers broadened their knowledge of lesson plan preparation by developing their understanding of designing and implementing their lessons. In this lesson, elements from the dimensions of Intellectual Quality and Connectedness were discussed to help enhance pre-service teachers' understanding of planning and conducting mathematics lessons.

Topic *V*: Effective Teaching Strategies (part 1 and 2)

These lessons aimed to support pre-service teachers in developing their knowledge and ability to use a variety of effective teaching strategies in their practices. Four teaching strategies – problem solving, cooperative learning, small group work and investigation strategy – were covered in two lessons. The pre-service teachers recognised the importance of these strategies in teaching mathematics and learned to use them productively. The advantages and disadvantages of these strategies also were explored. In these lessons

some elements from the Intellectual Quality and Supportive Classroom Environment dimensions were discussed.

Topic *VI*: Assessment and Evaluation

This lesson discussed the issues behind evaluation and assessment. Pre-service teachers developed their knowledge and skills in designing different types of assessments. They learned the types of assessment that have been used to evaluate primary school students. Some elements from Intellectual Quality and Recognition of Difference were discussed.

Topic *VII*: Diversity and Difference in the Classroom

The lesson explored the issues pertaining to working with and valuing differences in the classroom. The pre-service teachers have explored two positions on this topic: the view that each student should be treated the same (equality) and the view that each student needs to be treated differently (equity). With an equality view, teachers might teach students the same curriculum and give them the same assessments while, with in an equity view, teachers might change his or her teaching practices in order to support disadvantaged students in the classroom. Some elements of the Recognition of Difference dimension were discussed in this lesson.

These teachers were assigned classroom scenarios in which students need to be treated differently. They worked in groups to discuss each case in order to analyse and share their perspectives of the stories. They proposed solutions to each problem, and then shared their findings with the class. Different stories from different teachers were the centre of the classroom discussion. The pre-service teachers were encouraged to share their experiences of when they were school students and how their teachers worked with the differences in the classroom.

Topic *VIII*: Productive Pedagogies (Evaluation)

In Week 10, the pre-service teachers watched videos of teachers in authentic classroom situations and then reviewed the situations. Pre-service teachers viewed videotapes from three mathematics classrooms and used the 5-point

scale from the QSRLS code manual to develop an awareness of the Productive Pedagogies framework. In this lesson, students used a form to comment on the video. The form contained several questions related to the content of the videotaped short segment and the 5-point scale. I commenced by playing the first segment of the video while all students watched. As they watched, I reminded them to focus on particular situations. After the viewing, I asked them to work in groups to discuss their observation notes and explain their points in light of the QSRLS code manual. As the pre-service teachers rated the lesson differently, I joined groups together to review and clarify complex points. Pre-service teachers then viewed the second and third segments and reviewed their comments. This strategy helped students to be aware of how teachers' practice supported or hindered the elements of the framework. Hill (2002) wrote that viewing videos of a teacher in authentic classroom situations and reviewing the situations would dramatically assist pre-service teachers in mastering the Productive Pedagogies framework.

Topic *VIIII*: Observation of Mathematics Teaching

This lesson helped the pre-service teachers to identify high-quality mathematics pedagogies. In the week before this lesson, pre-service teachers were asked to visit and observe mathematics teachers in real classroom situations. They used the QSRLS code manual to guide their observation. In the lesson, pre-service teachers described and discussed their observations as well as viewed and reflected on videos of teachers in authentic mathematics classrooms. The lesson addressed some elements of Connectedness from the Productive Pedagogies framework.

Topic *X*: Micro-Lesson

This topic aimed to provide pre-service teachers with an opportunity to prepare and implement a short lesson to their peers. It involved them receiving feedback from the teacher and their peers about their teaching, as well as reflecting on this feedback to improve their teaching skills.

The instruction required pre-service teachers to research a topic from the mathematics textbook, understand the aims, objectives and the materials of

the topic. They were then required to teach the lesson in front of the class, using the Productive Pedagogies framework. Pre-service teachers were encouraged to create micro-lessons that involved as many elements of the framework as they could. In the lesson, each pre-service teacher developed and presented a 15-minute micro-lesson to the class, while his colleagues used the QSRLS code manual to highlight the elements which had been presented in the micro-lessons. At the end of each session, they worked in groups to discuss their reviews.

The process of preparing a micro-lesson and reflecting on the teaching allowed pre-service teachers to engage in higher order thinking and actual teaching experience. They showed their abilities to recognise the aims of the lesson that been selected to be presented. They demonstrated a good understanding of the need to choose different teaching strategies to conduct their lesson. They illustrated their ability to highlight some elements of the framework to conduct their lesson effectively. This helped them to make a connection between theory and practice.

5.2.2 Teaching through the Productive Pedagogies

The teaching process in this course is focused on Productive Pedagogies as a main framework to develop the pedagogy in this unit. After describing the integration of the unit content and aims with the Productive Pedagogies dimensions, this section provides specific examples of how each dimension of the framework was implemented.

Shift from traditional teaching toward intellectual quality
To ensure that pre-services teachers perform work of high intellectual quality, I gave a presentation to help shift the teaching process from traditional teaching methods to a more student-centred approach by introducing a list of steps and a series of actions that the pre-service teachers can use to construct their own understanding. In most of the lessons, the teaching process involved presenting information, problem posing, constructing and reconstructing ideas, group discussion around the topic, class discussing

and self reflection. One example of this was demonstrated in the topic of "Effective Teaching Strategies". All elements of the Intellectual Quality Dimension were used to guide classroom instruction. The instruction took the form of a workshop on cooperative learning. The classroom instruction required the pre-service teachers to work in groups to study this teaching strategy and select a lesson from a mathematics textbook to write a lesson plan to apply it. They started to answer the following questions:

- Why is lesson planning important for the teacher?
- Why are cooperative learning strategies important for mathematics?
- What factors influence cooperative learning?
- Why do not many schools utilise cooperative learning?

Each group read an article about cooperative learning from different sources. They raised some issues regarding its implication. The floor was open to discuss these issues and link them with article's ideas. This discussion helped pre-service teachers to recognise the importance of planning and to become aware of the theory behind cooperative learning. They spent most of the time exchanging ideas and sharing their understanding of the topic. They read from a variety of sources about this approach and discussed the advantages, disadvantages and implementation of cooperative learning. Pre-service teachers then studied a lesson from a mathematics textbook and constructed a plan based on the teaching strategy that had been discussed. They identified different behaviour objectives of the lesson and performed their tasks in stages. Firstly, they divided the lesson's task into small subtasks and assigned each to one member of the group. For example, after identifying the lesson's aims each pre-service teacher selected an aim to analyse its background knowledge requirements or what was the best way to demonstrate it to the students. Secondly, pre-service teachers from different groups, who had similar subtasks, collaborated. Thirdly, they returned to their main groups to complete the task. In the final step, they presented their work.

These steps provided the pre-service teachers with the opportunity to practice the cooperative learning approach. Here we see that while pre-service teachers were preparing their lessons based on cooperative learning, they were involved in teaching practice based on the same approach. These teachers engaged in higher-order thinking by analysing and applying different teaching strategies in mathematics lessons. They developed a deep understanding by discovering relationships between central concepts and how to implement the cooperative learning strategy in the classroom. They engaged in sustained conversation about the cooperative learning approach and the discussion encouraged critical reasoning, such as applying ideas and raising questions. In these lessons, the content developed pre-service teachers' ability to make decisions about the quality of performance to determine which of these strategies are significant for their practice. At the end of the workshop, they presented their work to the class for discussion and feedback.

Another example of implementing Intellectual Quality elements was in the topic about "Teacher Competencies". The knowledge developed in this lesson was constructed as problematic. When the construction of knowledge is considered as being problematic, there are no right or wrong answers; it encourages debate and questions. It involves an understanding of knowledge not as a fixed body of information, but rather as being constructed (Education Queensland, 2001). Pre-service teachers were provided with a variety of articles about teacher competencies to enhance their knowledge around the topic. They were then asked to formulate several principles of learning and teaching mathematics and discussed them with their peers. The pre-service teachers considered a range of competencies and raised a variety of issues related to their implementation. They incorporated many areas of knowledge of teaching theories from previous units to develop teacher standards and competencies for mathematics teachers. Each group then presented their work and the reasons behind their choices. At the end of the discussion, the most important principles of teaching and learning mathematics were explored.

In this example, the classroom teaching strategy was focused on enhancing the interaction between the teacher and students and among students to help to understand the teacher's skills and ethical principles. It allowed pre-service teachers to engage in sustained conversations and discussions about important ideas of teacher's competencies and standards. These conversations focused on the importance of implementing particular standards in teachers' practice. This helped to develop and disseminate understanding of these principles

One of the most important competencies of the teacher is to become a guide of the learning process. Sometimes the students may show disengagement due to difficulties in learning. The teacher, as a guide for learning, should be able to identify these learning difficulties and suggest ways to cover them. By doing so, the students' engagement in the learning activities will improve. However, in some cases, they might face difficulties that pertain to teaching practices and students' learning. For instance, students may refuse to participate in class or to do class work. Providing pre-service teachers with opportunities to discuss some of these difficulties helped them to be aware of potential problems and understand classroom situations in more depth.

In order to achieve high academic performance, pre-service teachers were required to perform work of high Intellectual quality. For instance, in the topic on Planning and Conducting Mathematics Lessons, the instruction was aimed at assisting pre-service teachers to complete a major lesson plan selected from mathematics textbooks, for the purpose of providing them with a systematic process for developing their skills of planning and conducting a variety of mathematics lessons. They were provided with several plans that have been created by previous students. They worked in pairs to explore these plans and identify the important details of writing rich plans for mathematics lessons. Then, each group selected a lesson from a primary school textbook and started preparing their lesson. The pre-service teachers studied the lesson to recognise the content aims, objectives, specific learning outcomes and common misconceptions. They engaged in higher order thinking in order to integrate their lessons with elements of Productive

Pedagogies. They have been challenged to make explicit connections between their lessons and life beyond the classroom. After this analysis, they conducted their lesson plans and wrote descriptive explanations of their choices. They developed their understanding of school mathematics by analysing the textbook lesson and discussing it with their peers. The instruction stressed that pre-service teachers should discuss and exchange ideas with their peers in order to perform well in class activities. Finally, they presented their work to the class to get feedback from the teacher and their peers. Additionally, they submitted their plan for assessment. Consequently, pre-service teachers showed deep understanding of planning a mathematics lesson and were able to share their understanding and exchange their ideas with peers.

Linked to the World beyond the Classroom

Connectedness ensures that students engage with real, practical or hypothetical problems which connect to the world, without being restricted by subject boundaries, and which are linked to their prior knowledge (Education Queensland, 2001). The pedagogies used in this course allowed pre-service teachers to link between their background knowledge and experiences and the lesson content. The unit tasks and assessments were based on real situations when it is possible, to ensure that pre-service teachers engage with real problems. One example was in the Observation of Mathematics Teaching topic. The lesson focused on pre-service teachers' experience and background knowledge. They viewed a video of a mathematics classroom teacher and then worked in groups to discuss their observation notes. They relied on their past experience in analysing and commenting on the video. They determined different issues that they found important to address in mathematics classes and identified effective practices of teaching mathematics for primary schools. After that, they used the QSRLS code manual to determine which of the productive pedagogies elements were present or absent in this lesson. The pre-service teachers then viewed the second and third segment and reviewed their comments.

The connectedness in this lesson was increased by asking the pre-service teachers to visit and observe mathematics classes at schools. They observed several mathematics teachers and used the QSRLS code manual to direct their observation notes. They also asked to have a discussion with the school's principal and mathematics teachers about other factors affecting the teaching of mathematics. Subsequently and for the next lesson the pre-service teachers worked in groups to discuss and present their observation notes. They compared their notes with their previous observations of the videos of mathematics classrooms. They identified how theories of learning and the Productive Pedagogies framework could be implemented in real classroom situations. These procedures allowed them to connect with the schools and with mathematics teachers.

When pre-service teachers learned about the Productive Pedagogies framework in class, they considered the construct in theoretical terms. However, when they observed real classrooms and mathematics teachers, they saw how the theory is applied. Not only did the observations lead to better understanding, it also increased their awareness of the school system. After pre-service teachers graduate from this program they will become teachers. Visiting schools and talking to teachers and administrators might help them to understand school systems. These pre-service teachers valued observing and reviewing authentic classroom situations. It assisted them in using the Productive Pedagogies framework as exemplified by one pre-service teacher's statement:

> *This opportunity* {visiting schools} *gave me a better understanding of what a career in education is really about, it allowed me to hear from the school's principal and teachers about different concerns. I have learned many things that were hidden from me before, especially in the way of using different learning strategies at the classroom. (PT4, Classroom observation reflection)*

One more example of this was in the topic of Assessment and Evaluation. Pre-service teachers worked in groups to expand their knowledge about formative, summative, diagnostic and continuous assessment. Each group read an article related to different issues of assessments. They discussed the advantages and disadvantages of different types of assessment. They discussed in groups the purpose of assessment and considered the various assessment tools which can be used. Further, they considered how to plan assessments. They then selected units from primary textbooks and developed a meaningful and sustainable assessment plan. After that, by using tables and charts, they reported their results to the class for discussion and feedback. Utilising mathematics textbook to perform tasks provided pre-service teachers with opportunities to link and apply the obtained knowledge in to the world beyond the classroom in order to make sense of their future practices.

The course was built to provide pre-service teachers with essential tools and experiences to develop their skills to become good teachers. It was designed in such a way to addressed different skills in each lesson. Table 5.1 shows how the topics of this unit were built in to provide pre-service teachers with skills related to planning lessons, teaching strategies, building assessments and evaluating students, culminating in the execution of a micro-lesson. Each lesson focused on the development of a skill needed for mastering these issues and opening the space for pre-service teachers to build extensive discussion about the skills they need. In sequence, pre-service teachers have used all these skills to conduct their micro-lessons. This strategy seemed to increase the level of problem-based curriculum in the unit content.

In addition, during the classroom activities, pre-service teachers mainly worked from mathematics textbooks that they will use in their teaching. As mention earlier, pre-service teachers used mathematics textbooks to perform most of the classroom tasks. This helped to develop their skills of teaching this content in the future. It has value and meaning beyond the classroom context. The pre-service teachers studied and worked on a topic that

connected to their careers and personal experience, as they could use these textbook lessons in their teaching practices. They explored and developed their skills of planning and conducting mathematics lessons. These actions seemed to increase the connectedness in this class to competencies for future work.

Built a supportive classroom environment

A supportive classroom environment ensures that students engage in their own activities, control their behaviour and understand what is expected of them (Education Queensland, 2001). Focusing on Supportive Classroom Environment elements in the classroom pedagogies seemed to facilitate learning. To increase the level of *student direction* during the semester, pre-service teachers were given the opportunity to select their ways of performing their tasks individually or working in small groups. They learned that working individually would help them to be more independent while working in groups would help them to raise questions and share understanding. They also have been given the opportunity to choose which mathematics lessons from primary textbooks would be used to perform their tasks. In addition, pre-service teachers were involved in discussing both the content and assessment of the course. For example, at the beginning of the course, pre-service teachers worked in pairs to answer these questions:

- What do I want to learn from this course?
- What knowledge and skills would I need to achieve my goals?
- What kind of topics do I need to help me in my Field Experience?
- How do I like my work to be evaluated during the course time?

Pre-service teachers discussed their own preferences on areas that needed attention during the semester. For instance, they wanted to add topics on time management and students' discipline. Adding topics that related to student needs might improve their learning and their enjoyment of the class. These issues have been integrated with the unit topics.

Regarding the units' assessments, a shift has occurred from the traditional 100% pen and paper based examination to 40% for the pen and paper examination and 60% for practical assessments. Pre-service teachers, at the first meeting, had the opportunity to discuss the assessments of the course. At the end of the discussion, they agreed about how their final grades would be calculated. The practical part of the course would account for 60% of the final grade, based on a weekly reflective journal (10%), participation in group discussions and class attendance (15%), reading articles and giving individual explanations (10%), observing a classroom (10%), and a micro-lesson (15%). The theoretical component of the assessment would comprise 40% of the final grade. For this, students must pass a written exam. Reviewing pre-service teachers' answers led the teacher to seek permission to change the way of assessing students from the Head of the Curriculum and Instruction Department. The Head of Department agreed that the final exam would account for only 40% of the final grade. This change allowed pre-service teachers to be more responsible for their choices and produce work that reflected their passions and enthusiasm.

The lessons' tasks and activities were based on the lessons from the mathematics textbooks that pre-service teachers will use in their teaching in the future. This helped to enhance pre-service teachers' engagement in the lesson. Pre-service teachers showed their enthusiasm and passion to perform their tasks which they expressed during their interviews and in their reflective journals (this will be discussed in more detail in the next chapter).

In addition, most of the activities during the semester stressed group work and discussion. Sharing ideas and thoughts among pre-service teachers was important in order to inspire them to keep talking about class matters and achieve the unit's goals. This helped them to understand the main concepts and see the relationships among them. However, encouraging pre-service teachers to work in groups was not an easy task. This was because a few members of the group sometimes tried to dominate the discussion. In this case I joined the group and explained how the dialogue should be allowed to move smoothly. Equal opportunity for students to talk and discuss their

understandings is one of the first priorities of this course. Since the unit content contained views that could be debated, it was important to build *an atmosphere of mutual respect* in the class in order to encourage all students to participate in class activities. The interaction among students and between the teacher and students encouraged students to make distinctions, exchange ideas and build on their understanding of the subject matter. Students felt less pressure when their opinions and views were respected. They valued their peers' views and opinions during the discussion and showed mutual respect for each other.

Explicit quality performance criterion was another element of Supportive Classroom Environment that seemed to facilitate learning. Two methods were used to achieve this element. First, in each class, I provided pre-service teachers with lists of learning outcomes that they were expected to achieve. Second, with each task or assessment, I developed a rubric to help pre-service teachers to know what they are going to do or achieve. All the tasks were associated with clear and *explicit criteria and established standards* to guide pre-service teachers to complete their task. Pre-service teachers' achievements were based on explicit assessment criteria that are constructed on their knowledge, processing and self-reflection. Fixed points along with the criteria to represent qualitative differences in performance were made to facilitate knowledge of the subject. This helped them to evaluate the quality of their work. These actions in turn seemed to help pre-service teachers to demonstrate better understanding of the concepts been taught. Pre-service teachers' comments on this are in the next chapter.

Valued the difference

Recognition of difference ensures that students know about and value other cultures, create positive relationships, and create a sense of community (Education Queensland, 2001). The pedagogies used in this course involved different elements of the Recognition of Deference dimension in order to understand and value the diversity of pre-service teachers' beliefs, practices and ways of knowing. For example, in the lesson on Mathematics History, the aim was to shed light on various cultural groups' contributions to

mathematics. Pre-service teachers learned how the Arabs developed the contemporary numeration system. The classroom discussion was focused on analysing stories about great Arab mathematicians in order to increase Cultural and Group identity. Stories about various Arab mathematicians including Alkhwarizmi with algebra and Alkashi with decimal fractions were presented. The Arab' identity was given positive recognition in classroom practices to motivate pre-service teachers about their culture and heritage. They were also taught about the contributions from Greeks and Europeans, who developed other aspects of mathematics.

The pre-service teachers were encouraged to represent their experience of learning mathematical concepts in narrative styles. They started telling stories in how they learn mathematics in their schools. They gave examples of great mathematicians from their culture and region. Telling stories encouraged all students to participate in classroom activities. They shared what they had learned with their peers and recognised different aspects of teaching mathematics. The discussion questions engaged pre-service teachers in discussions in order to integrate the contributions of women and various ethnic groups in mathematics, in order to integrate the contribution to mathematics by women, as many of the primary school textbooks in the country have been written or edited by female mathematicians, as well as the contributions of various ethnic groups.

Part of the mathematics history content was a discussion about mathematics in the 21st century and the impact of technology on teaching and learning. The pre-service teachers were from urban and rural areas of the country and came with different experiences in their learning of mathematics from their own school days. In urban schools, students learned mathematics with some computer applications such as mathematics software and computer games, while students who attended rural schools did not have this experience. Since the content contained the views of different groups, it was important to create an inclusive environment to encourage all groups to contribute to the class activities. The discussion in the classroom encouraged them to share

their experience and raise questions about some computer applications that helped or limited their understanding of the concepts being taught.

The group of pre-service teachers were all male as, as, in Saudi Arabia, the education system segregates genders at all levels. While gender difference, therefore, was not an issue in this study, there were some other areas of difference to be considered. All pre-service teachers were local residents, however some came from urban areas and others from rural areas. Working with technology during this course was a major challenge for some pre-service teachers, particularly those from rural areas who were less confident using computers and searching the internet. Those from rural areas had difficulties search for books or articles related to their class tasks. This difficulty was due to their lack of computer skills and their limited access to the internet, as the college does not provide internet access for the students in its building. To deal with these issues, I first asked pre-service teachers who had poor computer skills to work in pairs with a pre-service teacher with better developed skills when working in the College computer lab in order to develop the weaker pre-service teachers' skills. To avoid the late submission of assignments, I asked them to submit their assessments and reflective journals written by hand. Second, I asked those who did not have internet access to work as pairs with other who did. Another issue that I faced related to pre-service teachers' differences was that some of them were married with children and others were unmarried. This was considered during the assessment and reflection due dates, as some asked for extensions.

In summary, this section presented details about how Productive Pedagogies was incorporated into the unit content and teaching process of the course. The section commenced with descriptions of the integration of the unit content with elements of Productive Pedagogies and identified the two main procedures that helped to attain this integration. This was followed by details of teaching about and teaching through the framework during phase one of this study and providing examples of using the four dimensions of the framework to facilitate learning in the unit.

5.2 Reflections

Reflections on what was happening in my class was one of the main goals of this study. Within this study, working as a researcher and as a teacher at the same time gave me the opportunity to reflect on all aspects of my teaching instruction as well as the interaction between pre-service teachers and me, as their teacher, or simply among the pre-service teachers themselves. In this section, reflection on the teaching and learning processes were illustrated and some of the hindrances in the use of Productive Pedagogies were identified.

5.2.1 Reflection on the teaching and learning process

The Productive Pedagogies dimensions assisted me to organise my teaching practices. When I prepared the plan for my lesson, I usually referred to the four dimensions of the framework to make sure that I had used different strategies to highlight these elements. In this manner, I developed my teaching skills in order to improve the quality of the course.

I faced several challenges in implementing the framework elements in my lessons. At the beginning of the semester, I found the framework to be challenging, especially when I started to change my pedagogy in teaching this course, which was based on presenting information in a more student-centered approach. This is because the traditional way in which the unit was taught and understood as an educational unit focused on providing steps and techniques to teach mathematics. I worked hard to plan for each lesson and provided pre-service teachers with tasks that helped them to develop their skills of teaching mathematics. I also distributed a variety of reading materials in each lesson to help pre-service teachers expand their knowledge on the concept being taught.

Another challenge that I faced was to find a connection between the lesson and the world beyond the classroom in each class. I tried to focus on the primary level mathematics textbooks to increase the level of connection in

the lesson, as pre-service teachers will use these textbooks in their field experience. I learnt that building the lesson tasks on the mathematics textbook gave pre-service teachers the opportunity to implement their teaching skills effectively.

I faced the difficult challenge of giving an example from mathematics to each element of the Productive Pedagogies framework. In the original guide of the Productive Pedagogies classroom reflection manual booklet, there is only one clear example from mathematics and that was to demonstrate the higher order thinking element. However, Pre-service teachers need more examples of mathematics to develop a clear understanding of the framework and to improve their skills of using Productive Pedagogies elements in their teaching practices. Consequently, before the semester began, I developed several examples from mathematics textbooks to demonstrate different elements of the framework. It was challenged to develop mathematics examples to demonstrate some elements in the Recognition of Difference dimension.

In the first week, and after I introduced the course outline and discussed the possible assessments of the unit with pre-service teachers, I noticed that they were pleased to be involved in the determination of the unit assessments and felt comfortable with the process. They all got involved in this discussion and raised a number of questions about the assessments' content and marks. They participated in changing the way I assessed them during the semester. They also asked to add some content that they thought was important to their teaching practices in the future. Subsequently, pre-service teachers through the semester were involved in selecting some of their tasks as well as the way they preferred to complete them. They reported that this process was new to them and they benefitted from it.

In the second week of the course, and after the Productive Pedagogies framework was illustrated, I noticed that pre-service teachers during the class discussion hesitated to express their ideas and views. They were worried that their understanding of the framework was incorrect or mistaken.

For instance, when asked to reflect on the framework, they just considered the positive side of the dimensions. Consequently, I asked them to work in groups of five to discuss each dimension of the Productive Pedagogies framework. I observed that the pre-service teachers started talking and expressing their opinions more comfortably. They shared their knowledge and corrected each other's understanding. I joined each group to encourage all pre-service teachers to be involved in the discussion. When they valued their peers' views and opinions, they raised more questions and asked their peers for explanations. This later became one of the characteristics of my classroom, especially with the topics that required discussion to understand the content. Not only did small group work help the pre-service teachers express their views within the group, it increased their ability to communicate with each other productively.

In week ten, I observed that the pre-service teachers were eager to watch videos of teachers in authentic classroom situations. During the lesson, they worked in pairs to observe the videotaped short segment and write their notes. They were concerned about every step that the mathematics teacher took in his class. They asked me to repeat different parts of the videotape that they considered important to have a better chance to review it. They raised several questions about how they could use the QSRLS code manual to identify which elements of Productive Pedagogies were present or absent in the lesson. In addition, I noticed that the pre-service teachers were excited to visit schools and observe mathematics teachers. They were keen to take advantage of this opportunity by asking teachers and principals in schools about every aspect of teaching mathematics in primary schools. When they came back to the class after visiting the schools, they spent most of the lesson time discussing their experience with their peers and reflecting their observations. They raised different questions related to selecting the best schools for their practice and employment opportunities after their graduation.

In the last weeks of the semester and during the microteaching lessons, I found that most of the pre-service teachers had developed skills to enable

them to draw many clear mathematics lesson plans and they were able to utilise a number of strategies that helped them to integrate the content with the framework elements. They improved their understanding of Productive Pedagogies and started using the language of the framework to reflect on their practice as well as their peers' practices. They observed each other during the microteaching lessons and then received feedback from their teacher and peers. However, I observed that during microteaching, they found it difficult to implement the *Supportive Classroom Environment* and the *Recognition of Difference* dimensions. That was because the college setting is different from a classroom situation. The lesson time is only 15 minutes and the audience is their peers.

I noticed that when I provided pre-service teachers with tasks that required higher order thinking, they would take a long time to complete them. They kept asking about every step of the tasks, even when they were provided with the explicit performance criteria. To counter this, I tried to provide the pre-service teachers with reading materials before each class to extend their knowledge about the concept being developed in the lesson. However, they felt that the course required more effort than they expected. They claimed to have difficulties in the balance of this unit compared to other units in the semester. In addition, they reported that the reflective journals at the end of each lesson were hard to complete. They therefore completed them at home and returned them at the next lesson.

As the semester came to end, I found that, generally, most pre-service teachers had improved their skills and knowledge of the Productive Pedagogies framework. They were able to integrate mathematics lesson content with elements of the framework. They were able to conduct a mathematics lesson and reflect on their practice. They developed their skills of observing mathematics teachers and pointed out the factors that affected teaching practices. The pre-service teachers developed their communication skills and improved their debate skills, due to their ability to work with other peers in small groups and express their opinions freely.

5.2.2 Difficulties encountered in the implementation of the Productive Pedagogies

During the first phase of this study, two hindrances were identified which limited my ability to introduce the framework to pre-service teachers effectively.

First, a practical difficulty related to the amount of time spent introducing the framework to pre-service teachers. As mention earlier, the course contact time is two hours each week for 14 weeks in order to demonstrate the unit content, introduce Productive Pedagogies and allow pre-service teachers to perform a micro-lesson which is usually done in the last three lessons. This was not seen as making the best of the short time available to develop pre-service teachers' understanding of the framework. To get a better understanding of the framework, the time that pre-service teachers engage with productive pedagogies is important. They need to spend more time in discussion with their teacher and colleagues about the framework, while the content of the official unit is important also. Pre-service teachers were required to learn the main content of the unit. Therefore, there seemed to be obstacle to applying themselves fully to trying to understand the framework in just one unit. Gore, Griffiths and Ladwig (2001) stressed that Productive Pedagogies need to occur from the very start of teacher education programs in order to immerse the students within the framework. Zyngier (2005) suggested that pre-service teachers need to explore the metalanguage of the framework from an early stage.

Second, I encountered difficulty related to the implementation of each element of the Productive Pedagogies at high levels. The classroom observation manual of Productive Pedagogies contains 20 elements. The coding manual contains each element of the four dimensions, together with a score derived from a five point Likert scale indicating the level of manifestation of the element in the lesson. I found that reaching a high level in each element is highly demanding. For example, in the *students' direction* element, the lesson will rate as 4 if some deliberation/negotiation between teacher and students occurred during the period of the activity, including the

range of options and procedures. However, the lesson will rate as 5 if students determine some of their activity, its appropriateness and if the context is noted. This may be either independent of, or dependent on, teacher regulation (Education Queensland, 2001). Here we can see how the high expectation of students' direction should be. This, in practice, seemed to be difficult if we kept in mind that there is content that needed to be delivered. Also, the students' capability to make appropriate choices of content or activities that they want to learn is not adequate. If we take this example and apply it to all the 20 elements, we will see how much effort is needed to implement these elements at high levels when judged against the description of these elements in the classroom observation manual. Hayes, Lingard and Mills (2000) mention that "it should be noted that, while these dimensions are readily defended on ideal grounds, there is no research basis for believing that schools systems (anywhere) have been overly successful in consistently providing high levels of them to large portions of student populations" (p11). Hayes, Mills, Christie and Lingard (2006) agree that if all 20 elements had to be presented in the classroom all the time, the framework might be too demanding of students and teachers.

5.3 Teacher Educators views about the Alignment of Teaching Process with Productive Pedagogies

The two teacher educators, my colleagues, made three observations concerning the alignment of my teaching process and espoused framework. Firstly, they identified that the framework implied a wide variety of teaching approaches. Secondly, the teachers' trainers made comments regarding my teaching process in the unit. Finally, the teacher trainers commented that while the framework would provide pre-service teachers' with a highly useful guidance for the purposes of developing their teaching skills, some limitations remained.

5.3.1 Productive Pedagogies framework has distinguishable characteristics

The teacher educators regarded Productive Pedagogies framework as different from other models of teaching because it contains a very comprehensive list of desirable teaching principles. One colleague asserted

> *The Productive Pedagogies framework is new in terms of its categorization and dimensions' names. It is organized, comprehensive and contains all the aspects of teaching in classroom… I see the framework is strong in terms of the scope of its elements. (TT1, Interview)*

The Productive Pedagogies framework was seen as having a particularly powerful link between each of its dimensions and elements.

> *There is a clear link between the indicators and standards in this framework; it seems that each element is connected with its dimension. It is evident that much planning would have gone into this process. (TT2, Interview)*

Both colleagues identified a number of elements that make Productive Pedagogies an effective teaching model to use in the classroom. One teacher trainer found that the Connectedness dimension in the framework was important because many mathematics teachers fail to link the subject with their students' lives.

> *Connectedness in this framework is one of the main standards that the National Council of Teachers of Mathematics has provided as a vision for mathematics education in the future. It emphasizes the importance of the link between mathematics and the outside world. Students should see the link between the school and their life, the theory and its application, information and their experience. In my view, while many teachers in schools pay no attention*

> *to it, this element is one of the most important elements of teaching practices. (TT1, Interview)*

Intellectual Quality dimension was also seen as an effective dimension for teaching in terms of its clear elements. One colleague recalled

> *The influence of intellectual quality dimension is that it can help students to increase their spirit of discovery to become a producer of knowledge, not just received knowledge. All elements of this dimension clearly contributed to raise the level of intellectual ability of the student and that make it useful for the teaching. (TT2, Interview)*

A number of elements in the Supportive Classroom Environment dimension were mentioned as teaching strategies to help to increase student achievement. For instance, teachers should be aware of explicit criteria and provide students with specific statements and details about the learning task and expectations.

> *An explicit quality performance criterion is important for both teachers and students. This direction is vital for the teachers to help them to diagnose students' strengths and weakness, and moreover, for the students to know what is required,(in my experience) many students are eager to know the teacher's exact expectations regarding the learning problem. This helps them to reflect on their process to check the quality of their work. (TT1, Interview)*

Social support was also seen as a key engaging principle. Participation in classroom activities is greatly increased when students feel supported. An atmosphere of mutual respect and politeness between teachers and students was said to be vital.

> *Social support gives students psychological safety in the*
> *classroom. With this, students show their creative energies.*
> *Social support also helps students participate in all classroom*
> *activities without fear or hesitation… I apply this element in my*
> *teaching to the primary students to help students enjoy the*
> *class and increase their level of curiosity and tendency to ask*
> *different questions and clarify content. (TT1, Interview)*

5.3.2 Productive Pedagogies observed in the teaching process

Regarding how the two teacher educators see the alignment of my teaching process with the Productive Pedagogies framework, and after they checked my teaching plans, both colleagues agreed that, achieving high levels of incorporation, demanded a diligent attempt from the instructor.

> *I think in many of your lessons, the four dimensions' skills*
> *were obvious. I found that you made good attempts to align*
> *the teaching process with the framework. I think this helped*
> *the pre-service teachers to produce the knowledge not just*
> *transfer it. I expect that pre-service teachers' recollection of*
> *the content would be much stronger because of it. (TT2,*
> *Interview)*

Meticulous preparation was required. During the planning of the lessons, I wrote each classroom activity next to the framework elements in parallel. These were seen as a reflection of the elements that been applied.

> *Students' activities in your classroom were clearly linked with*
> *the elements of the framework. I guess there is no need for*
> *further explanation. (TT1, Interview)*

The colleagues felt that more elements were needed. In some lessons, the teacher trainers suggested that utilizing more elements into a single lesson would better demonstrate the advantages of the

framework through a better alignment of the teaching process with the theory.

> *In my opinion, the strengths of the framework would have been better shown if it was applied more liberally instead the result in some cases seemed to be similar to traditional teaching. (TT1, Interview)*

5.3.3 Productive Pedagogies framework is useful for pre-service teachers, but is highly involved

Both interviews suggested that the framework was an essential tool for pre-service teachers to develop their skills of teaching and learning in the unit. The elements of the Productive Pedagogies would assist pre-service teacher to focus on different parts of the classroom.

> *Training pre-service teachers on these four dimensions no doubt will help them to develop their skills of teaching in order to improve our educational outcomes. (TT1, Interview)*

Not only did the Productive Pedagogies framework in teacher education assist pre-service teachers, but it also motivated them to implement various strategies in their teaching.

> *If pre-service teachers have been trained on these dimensions, they will find something that drives them forward, and a new model that not used before in their preparation program in the College. This makes them eager to apply it in their field experience. (TT2, Interview)*

However, one of challenges to conducting classes using the approach is that participants need to first comprehend the Productive Pedagogies framework. Pre-service teachers need a clear understanding of the framework elements in order to create different activities in mathematics classes that help sustain a focus on Productive Pedagogies strategies. These need different examples

from mathematics to demonstrate the application of the framework. Having only one publication (booklet) that contains a few examples from mathematics, teacher trainers felt it would be difficult for students to understand the framework in high level.

> *Pre-service teachers need to be provided with more examples from mathematics to help them to understand the framework better. (TT2, Interview)*

Another colleague stressed that

> *Pre-service teachers need a deep understanding of this framework to produce a great work in their practices. It is clearly difficulty to give examples from mathematics for each of Productive Pedagogies elements. (TT1, Interview)*

Pre-service teachers also need to be able to apply these elements to their lesson plans and then use them effectively. As pre-service teachers are inexperienced, they may struggle to use the framework as intended by its designers.

> *One of the main factors that might affect the implementation of this framework is convincing the teachers that this is a useful approach. Not only do the pre-service teachers need to be convinced, the teacher trainers must be encouraged to use the framework. If Productive Pedagogies is a better system (than their usual teaching), how we can convince teachers about the importance and usefulness of the framework? From my experience, teachers want to stay away from any new approaches that will require additional effort to learn and use. (TT1, Interview)*

My colleagues considered that, in our education system, there is no financial incentive to reward good teaching performance. A high performance

teachers' and a low performance teachers' earnings are commensurate only with their teaching experience. Therefore, my colleagues wondered if teachers might avoid implementing it in their teaching practices because the framework requires more effort. Teachers need to be fully convinced about the usefulness of the framework. While the above claim points out that the framework would be difficult to implement, an alternative point of view was that the approach would be successful once stakeholders had the opportunity to see the framework in action.

> *It will be difficult to integrate this approach into what the pre-service teachers currently perceive as good teaching, however, through time and practice they might see the value of using it in their practices. (TT2, Interview)*

Another challenge was that extensive teacher effort was required to implement the framework. According to my peers, introducing any new innovation into teaching practice requires a substantial effort. One aspect that was discussed was that pre-service teachers would need more time for lesson preparation in their field work. My colleagues stated that learners of this framework might need an extended period of time to meet the framework elements. This demand represents an obstacle to implementation.

> *To apply this framework with sophistication, time and effort to prepare the lessons to ensure that the practices meet the elements' goals is needed. (TT1, Interview)*

One aim of this study was to examine the likelihood of effective Productive Pedagogies framework implementation into the Saudi environment. The data from the two peer interviews and research's reflection suggest that the Productive Pedagogies framework needs to be customized in order to gain the best results in the Saudi setting.

> *Productive pedagogies is a comprehensive model, but there are some elements in some of the dimensions of the*

> *framework, in my view, that need to be deleted because they*
> *might not be related to the teaching quality [as defined here].*
> *I mean that these elements are difficult to apply in our society*
> *and we need a model that fits properly with the Saudi*
> *environment. (TT1, Interview)*

Another colleague asserted that:

> *The framework needs to be examined in an Arabic*
> *environment and I am very interested to know the results of*
> *such an examination. (TT2, Interview)*

The framework elements that need to be customized in order to fit in the Saudi setting were described in detail as follows: Regarding the Connectedness dimension, there is one issue related to *problem-based curriculum* element. In Saudi schools, each student is provided with free printed textbooks for all subjects. The textbooks contain the prescribed lesson content and specific exercises students should learn. There are very limited real-life problems in the textbooks which the students need to solve. In other words, many of the problems are missing practical contexts. The mathematics textbook in schools did not support the problem-based curriculum. My view aligns with my colleagues viewpoints about the important of building our curriculum on real world problems and experience. One colleague asserted:

> *Our current curriculum is based on quantity more than*
> *quality, when I compared our curriculum and the U.S and*
> *Japanese curriculum, at each level, I found that we have*
> *more lessons in each stage. In Japan, they depend on the*
> *teaching method using problem-solving and the lesson may*
> *take a full session to study one real problem. I think our*
> *curriculum is different and not focused on problems. (TT1,*
> *Interview)*

Regarding the Supportive Classroom Environment dimension, there were two issues that came into view that need further explanation in order to be implemented in teachers' practices. First, Student Control will be new to the students and students might face a difficulty in selecting their preferred activities.

> *Are students capable enough to choose their own content*
> *or tasks? There are students at primary and middle schools*
> *and even many at high schools who, in my view, do not*
> *have the ability to make a right selection of tasks or*
> *activities that are good for them. (TT1, Interview)*

The second issue that was missing was the importance of the use educational materials in teaching practice. According to my colleagues there is a need to add one element such as "Educational Materials", that the teacher brings to the class to demonstrate the lesson., This dimension would ensure that, on one hand, students engage seriously in their study, and on the other hand, teachers develop different strategies and materials to help student to achieve their goals. Educational materials play a great role in students' achievement. The sentiment expressed by the teacher trainers, and observed in the classes, is that the choice of educational materials must be made to best support the students in their learning.

> *It is very important to add educational materials as an*
> *element of supportive classroom environment. Because this*
> *will enrich the educational process and increase student*
> *achievement as well as develop their creative thinking as*
> *many studies and research have supported that. (TT1,*
> *Interview)*

Regarding Recognition of Difference, they thought that identify one style of teaching may diminish variety. One colleague stressed that

Narrative is one style of teaching while there are individual differences between students. This element seems to be against its main dimension. It is better to replace this item with "variety of teaching styles" so that it can include narrative and different methods of teaching. (TT1, interview)

Not only was the "Narrative" element found to be not clear whether it is a part from the quality of teaching in mathematics, "Active citizenship" and "Group identity," were two other elements that were regarded as having little impact in the classroom. They fail to see how mathematics can be relevant to them.

In my experience, and during my observations of pre-service teachers' classes, there was no evidence that they display, Active citizenship and Group Identity in any level. (TT1, Interview)

In summary, this section presents the observations of two teacher trainers regarding the alignment of my teaching process and espoused framework. They identified that contained within the framework were numerous effective teaching strategies. The framework was seen as highly useful guidance for the purposes of developing pre-service teachers' teaching skills. However, it has some limitations that might limit its applications.
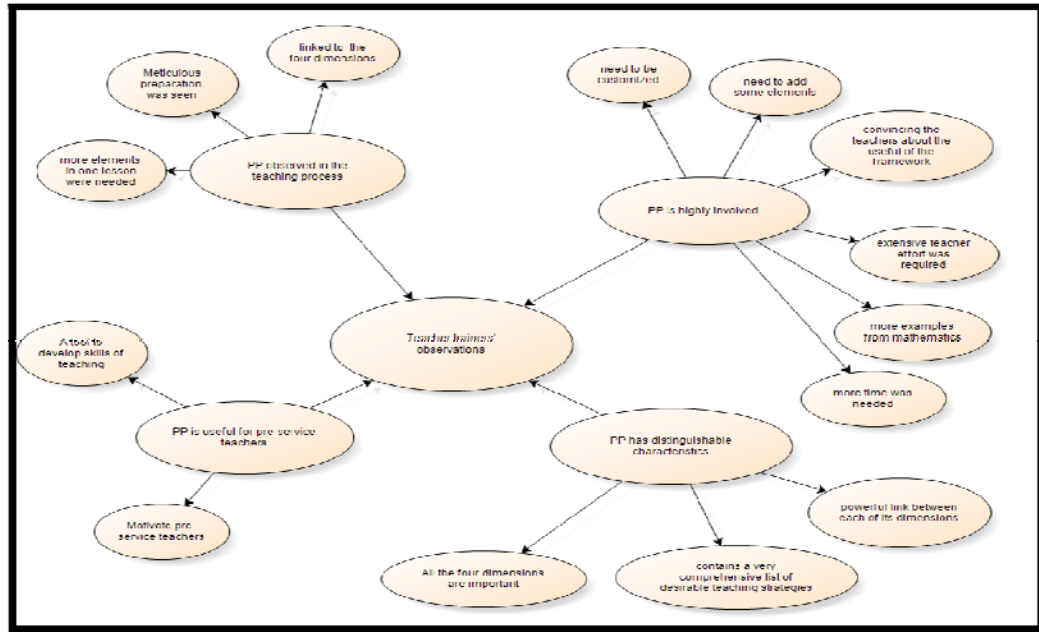
Figure 5.2. Summary of the teacher educators' observations

5.4 Summary

The results of the incorporation of Productive Pedagogies framework within the unit content of this study were presented in this chapter. In this chapter, the data arose from my weekly reflective journals, teaching process, pre-service teachers' work and from my two colleagues' interviews. Overall, there were attempts to integrate the Productive Pedagogies elements with the content of the official unit in mathematics education. Each topic was aligned with one or more of the dimensions of the framework based on the nature of the unit content. These alignments helped to demonstrate the content knowledge easily. The Productive Pedagogies framework was used as a guide to the teaching practices in this study. Most attempts to implement the framework elements in the teaching process were achieved. Different teaching strategies were used to facilitate integrated approach to the content. On the other hand, the teacher trainers felt that the Productive Pedagogies framework needed to be customized and treated with caution in order to be effectively implemented into the mathematics classroom.

This chapter also revealed data relating to the reflections of my teaching practices. Overall, the pre-service teachers felt comfortable with the process of the teaching and evaluation methods in this course. However, the Productive Pedagogies framework has some limitations with its implications. The next chapter will continually present the findings of this study.

CHAPTER 6

ANALYSIS OF THE DATA: PHASE II

The incorporation of the unit content and teaching process with the Productive Pedagogies framework were analysed in the previous chapter. This chapter continues to provide the results of the data analysis. The purpose of this chapter is to investigate the pre-service teachers' engagements with the Productive Pedagogies framework and their ability to implement it in their teaching practices. The data originated from four sources. Firstly, data are provided from the researcher's and pre-service teachers' weekly introspective reflections. The second source of data is focus group interviews. Data were collected from four focus group interviews with pre-service teachers. The focus group interviews focused on pre-service teachers' perceptions of the framework and their views about the lecturers' teaching practices. The third type of data collected was during Phase II of this study. This data is in the form notes from 30 observations of six pre-service teachers. Finally, data presented from interviews with pre-service teachers about their experiences of implementing the Productive Pedagogies in their field experience.

The analysis is presented under four main headings. Section 6.1 presents data concerning the pre-service teacher reactions to the framework. Section 6.2 provides data critiquing the application of the Productive Pedagogies by the pre-service teachers in their teaching practice. Section 6.3 highlights pre-service teachers' improvement in implementing Productive Pedagogies over the observation periods. Section 6.4 summarises the main findings.

6.1 Pre-service teachers' reactions to Productive Pedagogies

The data collected from the pre-service teachers in Phases I and II of the study showed that there was widespread approval of the Productive Pedagogies framework. It was perceived as an effective framework for

teaching for three reasons. Firstly, the framework was found to be valuable as a guide for pre-service teachers' teaching. Secondly, through the approach, pre-service teachers perceived a shift closer towards student-centred teaching. Thirdly, the Productive Pedagogies framework was seen as facilitator of students' learning. In addition, two hindrances were identified by pre-service teachers which contributed to limiting their understanding of the framework.

6.1.1 Productive Pedagogies as a valuable framework

The pre-service teachers perceived the Productive Pedagogies as a valuable framework to assist their practice. The first point of view was that the framework could be used to guide teaching practice. The other point was that the Productive Pedagogies could be used in the lesson planning stages of teaching. The last point that pre-service teachers mentioned was that the framework aided personal organization.

Guide to teaching practice
Productive Pedagogies as a guide to teaching practice was a common reference made by the pre-service teachers. The majority of the pre-service teachers in interviews suggested that the Productive Pedagogies framework was highly helpful for good teaching practice. During their study at the teachers' college, the pre-service teachers experienced a range of courses addressing learning and teaching theories, curriculum and school environment. They had been exposed to different models for teaching and had explored teaching pedagogies as part of their studies. At this stage of their professional development, they had become very familiar with teaching strategies and students' needs. From this viewpoint, the pre-service teachers expressed very positive views about the potential of Productive Pedagogies as a valuable framework that provides a good foundation for learning about teaching by new teachers. One pre-service teacher commented:

> *I saw the productive pedagogies principles as a key basic*
> *model for teaching; it is a tool that can lead pre-service*

> *teachers to the right steps to become successful teachers in*
> *the future. (PT1, Phase I, focus group)*

This participant valued the potential of the framework as a tool that can be used to guide beginning teachers towards successful practices. Becoming a good teacher is a goal of beginning practitioners, and the Productive Pedagogies framework was seen as helpful in guiding them in developing strategies teachers may apply in specific lessons. One pre-service teacher put it this way:

> *Productive Pedagogies, as a teaching model, helps to guide a*
> *teacher to choose the appropriate methods in his practice.*
> *(PT2, Phase I, focus group)*

Another student, said:

> *The model helped me to identify a range of activities before*
> *each lesson which all lead to positive student performance.*
> *(Algadi, Phase II, focus group)*

The usefulness of the framework in the progression from lesson planning to implementation was expressed by other participants. This can be a challenge for beginning teachers but was seen to be strongly assisted by the Productive Pedagogies framework.

> *The Productive Pedagogies framework helped me to organize*
> *my ideas and identify my steps and objectives of the teaching*
> *more clearly. (PT4, Phase 2, Interview)*

More specifically, the pre-service teachers identified the comprehensiveness of the framework as particularly useful.

> *The four dimensions are complementary. Each point has*
> *important qualities that can benefit students' learning. I think*

> *the teachers must draw up their plans according to these*
> *teaching dimensions. (PT5, Phase II, Reflection)*

The four dimensions of the framework: Intellectual Quality, Connectedness, Supportive Classroom Environment, and Recognition of Difference, helped the pre-service teachers to focus on the all aspects of the classroom practice. Classroom activities were created with the goal of including these dimensions into their teaching practice. The framework was seen as useful in assisting them to appraise the classroom from four different angles, and then to prepare a plan for teaching which will best benefit their students.

> *As I always have the four dimensions in my mind in every*
> *lesson and try to apply some of the elements that facilitate*
> *teaching to achieve the lesson's objectives, (I find) this*
> *framework is the best way to improve my practice. (PT6,*
> *Phase II, Reflection)*

Guiding teaching practice was seen to be one of the main strengths of the framework. It helps pre-service teachers to make sense of the number of approaches which they have been exposed to. It improves the transition for plan to practice, and it enables teachers to view their classroom in new ways.

Useful in their planning for teaching

Pre-service teachers felt that the Intellectual Quality and Connectedness dimensions were useful in their planning for teaching. Regarding Intellectual Quality, they strongly believed that focusing on specific activities that encourage students to engage in higher order thinking helped students to understand the concept better. One student asserted:

> *Math teachers need to focus on intellectual quality to create*
> *activities that allow students to engage in higher order*
> *thinking, analysis, synthesis and explanation because these*
> *will help students to apply the knowledge in different ways*

and in different situations as well as help them to learn the correct ways of thinking. (PT4, Phase II, Reflection)

Other participants tried to use different methods of teaching associated with the Productive Pedagogies to ensure that students engage in higher order thinking. These students commented that:

I used problem-solving techniques to engage students in higher order thinking and allow them to solve problem on their own to arrive at a conclusion, in this way the information will be establish effectively in the mind of the students (PT3, Phase II, Reflection).

Substantive Conversation was another element of Intellectual Quality that pre-service teachers believed it is useful in their planning of teaching. One student asserted:

Substantive conversation and establishing a dialogue to discuss the mathematics concept is good and I am willing to apply it in my teaching (PT9, Phase I, focus group).

Later, when substantive conversation was implemented in mathematics lessons the pre-service teachers found that:

Paying more attention to teacher-student interaction than I usually would, allowed me to understand how the students think and analyse the knowledge. This allowed me to be able to correct the misconceptions (PT9, Phase II, focus group).

The Connectedness dimension was another dimension that pre-service teachers felt was useful in their planning for teaching. One student asserted:

> *Connectedness is the main dimension of this framework that I am looking forward to applying to my practice. (PT1, Phase I, focus group).*

They were able to identify two main reasons why attempts to make content connected to the real world of the student is appropriate. One pre-service teacher recalled

> *I remember in the past [in my own schooling days], when the teacher connected the lesson materials to our daily lives, I completely understood the concepts and wished to know more. I think this experience of the connectedness to the world encouraged me to apply this model. (PT8, Phase I, focus group)*

Not only did the Connectedness dimension lead into better understanding, it also increased the students' motivation to learn the content:

> *The link of mathematical concepts with something in the students' lives out of the school context would be good and interesting. (PT5, Phase II, focus group)*

Well- organized model for teaching

Personal organization improvement was one of the positives of the framework according to the pre-service teachers. Overwhelmingly, the pre-service teachers expressed very positive views about the potential of Productive Pedagogies as a model of teaching that provides clear and organize teaching strategies. One participant mentioned that:

> *In my view, Productive Pedagogies is a complete model of teaching and it has all the elements of good teaching. (PT7, Phase I, focus group)*

In similar fashion, another participant strongly linked between the well-organized model and his mathematics teaching practice:

> *Productive Pedagogies is a well-organized model and I found that the four dimensions of the framework complete each other and must be applied in math lessons in order to benefit all students. (PT6, Phase I, reflective journal)*

6.1.2 Change towards student-centred teaching

The principle of student centred teaching was not a new concept for these pre-service teachers. There is, however, an apparent gap in acknowledging this as a general principle and a teacher's personal understanding and implementation. According to this study, the Productive Pedagogies framework influenced the pre-service teachers by challenging their views about their assumed learning theories. The pre-service teachers indicated that their views of learning and teaching had changed after studying and implementing the productive pedagogies framework. They stressed that replacing traditional methods with more student-centred learning focuses had benefits. They commented that the framework could assist them achieve this shift. In relation to this, participating pre-service teachers noted how the framework is not only a good way to change traditional ways of teaching, but it is also a concrete list of characteristics of good pedagogy that they can compare their teaching with:

> *With Productive Pedagogies I believe that knowledge must be expressed in various ways. I see us moving away from the traditional teaching methods and we are trying to introduce new student-centred interactions with the knowledge gained through discussion and a consensus being reached…In the end, students will have the correct information in an interactive learning environment which will ultimately help their learning skills. (PT1, Phase I, reflection)*

Another participant has put it this way:

> *I think the Productive Pedagogies framework was necessary for pre-service teachers, because it helps us to become teachers in ways that change the picture of a teacher from one who just transfers knowledge to the student. (PT3, Phase II, focus group)*

Teachers' views on learning theories are important influences on classroom practice. What teachers do in the classroom reflects their beliefs on how students learn. If the teachers believe that knowledge can be transmitted, then their class instructions might involve the directed one-way flow of information to students. However, if teachers subscribe to the constructivist view of learning, activities to help students to build knowledge would prevail. In this study, the Productive Pedagogies framework was seen to shift the focus of pre-service teachers towards student-centred learning. The following comment explained how the model worked to change the old view of pre-service teachers and to help them to focus on students' prior knowledge to build and explore new knowledge.

> *During my field experience, Productive Pedagogies helped me to consider the background knowledge of students to build on the new information, as part of this I was able to assess good dialogues to help students to analyse and synthesise knowledge in a socially supportive class (PT7, Phase II, interview).*

6.1.3 Productive Pedagogies facilitating their own learning

The pre-service teachers were able to identify particular lecturers' strategies that were aligned with the Productive Pedagogies framework and which had facilitated their learning. Three elements of the framework that pre-service teachers have seen as a new experience for them have been discussed in

this section namely; substantive conversation, explicit criteria and connectedness to the world beyond the classroom. Pre-service teachers expressed very positive views about substantive conversation during their learning experience. One participant commented:

The conversation in the classroom effectively contributes to my understanding of the issues being taught, I benefit from discussing my understanding with the lecturer or even with my colleagues. It caught my attention. (PT10, Phase I, Reflection)

In addition, conversation as a means of holding learner attention was commended. Participants shared the same views about how the focus on substantive conversation during the teaching practices which led to the gaining a better understanding, however, the benefit of conversation as a way of maintaining student focus was added.

I consider that the classroom conversation was useful and helped me to concentrate on the teaching issues. Even though I lost attention sometimes; the discussion brought me back to the lesson topic. (PT5, Phase I, Reflection)

Exchanging ideas and opinions during the class dialogue helped students to grasp the complex relationships between central ideas. One participant commented

The sustained discussion on today's concepts which included exchanging our opinions with each other and using our examples and experiences meant the lesson became more understandable. (PT1, Phase I, Reflection)

Conversation gave students an opportunity to formulate their own meanings of the elements of the framework express them in their own words. Another student said:

The dialogue between you (the lecturer) and us, and the
discussions within the groups helped us, to a great extent,
understand and identify the dimensions of the framework.
(PT11, Phase I, Focus group)

More specifically, the focus of substantive conversation in the teaching practices encouraged pre-service teachers to implement it in their field experience.

I think if we implement substantive conversation alongside
group work, students will understand and absorb the lessons
better. (PT8, Phase II, Focus group)

Explicit Performance Criteria was another element of Productive Pedagogies that pre-service teachers have identified as being beneficial. They found it useful to improve the quality of their work. One participant asserted:

Explicit performance criteria was a useful element which
helped me to keep on track with the lessons as well as
knowing what needs to be done for each task. (PT12, Phase I,
Focus group)

Knowing the task's expectations was listed as an encouraging factor for students. One pre-service teacher commented that presentation of the lesson's explicit performance criteria increased the students' motivation to learn the content:

… it determined the extent of my understanding of the lesson,
and what is required from me in the class, it increased my
motivation to learn and drew my attention to the lecture, by
identifying what was expected from me at the end of the
activity. (PT13, Phase I, Focus group)

The ordering of what is needed to be learnt was evident from the lesson's explicit performance criteria. One pre-service teacher asserted that

> *It helped us to understand the sequence of the points and know the basic things in the lecture; it even motivated us to anticipate what is coming in the lecture. (PT9, Phase I, Focus group)*

Focusing on Explicit Criteria not only helped pre-service teachers to know what they are going to do or achieve in each lesson, but also was also perceived as showing the clearest implications of this approach during their study in the teacher education program.

> *During my study in the college, I did not see such a clear example of quality performance standards as you (the lecturer) have exemplified each lesson. (PT7, Phase I, Focus group)*

Connectedness to the world beyond the classroom was another element of Productive Pedagogies that has been documented. Pre-service teachers felt that linking some unit's topics with practices in the schools' textbooks increased their understanding of teaching practices.

> *Using mathematics textbook facilitated my understanding of the different teaching strategies. I was acting as a teacher not student through the task process. (PT4, Phase I, Reflection)*

Connection with the day-today profession is essential. Pre-service teachers indicated that they valued visiting schools for observations of mathematics teachers. It seemed to have a personal significance to each of the pre-service teachers, seeing the possibilities of their chosen future career.

> *Observing mathematics classes and meeting with teachers has had a significant impact on my understanding of the actual school environment. (PT2, Phase I, Focus group)*

6.1.4 Productive Pedagogies hindrances

Although pre-service teachers thought that the framework had facilitated their learning, they identified some limitations that arose when introducing the framework. They stated that parts of the Productive Pedagogies framework required further examples and that the framework was highly involved and therefore time restrictions in the semester limited their full understanding.

Lack of references

Data from pre-service teachers' interviews suggested that the framework needed more references and examples so that they might understand how the Productive Pedagogies framework could be implemented.

> *We need some more references to help us to understand the model, and know why these elements are important. (PT12, Phase I, Focus group)*

Other participants stated that they needed more references throughout the unit to aid their understanding of the framework.

> *The lack of references about the Productive Pedagogies framework did not help us to understand it better. …. I would expect that in the final test it will be difficult for us to explain the model theoretically because sometimes we focus on practical elements and neglect other aspects. (PT4, Phase I, Focus group)*

Other participants highlighted the lack of Arabic references of the framework elements, but they found that writing reflective tasks helped them to understand the framework.

> *Because there are no Arabic references to this framework, I found writing reflective journals a very useful task. It helped me to understand and expand my imagination for a*

classroom environment and schools. (PT3, Phase 1, Focus group)

Lack of time

Pre-service teachers suggested that studying productive pedagogies in one unit was not enough to fully comprehend all the elements. This point of view suggested that the Productive Pedagogies framework needed to be expanded over multiple units.

> *One semester is not enough to understand and accommodate the Productive Pedagogies model. (PT5, Phase I, Focus group)*

Pre-service teachers felt that if they have a chance to study Productive Pedagogies in other unit it might help them to apply it in this unit to a greater degree.

> *I think if the framework were studied at an earlier semester it would be easier to absorb it in this semester. (PT14, Phase I, Focus group)*

Another pre-service teacher stressed that

> *I guess if we take a general idea of this framework in the "General Teaching Methods Unit" during the previous semester, and then in this unit we focus on its application, this will help us to understand the model effectively. (PT7, Phase I, Focus group)*
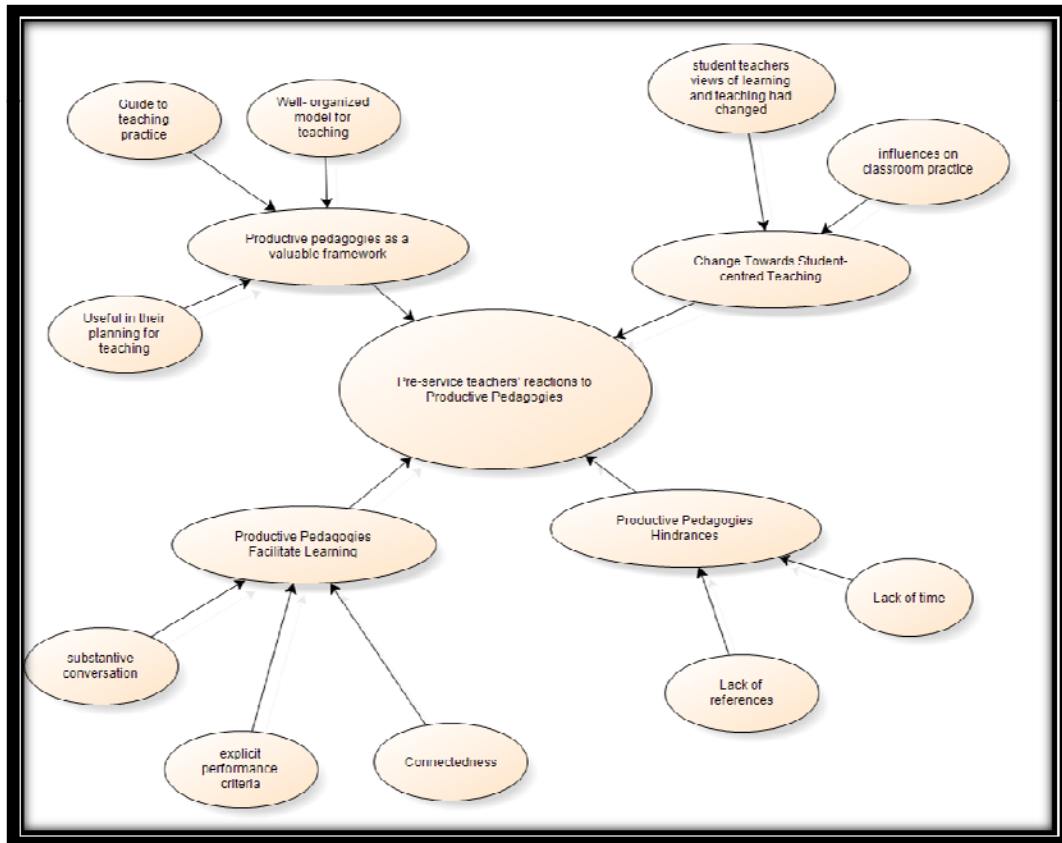
Figure 6.1: Summary of pre-service teachers' reactions to Productive Pedagogies

6.2 Implementation of Productive Pedagogies in Field Experience

In phase two of this study, six pre-service teachers were followed during their field experience in two primary schools. Each one was observed five times during their teaching practice. The observations were conducted to investigate the pre-service teachers' ability to implement the Productive Pedagogies framework. There was a formal meeting for two hours at the teacher college each week to review and discuss their observations as well as raise different issues regard classroom practices. Extensive student data was gathered regarding the implementation of the framework. This section presents data regarding the implementation of the four framework dimensions, Intellectual Quality, Connectedness, Supportive Classroom Environment and Recognition of Difference.

6.2.1 Intellectual Quality dimension

The data collected from classroom observations suggested that there was some evidence of attempts to implement intellectual quality elements by pre-service teachers in their practices. Using the manual scheme, Figure 6.2 illustrates the means, low and high scores of the implementation of the intellectual quality elements from all the 30 observations made of the teaching practice of the participating pre-service teachers. The data below represents the observed implementation of the six components of Intellectual Quality of the Productive Pedagogies framework: *higher order thinking* (HOT), *deep knowledge* (DK), *deep understanding* (DU), *substantive conversation* (SC), *knowledge as problematic* (KAP), and *metalanguage* (ML). The data collected from classroom observations showed that the mean of the intellectual quality dimension was below the framework average of 3. The mean scores for the pre-service teacher seemed to be high in the *higher order thinking*, *deep understanding* and *substantive conversation* and were between 2.2 and 2.3. In contrast, *knowledge as problematic* and *metalanguage* scored low between 1.76 and 1.53.
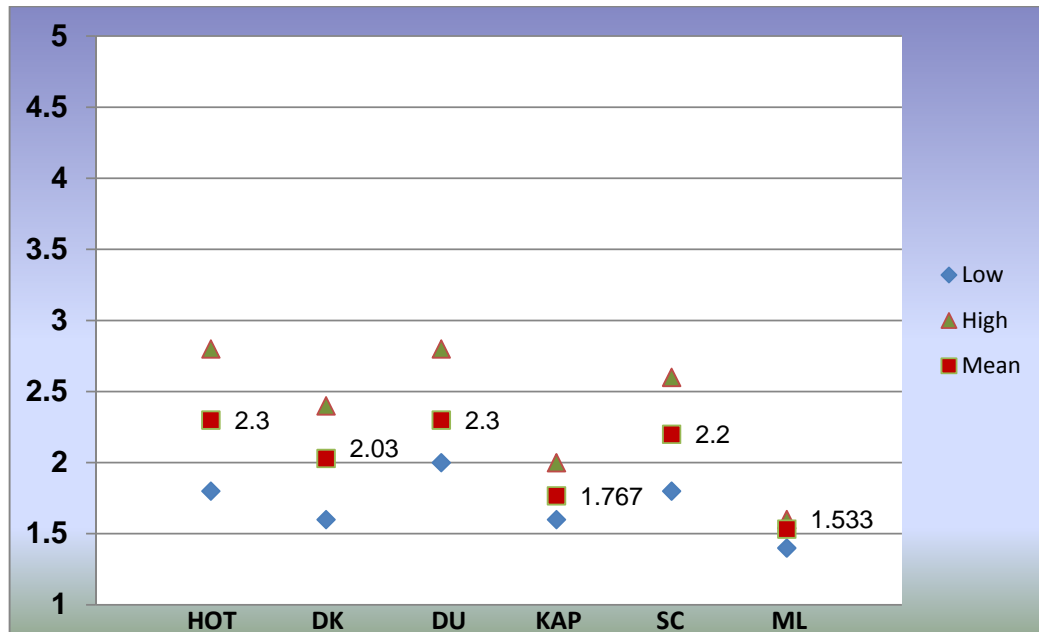
Figure 6.2: Pre-service teacher scores on the implementation of the six components of Intellectual Quality of the Productive Pedagogies framework

Implementation of Intellectual Quality

Intellectual Quality applied in the classroom is illustrated in the following observed Year 3 lesson with students aged 9 years old. The teacher attempted to convey knowledge and skills to the young students regarding weight. Through group-work, the teacher exploited the substantive conversation element allowing the students to self-assess and peer-assess their conceptions. Through the task, the teacher drew higher order thinking from the students requiring them to problem solve and think about the topic of weight.

I entered the Year 3 class and headed to my seat at the back of the classroom. The balance-scale on the teacher's table drew my attention. The students seemed eager to know more about this equipment. The teacher started his lesson by writing the topic on the board "Weight". In keeping with the Year 3 level of instruction, the lesson focused on the concepts of weight and related skills of using the scale. The teacher began the lesson by presenting different pictures and asking students to determine which was lighter and which was heavier. That was a task that enabled them to draw from their experience, for example, their knowledge that a car will be lighter than a train. The teacher divided students into four groups and provided each group with five different objects; a pen, a book, a balloon, an empty box and a key lock. Then the teacher instructed each group on how to use the balance-scale to arrange these objects on their desks going from the lighter to the heavier. This activity was challenging for the students and required them to use higher order thinking in order to complete it successfully. For Year 3 students, to order five objects by using balance-scale was not an easy task. Each group had to present their findings and share the results with the rest of the class. The teacher feedback included more extensive discussion on the material from which an object is made and its relationship to its weight. Subsequently, the teacher raised some questions related to students' own weights. Then the teacher opened the floor for a discussion on questions such as what kind of food makes you fat? Or what kinds of activities help you to lose weight?

Again, at the end of the class, questions were raised which helped to explain the meaning of equal weight, lighter weight and heavier weight. (Research diary, 30/3/2009)

In this scenario, the teacher created activities that required higher order thinking by asking students to use the balance-scale to arrange five objects from the lightest to the heaviest and to explain their reasoning to the rest of the class. These are not easy tasks for the majority of students at that grade level and it is not part of their normal classroom routine. The classification and explanation was designed to go beyond the development of skill of using the scale to compare two weights. It constituted a real-world-like problem for the students. Similarly, asking students to work in groups to perform their tasks helped them to co-develop and communicate their understandings with each other. Presenting their findings for discussions helped them to receive useful feedback from their teacher and other peers. Errors in their answers provided discussion about the process they used as well as helping them to identify a few misconceptions that the students had (e.g. bigger objects are heavier) and deepen their own knowledge by responding to challenges from other students. Another interesting observation from this class was that all the students were very engaged in the task and were eager to collaborate towards its achievement – some were responsible for weighing the objects and others for writing the findings. They showed enthusiasm by helping each other and raising questions on each other's work. This was one productive lesson where the teacher implemented effective pedagogies that focused the implementation of *higher order thinking* and *substantive conversation*. Interestingly, these observations correspond to themes identified by the pre-service teachers themselves when discussing Intellectual Quality dimension.

Another good example demonstrated how the focus on intellectually quality elements led to gain a better understanding was from a Year 4 lesson on the *relation* between two straight lines.

I started my visit to Altaqwa school with an observation of one student teacher delivering a lesson to a Year 4 class. The lesson was titled 'the

relationship between two straight lines'. In this lesson, the students were required to recognize and draw the orthogonal lines. The teacher began his lesson by reviewing the last lesson on points and lines with students. After the re-cap, he then asked each student to take one piece of paper and fold it a single time. After observing students' completion of the first fold, in order to make two intersecting lines, he asked them to fold the paper a second time. The students opened the paper and used their pens to drawn two lines on the folding lines. Each of the two lines was given a name, namely, AB and CD. He told the Year 4s that M was the point where the two lines intersect.

After that demonstration and monitoring, he asked students to answer two questions that he, at that point in time, wrote the whiteboard. These questions were: When we fold the paper at the AB line, what happens to the sections MC and MD? Secondly, when we fold the paper at the CD line, what happens to the sections MA and MB? All students did the activity, which raised numerous questions about the orthogonal lines. At the end, the students observed that when folding the paper the two orthogonal lines will meet. Then the teacher provided each student with a piece of transparent paper and asked each student to copy different geometric shapes from the textbook, and manually with paper, assess whether they contain orthogonal lines or not. After this exercise, the teacher explained how to draw a perpendicular, that is, a right angle, from a point on the line or outside of the line with the use of a triangle. The teacher then divided the class of students into four groups and assigned each group a task sheet containing a picture and a question. The picture was a line and a point outside it. The question was; "On this map, the AB line refers to a main road which passes near a town, which is represented by the point outside the line. We need to build a petrol station to service people in the town as well as the passengers who use the main road. Where is the best place to build the station and why?" The teacher monitored the progress of the four groups by moving around the classroom. In each group, several opinions were raised regarding the location and best way to use today's lesson to solve this

problem. The teacher provided feedback to the students to help the students appraise their conclusions. At the end, students constructed the required knowledge that from any point outside a line, they can draw a perpendicular, that is a right angle, to the straight line and this will give the nearest section. (Research diary, 29/3/2009)

In this observation, the teacher challenged his students to construct the knowledge concerning the relationship between two straight lines, and the conditions in which these lines are termed orthogonal lines. Asking students to use transparent paper and copy different geometric shapes from the textbook to find orthogonal lines was useful strategy encouraging all students to participate in the classroom activities. Another one of the strengths of the teacher's lesson was that he was able to convincingly link the lesson's content with the real life of the students. Even though the students do not drive, they are well aware of the function of petrol stations, highways, and the logic of finding the most convenient positioning of the store.

The data from pre-service teachers' interviews and reflective journals revealed that they have consciously attempted to apply intellectual quality elements in their practices. They identified two reasons for the importance of a focus on this particular dimension. Firstly, the pre-service teachers argued that implementing *higher order-thinking* and *substantive conversation* elements helped students to gain deeper understanding of the content discussed.

> *Encouraging students to complete tasks that required higher order thinking and critical thinking helped in the achievement of clear understanding of concepts. (PT7, Phase II, Focus group)*

Another student put it this way:

> *Math teachers need to focus on intellectual quality to create activities that allow students to engage in higher order thinking, analysis, synthesis and explanation. Because these will help*

> *students to apply the knowledge in different ways and in different situations as well as help them to learn the correct ways of thinking. (PT4, Phase II, reflection)*

Other participants identified specific teaching approaches towards achieving this aim. One student commented on the use of problem solving:

> *I used problem-solving techniques to engage students in higher order thinking and allow them to solve problems on their own in order to arrive at some conclusion. In this way the information will establish effectively in the mind of the students. (PT3, Phase II, reflection)*

In a similar way, another participant expressed the view that focusing on activities that required intellectual challenges could lead to a good understanding of the mathematical concepts.

> *Higher order thinking is one of the most important elements to be applied because it motivates students to think deeply. (PT10, Phase II, Reflection)*

Although the context of Saudi classrooms seemed to have less teacher-student interaction, pre-service teachers have succeeded in applying substantive conversation at a considerable level. Pre-service teachers encouraged their students to engage in substantive conversation to complete their tasks in the classroom. They believed that when students are involved in discussions, they seemed to develop a deeper and clearer understanding of the concepts under consideration.

> *I focused on substantive conversation in my classroom because it increased the students' thinking and confidence so they interacted with each other and exchanged ideas, which in turn, facilitated effective understanding of the concepts discussed. (PT4, Phase II, Reflection)*

Other participants who supported this idea mentioned that:

> *Interaction between me and students in the classroom through extended dialogue was important in clarifying the lesson concepts and in facilitating teaching. (PT10, Phase II, Reflection)*

Secondly, the reason for pre-service teachers implementing Intellectual Quality elements in their practice is not only to help students to gain a clearer understanding of concepts being taught, but also to make the lesson more enjoyable. The participants expressed views indicating that students seemed to enjoy the learning process more when they were involved in challenging tasks.

> *The enthusiasm and interaction of students are apparent when they not only rely on delivery of knowledge, but on their self-reliance in accessing to information and using the high order thinking to combine facts or analyse ideas on the topic. This method helps students to gain a better understanding of the lessons. (PT4, Phase II, Reflection)*

> *Focusing on higher order thinking in their learning process helps students to understand the subject matter and enjoy the classroom activities better. (PT10, Phase II, Reflection)*

When teachers are implementing a specific method which they find useful and is having a good impact on students' outcome, they will continue to improve this approach and use it in a variety of scenarios or situations.

> *As a teacher, I try hard to encourage students to be involved in a dialogue within the group. I also aim at increasing the level of conversation between my students and me. I stimulate discussion on mathematical concepts, and I invite*

students to raise questions to clarify issues relating to the
subject. (PT9, Phase II, Reflection)

The previous responses as well as other similar responses from pre-service teachers stressed that that intellectual quality elements contributed significantly towards raising the level of students' understanding and enthusiasm as well as getting disadvantaged students involved in classroom tasks. This has resulted in pre-service teachers focusing on different activities that helped them to apply these elements.

Limitations and challenges in the implementation of Intellectual Quality
In spite of the positive feedback on the effectiveness of the Productive Pedagogies framework in assisting these pre-service teachers in their understanding, planning and execution of their teaching, there are three challenges that emerged when analysing the data and are worthy of consideration. A number of lessons, which were observed, were not particularly successful in involving all students or challenging them. Careful consideration of the data represented in Figure 5.3 shows that there was significant variation in the scores in many of the elements and considerable variation between the different elements. Each of these three issues limited pre-service teachers' ability to score higher in the intellectual quality elements in their practice are discussed below.

First, not all elements of the Intellectual Quality were demonstrated at the same level. In particular, the pre-service teachers did not seem to apply *Knowledge as Problematic* and *Metalanguage* to the same level as the other elements. *Metalanguage*, which refers to pedagogies that incorporate frequent discussion about talking and writing, were implemented infrequently in most of the observed mathematics lessons. One participant stressed the difficulty of incorporating discussion about talking and writing into the mathematical classroom by saying that

Sometimes in mathematics classrooms it is hard to use
alternative words to explain the mathematical concepts. In

my class (Year 3) focusing on aspects of language or writing
will use up too much teaching time. Students have difficulty in
reading and writing because they are still young. I usually
have to read the questions to them. (PT6, Phase II, Interview)

It seems that the lack of experience limited the pre-service teachers understanding of the importance of metalanguage and narrowed their thinking on how to create activities that reflect language use in mathematics lessons. Pre-service teachers seemed to believe the mathematical lessons depend on just numbers and symbols; therefore, that focusing on discussion about reading and writing would not have effect on students' outcomes. Another pre-service teacher questioned whether metalanguage is applicable at all in subject such as mathematics.

I could not create activities to apply the metalanguage
element in my lesson. I think this element will be more
suitable for social studies and Arabic language classes.
(PT3, Phase II, Interview)

The second limitation to pre-service teachers' ability to score highly in intellectual quality elements was the fact that the principles of Productive Pedagogies need significant time to be applied in mathematics lessons which is last for only 45 minutes.

Higher order thinking activities take up so much time to
prepare and apply, that I often run out of time. I just have 45
minutes for the class! (PT7, Phase II, Focus group)

As a new teacher, I need time management skills that are not
available in this model. Actually this framework needs more
time to apply higher order thinking and other elements to
class activities. (Aldaile, focus group interview -4)

Teachers and, in this case pre-service teachers, are often under pressure to fulfil the requirements of the curriculum. As stated earlier in Chapter 2, mathematics textbooks, at the primary stage, contain about 40 topics that need to be taught in a 15 week-long semester. In this case, deep learning, which is usually not assessed, was sacrificed because of the need to follow the curriculum.

Third, not all students demonstrated the same level of application of the framework in their teaching. While the group averages in many of the elements indicate that attempts have been made to implement the principles of Productive Pedagogies in the different classes, some pre-service teachers were more successful than others. To a large extent these variations can be explained by consideration of the level at which the pre-service teachers were teaching. Figure 5.3 shows how the six elements of the dimension of intellectual quality scored differently in relation to year levels. Primary school is divided into two stages, the lowest stage is year 1, 2 and 3 and the upper stage is year 4, 5 and 6. In general, pre-service teachers teaching at higher level classes (4 – 6) have demonstrated a greater use of the elements of the Intellectual Quality dimension that those at lower level classes (1 – 3).
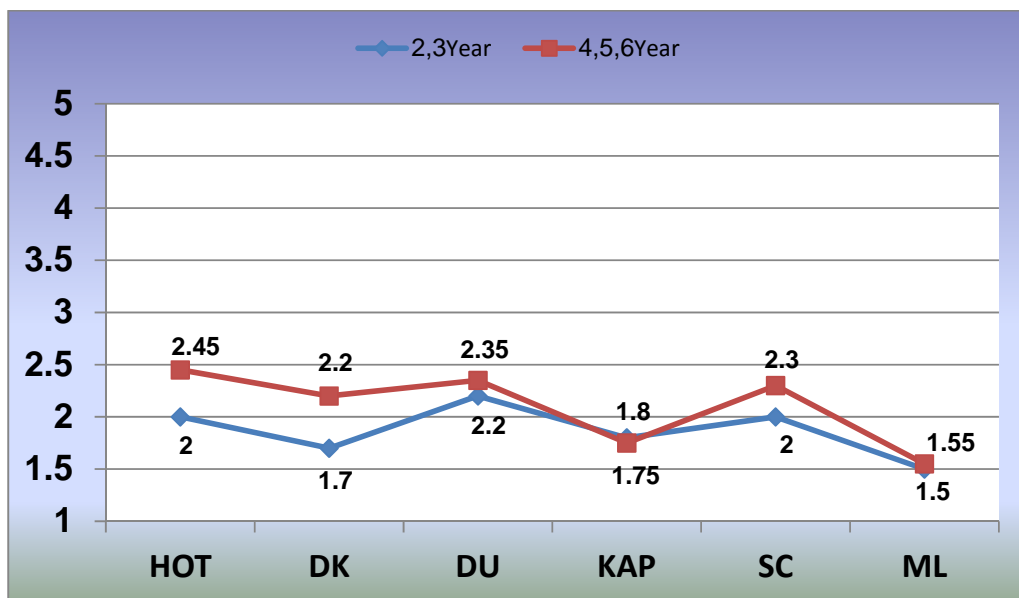
Figure 6.3: How the six elements of the Intellectual Quality dimension scored in relation to year levels.

The ranges of the different variances for three of the elements were in *higher order thinking* (0.45), *deep knowledge* (0.5) and *substantive conversation* (0.3). In each of these elements, the upper stage pre-service teachers exhibited higher variation than their lowest stage colleagues. The interviews and focus group discussion indicated that pre-service teachers at lower levels of the school faced some difficulties in the earlier years. This may also be due to the lack of pre-service teachers' experience. Pre-service teachers faced difficulty in dealing with students in Years 2 and 3. Students at this stage need the teachers to understand their capacity to think and ensure that the tasks and activities are well suited to them. One participant expressed that

> *It is a difficult task to apply intellectual quality elements*
> *to the primary school curriculum, especially at the*
> *lowest stage. (PT3, Phase II, Focus group)*

Some pre-service teachers have attributed these difficulties to the level of maturity of the student and their language ability.

> *For students at the lowest stage, the activities that*
> *focus on higher order thinking can be difficult because*
> *they require high mental capacity. (PT6, Phase II,*
> *Interview)*

Other students expressed wider concerns about the use of higher order thinking activities in their classes. They were concerned that a focus on higher order thinking should provide a challenge for the students; however, some student might find these tasks too frustrating and not be able to cope with them, thus resorting to copying the responses of other more capable students in the class. These pre-service teachers have rightly concluded that higher order thinking tasks should be used judiciously with care about their appropriateness to the students' particular level of knowledge development. Involving students in in-depth discussions to understand the mathematical

concepts was challenging for the lowest stage pre-service teachers. The classroom seemed to have less student- teacher interaction in these cases.

> *Applying substantive conversation with my students (Year 3) seemed to be difficult. I encouraged them to raise questions, but there were no more questions to be raised in the classroom. (PT6, Phase II, Interview)*

Regarding *deep understanding*, upper stage pre-service teachers performed slightly higher than their lowest stage colleagues. They scored 2.35 out of 5, while their colleagues scored 2.2 out of 5. This result was expected because they also performed high in *higher order thinking* and *substantive conversation*. This supported the findings that intellectually challenging tasks with extensive conversations have resulted in raising the level of students' understanding.

In all, the observations indicated that there were attempts to apply Intellectual Quality elements by pre-service teachers in their teaching practice. Pre-service teachers showed their ability to create activities that required *higher order thinking* and *substantive conversation* to help their students to co-develop and communicate their understandings with each other. In addition, they challenged their students to construct knowledge concerning the lesson topics. In their interviews and reflective journals, they highlighted two reasons for the importance of a focus on the Intellectual Quality dimension. They reported that it helped students to gain deeper understanding of the content discussed and made the lesson more enjoyable. However, not all the lessons, which were observed, were successful in involving all students or challenging them. There were three issues were identified as being the reasons for such limitations. First, the lack of experience of pre-service teachers limited them to apply *knowledge as problematic* and *metalanguage* to the same level as the other elements. Second, The 45 minutes of the lesson seemed to restrict pre-service teachers from applying more elements in one lesson. Third, the grade-level

at which the pre-service teachers were teaching explained the variances for Intellectual Quality elements in the observation scores.

6.2.2 Connectedness dimension

The data collected from classroom observations suggested that there was little evidence of attempts to connect the mathematics content under consideration in the manner that is promoted by the Productive Pedagogies framework. Using the manual scheme, Figure 6.4 illustrates the means of connectedness elements for all the 30 observations and shows the low and high scores for the participating pre-service teachers. The data below represents the observed use of the four components of Connectedness of the Productive Pedagogies framework: *connectedness to the world* (CW), *knowledge integration* (KI), *background knowledge* (BK), and *problem-based curriculum* (PBC). The data collected from classroom observations showed that pre-service teachers' scores in the connectedness dimension were all in the lower half of the possible scores. While pre-service teachers seemed to score higher on *connectedness to the world*, they were very low on the rest of the components. As can be observed, *problem-based curriculum* scored very poorly – a mere 1.5 out of 5.
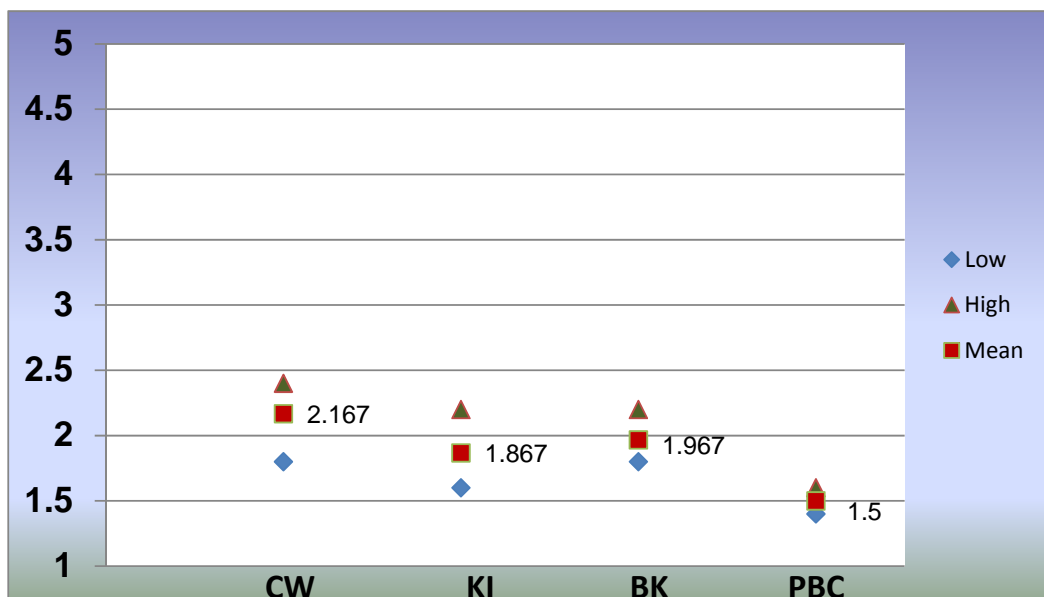
Figure 6.4: Pre-service teacher scores on the implementation of the four components of Connectedness of the Productive Pedagogies framework

Investigating the phenomenon of under-implementation of the Connectedness dimension of the Productive Pedagogies framework is worth examining in more detail. It seems that two possible reasons can be identified: lack of understanding of what connectedness may mean and the effect of other contextual factors. These will be discussed below after first considering some attempts at applying Connectedness in some pre-service teachers' field experience.

Implementing of Connectedness

There were a number of indications that pre-service teachers were attempting to apply the components of *connectedness to the world*, *background knowledge* and *knowledge integration* in their instruction. One example was in Year 5:

> *The lesson was based on the calculation of area. The teacher began his lesson by raising some questions that related to the area and perimeter of the quadrilaterals. Students had already studied this in previous lessons and were therefore familiar with the concept. The teacher asked his students to separate themselves into three groups of six. The manner in which the students divided themselves quickly in an organized way pointed to the fact that they were comfortable with working in groups and have done it before. The task was to go out to the school playground to calculate and draw a car park with its entrance, pathways and exit. The task required the students to calculate the area and divide it into a number of parking spaces. Each car needed parking space of 2 m by 3 m. The pathways had to be 5 m wide. Each group had an information sheet and a tape measure. Each student in the group was involved in a different task and needed to report his plan to the class at the end of the lesson. After 35 minutes, the students completed their task, showed their plan to the class, and answered questions from their teacher and their peers. The discussion related to the calculation of the area and vicinity to reach the maximum capacity of the park and the easy movement inside the relevant area. (Research diary, 7/4/2009)*

Here we find that the student teacher tried to connect what the students had learned about area and perimeter to the real life issue of parking cars, which is relevant in the outside world. Students used their skills of mathematics to create a plan of their school car park. They had learned from the lesson that they needed to think about other elements that affected their plan such as an easy movement for the cars in the car park and the best spot to place the entrance and the exit. This was a productive example of applying the connectedness element into the class task. However, if the teacher had focused on *knowledge integration* in this task by raising questions related to the environment and budget it would have raised the Connectedness dimension in his lesson to a higher level.

While the above example demonstrated the good practices that involved Connectedness dimensions, there were other examples that showed clear attempts to implement Connectedness elements in teaching practices. another example from classroom practice to explain how pre-service teachers applied connectedness in their lessons was from a Year 3 lesson on the concept of division.

> *The teacher began his lesson by writing the topic on the board. He started asking questions from his students about division, explaining the meaning by using other words to clarify the concept such as distribution, separation and equality. After a short introduction, he divided students into four groups of five. He provided each group with an equal number of apples and a different number of plates. Then he asked each group to distribute apples into the plates equally. Interestingly, three groups out of the four, found some extra apples that they could not place into the plates. Some placed the extra apple in one of the plates and another took them away from the plates. After that, each group presented their ideas of division based on, how they dealt with the apples. Raising questions for a discussion was a part of the lesson before the teacher began to demonstrate the concept of dividend, divisor, quotient and the use of the symbol (÷).* (Research diary, 6/4/2009)

Here we found that the teacher tried to apply the model of *connectedness to the world* beyond the school by creating an activity that simulated a real problem by bringing a few materials to the classroom. This was good to some extent, and provided students with opportunities to face some problems when they performed their tasks. In this case, some groups had extra apples that they could not place into the plates and that led to open the discussion on the concept of division.

Another one of the classes that I observed, which illustrated useful application of Connectedness as a dimension of the framework, was a Year 5 lesson. The teacher observed clearly focused on elements of *knowledge integration* and *background knowledge* in order to gain the best results from his Year 5 lesson on operations on large numbers.

The lesson was titled 'operations on large numbers'. Firstly, the teacher showed a large map of the world on the whiteboard. The map contained the seven continents with their calculated areas. The task was to answer the following questions. "Which is the largest continent in the world? Which is the smallest continent in the world?" The Year 5 class was also asked to arrange the continents in ascending order from smallest to largest. And finally, the teachers asked students, based on the calculated areas of each continent, to write the value number, for example, tens, hundreds, thousands etc., for certain numbers selected by the teacher. After the students had performed this task and had discussed their results with the class, another map was shown on the board. This second map was a map of Saudi Arabia showing the distance between Riyadh and other major cities. The teacher then asked the students different questions which required the students to calculate and compare the distances. (Research diary, 5/4/2009)

This teacher has effectively connected the concepts of the lesson with the students' background knowledge. In this case, the teacher utilized Year 5 knowledge on, firstly, the globe, and secondly, the nation, in which they live. Here, we find how the teacher created activities that help students make links

between the mathematics and their background knowledge and between the mathematics and other sets of subject area knowledge such as geography. The use of different questions and formats of explanations resulted in students making more meaning of the mathematics at hand. All students were involved in the task, and they showed enthusiasm by helping each other and raising questions as well as being focussed and keen participants.

Pre-service teachers, during their field experience, have attempted to apply Connectedness elements in their practice. They highlighted, as stated earlier, that connecting the mathematics lesson with the world beyond the classroom helped their students to demonstrate better understanding and increased their motivation to learn the content. One pre-service teacher in his lesson, about the fraction as a part of whole, used some oranges and coins to demonstrate the parts of a whole. He wrote in his reflective journal that:

> *Trying to link the lesson with students' everyday life helped me to teach better... I cut some oranges in front of the class and used coins to demonstrate fractions…I found this turned students' attention to the lesson and they might benefit from this in their life beyond the classroom. (PT3, Phase II, Reflective Journal)*

Here we found that this pre-service teacher linked the activities in his lesson with fractions to the world of the students. He used the language of students to cut the orange in half and then in -quarters. He drew his students' attention to the fact that the orange is whole, but is going to be cut equally into pieces. He also continued to challenge his students with more fraction concepts by using the coins and notes.

In a similar way, another participant expressed the view that by connecting the lesson with students' daily lives, they were motivated to participate in the lesson's activities.

> *In my lesson (Issues with money for Year 2) I distributed some candies to some groups of students while other groups had the money, then the money group students equally divided their money and went to buy some candies from other group students who tagged the candies with prices...these activities drew my students attention to the lesson and they actively participated in the class tasks. (PT6, Phase II, Reflection)*

Pre-service teachers, even when they used simple activities that connected the lesson with the students' daily life experiences, seemed to recognize that their students could benefit from such connections by showing their enthusiasm and motivation to participate in classroom activities. They highlighted that their students obtained better understandings of the concepts being taught.

Limited Implementation of Connectedness

Pre-service teachers have limited implication of the connectedness and most attempts by pre-service teachers to connect the lesson content with the outside world were artificial and meaningless. Here is one example from classroom practice to explain how pre-service teachers applied connectedness in their lessons. This instance was from a Year 6 lesson on geometric shapes and their surface areas. The teacher started his lesson with short introduction on geometric shapes in mathematics. He examined his students pervious knowledge of basic geometric forms such as rectangle and triangle shapes and then tried to connect the lesson to the students' daily life by provided his students with some examples of shapes such as a triangle within a stadium playing field. Then he introduced the new shapes such as pyramid and linked it with the great pyramids of Egypt. In his reflective journals, he wrote that

> *There is a clear connect between the lesson and the world beyond the classroom as I tried hard to do so…. For instance,*

> *I asked the students about a pyramid shape in mathematics and told them that there are famous pyramids in Egypt.…I connected the rectangle with the stadium. (PT10, Phase II, Reflection).*

Here we found that the teacher thought that by giving examples of real shapes would demonstrate a level of connectedness in his practices. This did not provide students with adequate skills that they would need to face real-life issues that related to surface areas of geometry shapes. These attempts to implement the connectedness dimension of Productive Pedagogies clearly demonstrated some misunderstanding of the difference between connectedness to real life activities and common practices.

In addition, the division example, shown above, demonstrated some ambiguity about the difference between connectedness to real life activities and the more common attempts in mathematics classes to have concrete representations of mathematical concepts. While dividing whole apples onto plates may be regarded as use of a concrete model of the concepts, they are not the same as connectedness and fail to be an authentic task that students could encounter in everyday life. It seems that some pre-service teachers confused the two. The limited understanding of the Connectedness dimension of the framework seemed to play a major role in the lack of its implementation in those situations.

Three contextual factors have been identified as limiting the implementation of connectedness. During my discussions with pre-service teachers, I asked them why they did not go beyond simple connectedness to be more creative and use other techniques to introduce the lesson that had relevance to students' lives. The participants identified three reasons why such implementation was hampered. First, pre-service teachers and, for that matter, novice teachers are often limited in their teaching by their previous experiences as students of mathematics. Traditional mathematics classrooms are known for presenting the context as abstract and isolated

from life experiences of students. For these pre-service teachers, it was difficult to find applications that were real and accessible for their students. One pre-service teacher acknowledged:

> *When I prepare the lesson, I face problems with connecting*
> *to the world beyond the classroom, but sometimes I manage*
> *to bring materials from outside to the classroom to enhance*
> *my teaching. (PT6, Phase II, interview)*

Another pre-service teacher said:

> *Choosing tasks or real world problems to be a main focus of*
> *the classroom practice is a difficult part of the connectedness*
> *dimension. (PT7, Phase II, Focus group)*

Secondly, the school's tradition of strictly following textbooks as guides for planning and assessment were found to restrict the teachers from creating activities that may help students to combine mathematical knowledge and the real world outside the classroom. As mentioned before, in Saudi schools, each student is provided with free textbooks for all subjects. This put teachers under pressure to follow the tradition of the school and use the textbook as the main source for students' work.

> *Completing students' text book questions with them and*
> *offering feedback while reviewing their work is important to*
> *my teaching" (PT6, Phase II, reflective journal)*

As a supervisor of the pre-service teachers' field experience, I was aware of being subject to this same limitation. As part of the traditional classroom observations required by the College, the supervisor should check the students' textbooks to see how the pre-service teacher corrected the students' work. This practice itself tends to reinforce the focus on textbooks and limits pre-service teachers' thinking required to create different and rich

activities that might help them to apply the Connectedness dimension at a higher level.

Thirdly, the pre-service teachers were subject to the traditional demarcation between the different school subjects in terms of content that is reinforced by separately timetabled lessons that are taught by different teachers. *Knowledge integration* was also another element of the Connectedness dimension that pre-service teachers faced difficulty in implementing in their field experience. They scored just 1.86 out of 5. Undoubtedly, this is in part a result of the lack of the pre-service teachers' experience and the limited possibilities of discussion with other teachers in other subjects taught at the school.

> *As a new teacher in the school environment and a first timer, I cannot make links between what I teach and other subject areas. I guess as time goes on, I should be able to integrate the lessons with other school subjects successfully. (PT6, Phase 2, interview)*

> *There are no opportunities for formal meetings or discussions about subject area integration, in our school. Whenever I attempt to establish a discussion about our practice with other teachers, they do not take it seriously because I am a new teacher. (PT9, Phase 2, interview)*

In summary, pre-service teachers attempts to apply the components of Connectedness were not particularly successful. In spite of some good examples of teaching practices that involved some elements of Connectedness, most of the attempts were unproductive. Pre-service teachers documented that the Connectedness dimension could help students to demonstrate better understanding and increased their motivation to learn the content. However, three contextual factors have been identified as limiting the implementation of connectedness. First, previous experiences

of pre-service teachers as students of mathematics who learned in traditional mathematics classrooms that are known for presenting the context as abstract and isolated from world experiences of the students, limited their imagination to find links between the content and life outside the classroom. Second, the tradition of strictly following textbooks as guides for planning and assessment were found to restrict the teachers from helping students to combine mathematical knowledge and the real world outside the classroom. Finally, limited discussions in schools between teachers of the same subjects or even different subjects have resulted minimal application of some Connectedness elements such as *knowledge integration* by pre-service teachers in their practices.

6.2.3 Supportive classroom environment

The data collected from classroom observations suggested that pre-service teachers are better at producing a supportive classroom environment than they are at other dimensions of the Productive Pedagogies framework. Using the manual scheme, Figure 6.5 illustrates the means of supportive Classroom Environment elements for all 30 observations and shows the low and high scores for the participating pre-service teachers. The data below represents the observed implementation of the five components of Supportive Classroom Environment dimension of the framework: *student direction* (SD), *social support* (SS), *academic engagement* (AE), *explicit quality performance criteria* (EQPC) and *self-regulation* (SR). The data collected from classroom observations showed that while pre-service teachers performed low in *student direction*, just 1.5 out of 5, they performed high in *social support* and *academic engagement* elements.
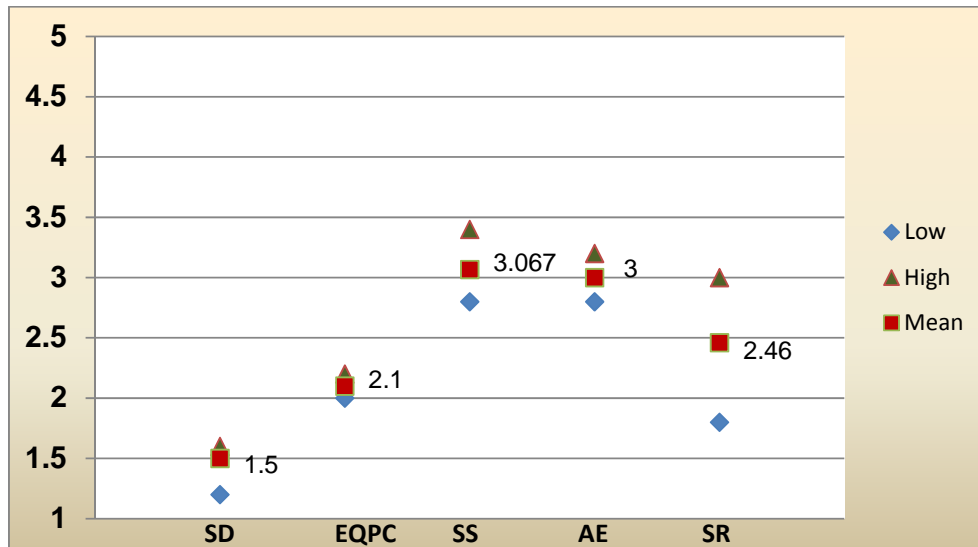
Figure 6.5: Pre-service teacher scores on the implementation of the five components of Supportive Classroom Environment of the Productive Pedagogies framework

Implementation of Supportive Classroom Environment

There were two main elements of supportive classroom environment clearly observed during the field experience. First, pre-service teachers were successful in implementing *social support* during their practice. They scored 3.06 out of 5, which was one of the highest scores that pre-service teachers achieved for implementing a Productive Pedagogies element during their field experience. *Social support* is present in classes when the teacher supports students by providing encouragement so they can all meet the high expectations required of them. These expectations include: taking risks when necessary and trying hard at all times to master challenging academic work; learning important skills and gaining relevant knowledge; and ensuring that a climate of mutual respect is established among all students and the teacher. Second, *academic engagement* was another element in which pre-service teachers performed relatively well during their practice. They scored 3.0 out of 5. *Academic engagement* occurs when students show enthusiasm for their tasks by taking the initiative to raise questions, contribute to group activities and help and support peers.

During the classroom observations, I noted that pre-service teachers achieved a high level of success in these elements by creating activities that

required the students to work in pairs or in groups. Sometimes they changed the class seating arrangement by setting students in groups of three or four on one table, face to face, to encourage cooperation. Working in pairs or groups is not a common teaching practice in Saudi classrooms. Most of the teachers in schools teach to a whole class and students work individually to perform their tasks. However, these pre-service teachers, in their field experience practice, seemed able to provide opportunities for students to discuss and perform their tasks with their peers. The pre-service teachers stressed that encouraging students to work in groups or pairs contributed significantly towards raising the level of classroom social support.

> *Providing tasks that required group work helped students to have long and extensive discussions on the task. Students exchanged ideas, experiences, and skills and helped each other to understand the concepts. This resulted in creating a great spirit of cooperation between groups. (PT9, Phase II, Reflective journal)*

In a group-work situation, each member of the group has a specific role to play towards completing the task and achieving success. Groups then interact with other groups and explain their findings. In these situations, students had opportunities to discuss, explain and reflect their ideas with each other. Pre-service teachers seemed to provide a good social climate in which students feel that it is beneficial to question the teachers about plans and methods that affect their learning. Another participating pre-service teacher commented that:

> *Even if a particular response or idea expressed is incorrect, students should be encouraged to speak out so that every student realises that everyone is not always right, but needs an opportunity to express themselves. (PT6, Phase II, Interview)*

The results from the observations indicated that pre-service teachers in their actual classroom environment were confident in frequently being of assistance to their students. Pre-service teachers did seem to be interested in helping students when they had trouble with their work and they appeared to consider their feelings. The observations also indicated that they liked to move around the class to discuss matters with students and ask questions to help understanding. Interestingly, during phase one of this study, I provided guidelines to pre-service teachers, for example, I recommended that teachers should not sit down during the class, and teachers should move around the class. These school-based guidelines seemed to play a major role in pre-service teachers' practices. Pre-service teachers, to some extent, succeeded in creating the appropriate climate for students to raise questions and contribute effectively to group activities.

> *Working in pairs encouraged disadvantaged students to participate with their colleagues comfortably and show enthusiasm towards their tasks. This move seemed to bring about a drastic change from their earlier behaviour which involved not bringing their books to class and poor participation. (PT4, Phase II, Focus group).*

These responses as well as other similar responses from the data collected indicated that pre-service teachers were better at producing a supportive classroom environment than they were at producing intellectual quality, connectedness, or recognition of difference. Pre-service teachers were more inclined to improve their learning environment by trying to support their students as a means of providing the best learning environment. However, the sentiment of trying to improve the classroom has not been enough to develop a good teaching approach to teach mathematics in primary school. Endeavors to improve teaching needs to be spearheaded by greater sharing of control with students in the classroom and providing them with opportunities to negotiate and speak out. The next section discusses some of the potential opportunities as well as some challenges in implementing the

supportive classroom environment by pre-service teachers in their field experience.

Limited implementation of Supportive Classroom Environment

Pre-service teachers seemed to create an effective environment for their students to gain good skills and show enthusiasm. However, they failed to successfully demonstrate many strategies that show *student direction* and *self-regulation* in their practice. It seems that there are two possible reasons behind the lack of success at some elements of Supportive Classroom Environment. First, the pre-service teachers seem to provide little space for their students to select their tasks. As a result of the classroom observations I noted that students did not have the opportunity to choose or select the particular activities or tasks that they had a preference for. Furthermore, students were not permitted to engage in discussion or talk with each other without the teachers' permission. This may be explained as pre-service teachers had a lack of confidence and experience in sharing control with students. The pre-service teachers determined and executed control over the type of content or tasks that students should engage in. Pre-service teachers came to classroom with specific content that needed to be taught. Additionally, the textbooks allow no opportunity for teachers to alter or change any content in them. They provide little space for teachers to introduce new content that may be required for their students. Therefore, it was not surprising that pre-service teachers focused solely on the textbook contents as highlighted by comments from pre-service teachers' reflections.

> *During my teaching, I focused mainly on explaining the concepts to the students and then guiding them to answer the textbook's questions, making sure that students had understood the lesson and completed their exercises successfully. (PT7, Phase II, Reflective journal)*

This reemphasised the difficulty of changing traditional of teaching methods, especially for pre-service teachers. This was partly due to the inadequate primary level lesson period of 45 minutes. Pre-service teachers are under

pressure to finish the lesson quickly without sharing the direction of the class with students. Based on the observations, the *student direction* element would be more effective if the pre-service teachers had consulted with their students on what their task preference would be so they could incorporate student ideas into their curriculum. To attain success in this process, the pre-service teachers also need to be certain of the students' abilities to make correct choices about their tasks and how they want them to be implemented.

Second, pre-service teachers need a school environment which is supportive of their teaching practices. *Student self-regulation* was one of the hardest elements that pre-service teachers struggled to apply. From an observation of a Year 5 class, I noted that thirty-three words had been used by the teacher to discipline students and regulate their movement within 45 minutes which was an excessive amount of classroom time spent on controlling students' behaviours. One of the issues observed from the first six classroom observations was that pre-service teachers seemed to have difficulty in controlling their classes. Pre-service teachers need a great deal of support from the school administration to help them to find ways to manage their classes

> *I faced a problem with student-self regulation especially in one of my lessons which is just before the time of pray. The rules of the school allow students to go to the water cycle for the ablution for prayer and this interrupted my lesson many times. (PT4, Phase II, Reflection)*

> *Student self-regulation was difficult especially in the first 20 minutes. I sometimes discipline students by moving them to a corner of the classroom, and having them standing in that spot for a few minutes. (PT10, Phase II, Focus group)*

Other participating pre-service teachers stressed that

> *I would make a note against the offending student's name then, if it happened three times, I would send him to the school principal. (PT9, Phase II, Focus group)*

> *My class was interrupted many times because the school principal often sending students to check classes for different reasons. (PT4, Phase II, Reflection)*

Controlling the class was a difficult task for the pre-service teachers who were in a school environment for the first time. They might need some time in order to understand the classroom situation and to get students excited about learning.

To sum up, pre-service teachers showed their ability to implement *social support* and *academic engagement* at an accepted level in their teaching instructions. Pre-service teachers' attitudes about considering students' feelings and discussing matters with students seemed to contribute significantly towards raising the level of classroom social support. However, sharing control with students in the classroom and providing opportunities for students to negotiate the lesson content were not frequently observed during the pre-service teachers' field experiences. It seems that there are two possible reasons behind this lack of success. First, pre-service teachers' lack of confidence and experience played major role in their inability to implement of some elements of the Supportive Environment dimension. Second, textbooks inhibited the ability to provide opportunities to alter or change any of their content.

6.2.4 Recognition of Difference

The data collected from classroom observations suggested that pre-service teachers are weaker at implementing recognition of difference than they are at other dimensions of Productive Pedagogies framework. Using the manual

scheme, Figure 6.6 illustrates the means of Recognition of Difference elements for all 30 observations and shows the low and high scores for the participating pre-service teachers. The data below represents the observed implementation of the five components of Recognition of Difference of the framework: *cultural knowledge* (KN), *group identity* (GI), *inclusivity* (INC), *narrative* (NAR), and *active citizenship* (ACIT). The data from classroom observations showed that pre-service teachers scored low in all elements of Recognition of Difference except in *inclusivity*. Pre-service teachers found it challenging to implement Recognition of Difference elements in their teaching. They could not score more than 1.5 out of 5 in most of the elements.
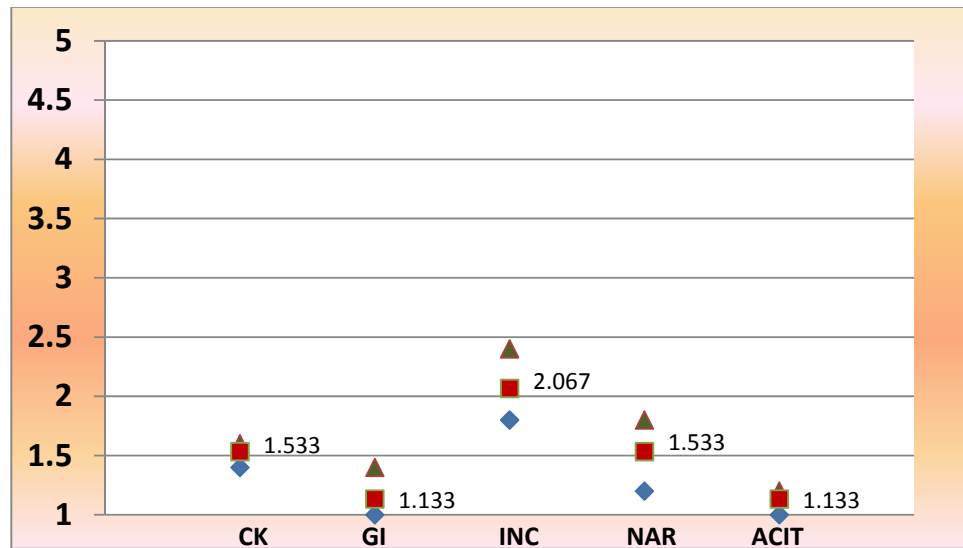
Figure 6.6: Pre-service teacher scores on the implementation of the five components of Recognition of Difference of the Productive Pedagogies framework

Implementation of Recognition of Difference

As can be seen from Figure 6.6, pre-service teachers' rates of implementing Recognition of Difference were low. All the elements of this dimension have been poorly implemented in the classroom practices. Pre-service teachers, during the first phase of this study, were engaged in several discussions about how teachers work with and value the difference in their schools. For example, the Recognition of Difference dimension was addressed to pre-service teachers in the first week to explain the diversity and difference in the classroom. In the week 7, the lecture "Diversity and Difference in the Classroom", pre-service teachers were given a task comprising several

scenarios and questions to enhance the discussion about difference in schools. Questions related to equity and quality included:

- Do you think all students should be treated the same?
- Do you think each student has an equal opportunity to be involved in the task?
- You went to teach in a rural area and found that students were poor in mathematics; do you think you need to eradicate certain topics to produce easier tasks for the students to grasp?

I joined each group at different stages to raise other questions. Each group presented its conclusion to the rest of the class and explained the factors that affected their understanding. Classroom discussion on topics such as equality and quality seemed to make students aware of the Recognition of Difference dimensions. One group responded to the last question:

> *We are going to remove some of the topics in order to help students to understand the mathematical concepts. Teaching students topics that are above their level of understanding may frustrate their learning process. (Task 1-L8, group C)*

Another group wrote:

> *... We will teach students the entire curriculum in order to achieve equality in learning. Students must learn like other students in the major cities so that they have the same opportunity in their future careers. (Task 1-L8, group A)*

It is clear that there were different perspectives of the situation. This opened the floor to much discussion about students' differences. It concluded that it is important to recognise differences in the students and provide as much assistance as possible to help these students to achieve high performance in mathematics.

In addition, in week 10 pre-service teachers went to schools and observed how the framework elements might be implemented in classrooms and identified the value of focusing on all students. One participant asserted that

> *In the classroom that I have observed, there were a number of students who did not participate in solving the lesson's exercise. I also observed that the teacher did not give them any attention. It is sad that they didn't have the same chance as the others did. (*PT15, Classroom observation reflection)

Another student teacher stressed that

> *The teacher, who I observed, was focusing on only the top students. He did not distribute the questions to all students, and there were some students outside the learning process. Maybe the reason for that is the difficulty of the lesson "dividing decimals" but this, in my view, was not equal opportunity.* (PT8, Classroom observation reflection*)*

While pre-service teachers developed their understanding of working with differences, the *Inclusivity* element seemed to be the most common element of Recognition of Difference dimension practiced in pre-service teachers' field experience. There were a number of indications that pre-service teachers used different teaching strategies to help them to focus on this element. For example, and as mentioned earlier, students working in pairs or groups were most common observed activities during the field experience. The small group discussions, in which students interact successfully with their peers, tend to increase the confidence of students. Pre-service teachers pointed out that working in groups allowed all students to participate and negotiate regarding their tasks.

> *The use of small group discussions helped me to focus on all students. I found that my students interacted with me with enthusiasm.   From my practice, I observed that students*

became more effective in the classroom through this method
more than through any other. (PT4, Phase II, Reflection)

Encouraging all students to be involved in a substantive conversation by raising valuable questions and following clear explanations might help disadvantaged students. One participant asserted

Implementing substantive conversation in the classroom had a
positive outcome. This was clear when the interaction was
between teachers and low achievement students because it
served to increase their motivation to learn and engage with
the classroom tasks. (PT7, Phase II, Reflection)

Limited implementation of Recognition of Difference

The limited understanding of the Recognition of Difference dimension and some socio-cultural factors seemed to play a major role in the lack of its implementation. Pre-service teachers claimed that teaching mathematics did not freely allow for the successful implementation of elements like *narrative* and *active citizenship*.

Recognition of Difference was the most difficult part of the
Productive Pedagogies framework. That was due to the
lack of clarity of how to implement citizenship or narrative
into the mathematics lesson. (PT7, Phase II, Interview)

Another participant, who shares the same view, stressed that

Usually telling stories as a teaching approach is not strong
enough to help students to understand mathematics. For
examples, in geometry units (Year 4) students need to learn
how to use math kits such as protractor and pencil compass
properly to measure angles and draw circles, where
narrative cannot help them to learn these skills. (PT4,
Phase II, Interview)

According to the pre-service teachers, *narrative* as a teaching approach, which is a form of stories and narrations, is simply not applicable to mathematics. Pre-service teachers asserted that narrative as a teaching approach might limit their teaching activities to provide their students with a useful assistance to understand some mathematics concepts. Misunderstanding of how narrative ought to be implemented in classrooms was demonstrated when teachers used short stories as introductions to their lessons. Some pre-service teachers started their lesson with two minute stories, which were not even related directly to the lesson, and consider that as *narrative*. For instance, in the lesson on division, the pre-service teacher started his lesson by saying that one boy went to the library with fifty Riyals to buy some pens, if a pen cost two Riyals he will need to use division to know how many pens he could buy. Then the pre-service teachers moved to the main part of his lesson. This example clearly did not reflect narrative as a teaching approach as it was intended by the developer of the Productive Pedagogies framework. *Narrative* should be a series of events chained together. They can be personal stories or cultural texts which demonstrate the concept being taught. Not only was *narrative* poorly implemented in mathematics by pre-service teachers, but *active citizenship* and *group identity* were also implemented infrequently in mathematics lessons. Another participant, sharing the same view, stressed that

> *I cannot implement active citizenship in every lesson, and I taught many lessons before I found a link that allowed me to use this element in my practice. (PT9, Phase II, Focus group)*

Some participants believed that achieving *active citizenship* does not belong to the disciplines but the school itself needs to be more involved in the effective facilitation of such elements of the framework.

> *I believe that the school administration should be responsible for the creation of activities that support active citizenship. (PT6, Phase 2, Interview)*

It was clear that the Recognition of Difference dimension was not obviously observed during the pre-service teachers' field experience. A number of factors related to pre-service teachers' understanding of the elements and socio-cultural issues limited their ability to produce classroom instructions that reflect these elements at high levels (more discussions on these factors were provided in the next chapter).

Overall, the data arising from pre-service teachers' observation field notes, interviews and reflective journals of using the four dimensions of the Productive Pedagogies framework indicated that there was clear evidence of attempts to implement the framework by pre-service teachers in their field experience. The four dimensions, Intellectual Quality, Connectedness, Supportive Classroom Environment and Recognition of Difference were implemented with different levels of success. Although pre-service teachers performed slightly better in Supportive Classroom Environment dimension, they faced difficulties in applying Recognition of Difference in their teaching practices. The next section discusses the how the pre-service teachers improved their ability to implement each dimension of the Productive Pedagogies framework over the course of the observation period.

6.3 Productive Pedagogies Development through the Observations Time

The data collected from classroom observations showed clear evidence of improvement in the implementation of Productive Pedagogies by pre-service teachers over the time. Figure 6.7, illustrates the change of the means in all dimensions throughout the observation period. As can be seen, there was a considerable increase on the all dimensions; Intellectual Quality, Connectedness, Supportive Classroom Environment and Recognition of Difference during the observations.

As shown in Figure 6.7, in the first observations round, the pre-service teachers scored only 1.44 out of 5 in the Intellectual Quality dimension, and 1.25 in Connectedness dimension. In the Supportive Classroom dimension

the score was 1.73, and in the Recognition of Difference dimension it was 1.23. Over the next four observations, pre-service teachers' scores increased gradually on all dimensions. In Intellectual Quality dimension pre-service teachers' score increased from 1.44 to 2.43, while in the Connectedness dimension their score increased from 1.25 to 2.37. In the Supportive Classroom dimension, pre-service teachers' score almost doubled from 1.73 to 3.06, and in the Recognition of Difference dimension, it increased slightly from 1.23 to 2.09.
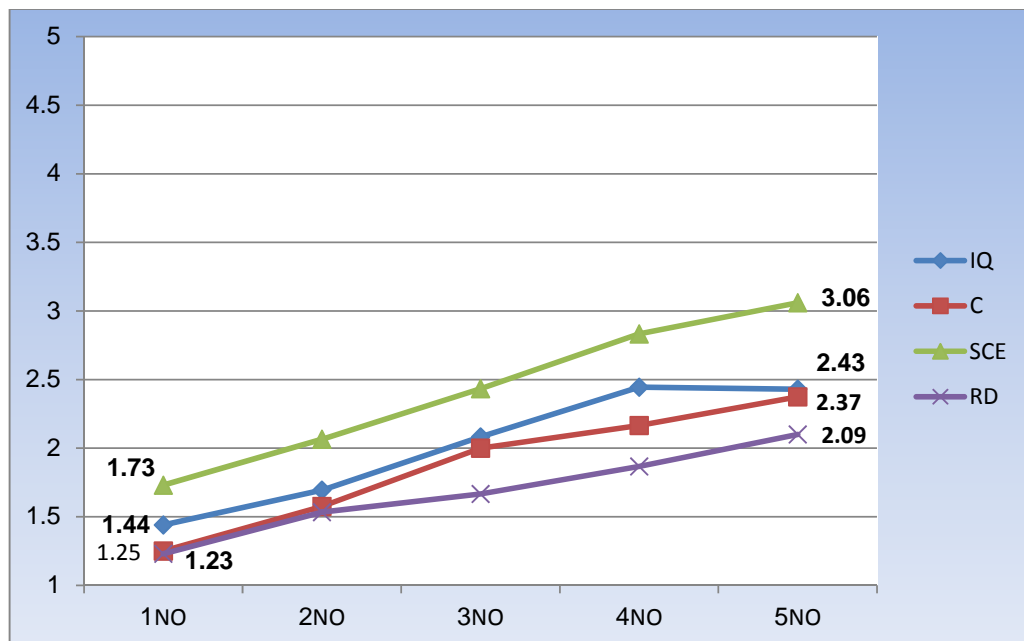
Figure 6.7: The change of the means of Productive Pedagogies dimensions through the observations time.

The pre-service teachers themselves seemed to be aware of their increased ability to use the different dimension in their field experience.

> *I felt that my teaching improved from one day to another. I adapted my way of teaching to meet with most principles of Productive Pedagogies. (PT3, Phase 2, Reflection)*

Another participant asserted

> *My teaching skills improved from one lesson to another. As a beginner, my implementation of higher order thinking, substantive conversations and connectedness were low, but improved after I focused on them. (PT6, Phase 2, Reflection)*

The pre-service teachers have utilised the framework in a variety of ways to expand their teaching practices according to the characteristics of effective teaching stipulated in the framework. For some students, the framework was a useful tool to reflect on their own practice. One student teacher asserted

> *How to improve my teaching? Before I asked myself this question, I should ask what the level of satisfaction of my teaching is and what I want to do to improve it. Then I think I can develop my teaching skills. If you do not move forward, you definitely will go backwards. (PT9, Reflection, Phase 2)*

Another student teacher found that using this model to share his experience with his colleagues helped to expand his understanding of the framework and develop his teaching skills.

> *The experiences gained from the discussion with my supervisor and my colleagues in the weekly meeting, helped me in solving some of the problems that I faced in implementing the framework. (PT4, focus group 4, Phase 2)*

Yet another student teacher used the Observation Manual in his observation of more experienced teachers to his benefit in developing his own understanding of the framework and its application:

> *I developed my teaching skills by attending some of the lessons of expert teachers during my free time in the*

school. This helped me to recognize how the framework might be able to be applied. (PT5, focus group 4, Phase 2)

Finally, the meeting with the supervisor has provided some pre-service teachers with not only the ability to recognise areas that they may be neglecting, but also to develop specific plans to rectify them.

I will work on creating a classroom environment where students can share their views and opinions freely so that they understand the lesson well. I will increase the mutual respect between students and encourage them to participate. (PT5, Reflection, Phase2)

In the next lesson, I will start with a story to attract the attention of my students, and I will connect the lesson to their everyday life. (PT3, Reflection, Phase2)

6.4 Summary

In summary, the results of the study are presented in this chapter. The data arising from weekly reflective writing, observations of 30 classes and pre-service teacher focus group interviews and journals all lead to these findings. Overall, the pre-service teachers were positive about the framework, commenting that it could be used to help guide instruction and planning of classes. The chapter reported on their levels of understanding as this was revealed to be a key part of the implementation. Most understood the framework to be helpful however, some of the sample commented that more time was needed in order to better understand the details.

This chapter also analysed data relating to the implementation of Productive Pedagogies. Overall, the pre-service teachers tended to implement the framework partially missing significant elements of the model, particularly, the Recognition of Difference dimension. Potentials and challenges in using

Productive Pedagogies by pre-service teachers in the field experience were highlighted. The next chapter will present the summary of the findings with the discussion, conclusions and recommendations.

CHAPTER 7

DISCUSSION AND CONCLUSION

The study reported here investigated the use of the Productive Pedagogies framework in a teacher education program in the context of Saudi Arabia. Although research on Productive Pedagogies has been conducted in the last 10 years, no such research has been conducted in Arabic countries in general or in Saudi Arabia in particular. The current study investigated the incorporation of the Productive Pedagogies framework within a teachers' pre-service unit in mathematics education, examining the pre-service teachers' understanding, attitudes towards, and their ability to implement it in their field experience. This study took place during both final semesters of the course and was conceptualised to consist of two phases

In Phase I of this study, a sample group of eighteen students in their seventh semester of the program were introduced to the Productive Pedagogies framework in the unit of Mathematics Teaching and Methods. The unit had been developed with altered methods of teaching to enhance pre-service teachers' engagement within the Productive Pedagogies framework. The framework had been demonstrated to the pre-service teachers through a series of seminars and group-based workshops. This phase involved teaching about and teaching through the framework.

In Phase II, six pre-service teachers were followed during their field experience in two primary schools. Each pre-service teacher was observed five times during his field experience. In each observation, evidence of implementation of the four dimensions of the framework was ascertained by using the QSRLS Productive Pedagogies Classroom Observation Manual (Education Queensland, 2001) which formed the basis for the usual feedback from the lecture on the observed teaching. The coding manual contains each element of the four dimensions, together with a score derived from a five

point Likert scale indicating the level of manifestation of the element in that particular lesson (1 being the lowest).

The data collection of this study was obtained from four focus group interviews with pre-service teachers, semi-structured interviews with two teacher educators, reflective journals that pre-service teachers and I kept, and 30 observations of pre-service teachers' practice in their field experience.

The previous chapters reported the theoretical background, the methodology and sources of data used, and the findings of this study; this chapter discusses and summarises the major findings. The chapter is divided into three major sections. Section 7.1 addresses and discusses the aims. Section 7.2 presents the limitations of this study, and section 7.3 discusses its implications and makes recommendations for future research.

7.1 Addressing the aims

To conclude this thesis, this section discusses the four aims of this study and its research questions posed in Chapter 4. A number of quotations from Chapters 5 and 6 are presented here to highlight the different issues discussed.

7.1.1 The first aim of this study

To investigate the incorporation of the Productive Pedagogies framework within a teachers' pre-service unit in mathematics education in Saudi Arabia. In particular, this project aims to investigate:

1.   How might the official unit content be integrated within a Productive Pedagogies framework?
2. How can the teaching processes in the unit incorporate Productive Pedagogies?

Movements to reform the teaching of mathematics is a current concern for many countries (Simon, 2008). However, there are many debates centred on the issue of the effectiveness of research and reform programs in changing actual school practices (Atweh, 2004). A cornerstone of these reforms involves teacher education. Teacher education must endeavour to provide learners with different theories and knowledge about teaching so that they can apply this knowledge in the classroom. However, teacher education faces four contemporary challenges. First, helping student teachers to make a link between theory and practice seems to be a major concern for many educators. Research indicates that teacher education programs are too theoretical and not helpful for novice teachers to ensure a real understating of pedagogies (Jaworkski & Gellert, 2003; Stuart & Thurlow, 2001). Barone, Berliner, Blanchard, Casanova, and McGowan (1996) state that in many teacher education programs, theory is presented without much connection to practice. Malara and Zan (2002) referred this problem as "the distance between theory - a corpus of knowledge on mathematics education in the hands of researcher -and practice- the actual teaching carried out by teachers" (p. 555). It is clear that there is a gap between theory and practice in teacher education programs. Some educators suggest reflection is a means through which this gap can be bridged (Jaworski, 1998; Mason, 1998; Malara & Zan, 2002). Jaworkski and Gellert (2003) stress that in mathematics teacher education, theory and practice might fruitfully support teaching development when theory used as a lens to reflect on practice, and practice can develop from theoretical reflections.

The second challenge faces teacher education is how to improve pre-service teachers' skills to reflect critically on their teaching practice. Reflection and development of reflection thinking is an aim of many teacher education programs (Goodell, 2006; Hatton & Smith, 1995; Loughran, 1996). Pre-service teachers will have a better opportunity to integrate theory and practice when they are introduced to reflection on teaching practice (Llinares & Krainer, 2006).

Another challenge is that pre-service teachers rely on transmission approaches of teaching as a result of their previous learning experiences. Teacher education programs have tended to use a transmission approach to learning (Clark, 2005). Therefore, pre-service and beginning teachers return to teaching styles similar to those their own teachers used (Brown, Cooney and Jones, 1990; Brown & Borko, 1992; Goos, 1999; Janvier, 1996; Triosh & Graeber, 2003). Simon (2008) mentioned that while many countries are involved in movements to reform teaching of mathematics that improve students' conceptual learning and problem solving, teachers were still educated under the traditional system of mathematics instruction. Teacher education should help pre-service teachers to understand the theoretically grounded view of learning that shifts traditional conceptions of knowledge as 'being out' there to knowledge developed by those who are involved in the teaching and learning process (Tatto, 1999). Lane (2007) suggested that teacher educators need to incorporate more student-centred instructional techniques in their teaching. Chapman (2008) identified student-centred interaction as one of the characteristics of instruction used by mathematics teacher educators to enhance pre-service teachers' content and pedagogical knowledge.

The fourth challenge is developing pre-service teachers' ability to recognise the most important factors that influence students' learning and understanding. The first factor is the intellectual quality which has a determining impact on students' achievement. Research has shown that because schools do not always require students to complete work of a high intellectual quality, students do not achieve high academic performance (Hayes et al., 2006). Several studies observed a significant trend in students' achievements when they perform intellectually demanding tasks (Anthony et al., 2000; Anthony &, Walshaw, 2008; Hiebert & Wearne, 1993; Koh and Luke, 2009; Newmann, et al., 1998; Newmann et al., 2001). Another factor is that connection to the world beyond the classroom has a tangible value. Students must be able to connect the new information with their experience in a way which has value in their lives (Newmann et al., 1996). Connecting mathematics to the world beyond the classroom enhances students'

understanding of mathematics concepts and strengthens their understanding (Newmann and Wehlage, 1993; De Lange, 1996; Gainsburg, 2008; Sawyer, 2008). Darling-Hammond (1998) stressed that teachers need to see how ideas and knowledge connect across fields and to everyday life. Third, the classroom environment has a significant impact on students' achievement. Many educational researchers have found that, student academic outcomes are strongly influenced by the quality of learning environments (Fraser, 2001). Research revealed a positive impact on students' achievement when school and teachers offer a supportive learning environment (Doane & Secada, 1996; Rawnsley, 1997; Roeser et al, 1996; Wentzel, 1997; Wubbels & Brekelmans, 2005). Recognition of the need to value diversity in the classroom has become the another area of education reform in many countries. A great deal of research has considered the connection between respect for diversity in the classroom and academic performance. According to Cary, Fennema, Carpenter and Franke (1995) students including females, members of ethnic minorities and those from lower socioeconomic groups tend not to participate effectively in mathematics classroom activities. Therefore, there is a need for a new pedagogical framework to help all students to learn and achieve equity.

All of these four challenges discussed above can be successfully addressed by introducing the Productive Pedagogies framework (Lingard et al. 2001) to pre-service teachers in teacher education programs, since the framework directly addresses all these challenges. The framework seems to bridge the gap between theory and practice as it is "a balanced theoretical framework enabling teachers to reflect critically on their work" (Education Queensland, 2002, p. 2). Hill (2002) stressed that Productive Pedagogies is a useful tool for reflection on teaching practices. Furthermore, the framework was built with a view that knowledge is constructed and not transmitted. It describes the productive classroom practice that puts students in the centre of the teaching and learning process. In addition, it has focused on the improvement of students' intellectual reasoning and makes teaching and learning in schools more applicable to the students' everyday lives, in addition to creating supportive environments which accommodate diversity in

the classroom and achieve educational equity (Luke, 1999). In this study, the Productive Pedagogies framework was incorporated into the mathematics teaching method unit by using two main forms: teaching *about* the framework and teaching *through* it to pre-service teachers.

Teaching about the Productive Pedagogies Framework

It was my belief, as well as my critical friends' viewpoints, that the framework, with all its dimensions, is different from other models of teaching because it contains a comprehensive list of desirable teaching principles. The teacher educators' interviews suggested that the framework was an essential tool for pre-service teachers seeking to develop their skills of teaching and learning in the unit. The four dimensions make Productive Pedagogies an effective teaching model for use in the classroom. Therefore, it was worthwhile to introduce it to pre-service teachers in their mathematics education unit. Introducing the Productive Pedagogies to pre-service teachers involves introducing the entire framework in one lesson and then incorporating some elements of the framework into the following lessons. The introduction lesson was to introduce the concept of the Productive Pedagogies and to establish the language and overall picture of its twenty elements. Then each dimension was further discussed in one or two lessons regarding the content of the lesson. This has been discussed in more detail in Chapter 5.

Some challenges emerged in introducing the framework to pre-service teachers. These challenges focused on providing examples from mathematics to each element of the Productive Pedagogies. In the original Productive Pedagogies classroom observation booklet, there is only one clear example from mathematics to demonstrate one element of the framework. The other 19 examples came from other disciplines. Although several mathematics examples were added to the Arabic version of the framework, pre-service teachers pointed out that the lack of references and examples of mathematics in the framework limited their understanding of its implementation in the classroom practices. They found that they needed a clear understanding of the framework to develop their skills in using

Productive Pedagogies elements in their teaching practices. Pre-service teachers want more practical activities, lessons, ideas, and examples to use in the classroom, while teacher educators believe that these should be part of their work or assessment (Wilson & Klein, 2000).

To develop a better understanding of the framework, not only are examples of mathematics classroom practices essential, but the time that they spend engaging with Productive Pedagogies is also important. Pre-service teachers reported that studying productive pedagogies in one unit was not enough to fully comprehend all the elements. This point of view suggested that the Productive Pedagogies framework needed to be expanded over multiple units. Integration of Productive Pedagogies needs to occur from the very start of teacher education programs in order to immerse the students within the framework (Gore, Griffiths, & Ladwig, 2004). This view was also supported by Zyngier (2005) who suggest that pre-service teachers need to explore the metalanguage of the framework from an early stage.

Teaching through the Productive Pedagogies framework

The teaching process in this course was focused on Productive Pedagogies as a main framework to develop the unit content for the pre-service teachers. I found the framework to be a useful tool to help me reflect on my teaching as a teacher in the unit in order to develop my teaching skills to improve the quality of the course. Considering the Productive Pedagogies four dimensions while preparing the lesson on developing lesson plan assisted me in organizing and using different strategies to implement these dimensions. In this manner, focusing on several elements of the Intellectual Quality dimension in the teaching process (as mentioned in Chapter 5) helped build a rich environment whereby pre-service teachers developed their understanding of the concepts being developed and explored ideas and their implication, as well as constructed their own knowledge. The framework encouraged me to apply teaching strategies that focused on enhancing the interaction between me and my students as well as among students to develop and disseminate their understanding of unit topics. The interaction

encouraged pre-service teachers to make distinctions, exchange ideas, and build on their understanding of the subject matter. Pre-service teachers expressed very positive views about substantive conversations during their learning experience.

> *The conversation in the classroom effectively contributes to my understanding of the issues being taught, I benefit from discussing my understanding with the lecturer or even with my colleagues. It caught my attention. (PT10, Phase I, Reflection)*

Focusing on substantive conversation during the teaching practices seemed to help participants to gain better understanding. It maintained student focus.

> *I consider that the classroom conversation was useful and helped me to concentrate on the teaching issues. Even though I lost attention sometimes; the discussion brought me back to the lesson topic. (PT5, Phase I, Reflection)*

Higher order thinking activities and substantive conversation in classrooms have been viewed as playing a major role in students' achievements (Avery, 1999; Smith, Lee and Newmann, 2001). Through substantive conversations in effective group work students can discuss and develop deep understanding (Grootenboer, 2009).

The framework also raised my awareness of connectedness in my teaching practices. Different teaching approaches were used during the lessons to create a connection between the lesson and life beyond the classroom. For example, pre-service teachers were sent to different schools to observe and engage in discussions with mathematics teachers and school principals in order to gain a better understanding of school life. They valued these visits and explained how this opportunity helped them link between theories learned in class and their practice in classrooms. Such experiences seemed to provide personal significance to each of the pre-service teachers, who recognized the possibilities of their chosen future career.

> *This opportunity* [visiting schools]} *gave me a better understanding of what a career in education is really about, it allowed me to hear from the school's principal and teachers about different concerns. I have learned many things that were hidden from me before, especially in the way of using different learning strategies at the classroom. (PT4, Classroom observation reflection)*

In addition, pre-service teachers felt that linking some units' topics with practice from schools' textbooks increased their understanding of teaching practices.

> *Using mathematics textbooks facilitated my understanding of the different teaching strategies. I was acting as a teacher not student through the task process. (PT4, Phase I, Reflection)*

Furthermore, using the framework as a tool to reflect on my teaching enabled me to turn my attention to the supportive classroom environment. For example, regarding the Student Direction element, in the past I provided no space for students to contribute to the content of the unit. However, I gave the pre-service teachers the opportunity to voice their reactions to the unit assessment system and the topic content (see Chapter 5). To some extent, they freely participated in building their unit content and selecting the best tools to be used to evaluate their work in the unit. In addition, pre-service teachers identified Explicit Performance Criteria as a great element that benefitted them as the criteria were useful for improving the quality of the teachers' work.

> *Explicit Performance Criteria was a useful element which helped me in keep tracking of the lessons as well as knowing what needs to be done for each task. (PT12, Phase I, Focus group)*

Knowing the task's expectations was listed as an encouraging factor for students. Focusing on explicit criteria not only helped pre-service teachers know what they were going to do or achieve in each lesson, but was also seen as one of the clearest implications of this approach during their studies in the teacher education program.

Generally, attempts were made to integrate the Productive Pedagogies elements with the content of the official unit in mathematics education. Regarding the teaching process, both colleagues agreed that good attempts were made to integrate the teaching process with the framework. Each topic incorporated one or more of the dimensions of the framework based on the nature of the unit content. Most attempts to implement the framework elements in the teaching process were successful. Different teaching strategies were used to facilitate the integrated approach to the content as mentioned in Chapter 5.

In spite of this successful integration into the unit content, implementing PP in general is highly demanding. My view aligns with my colleagues' opinions, which stressed that extensive teacher effort was required to implement the framework. Introducing any innovation into teaching practices requires a substantial effort. Some of the challenges in implementing the framework in classroom practices were found to restrict such implementation. These were a practical difficulty related to the amount of time spent introducing the framework to pre-service teachers and a difficulty related to providing high levels of each element of the Productive Pedagogies.

7.1.2 The second aim of this study

To investigate the pre-service teachers' engagement with Productive Pedagogies. In particular, this project aims to investigate:

1. To what degree do the pre-service teachers' appreciation and have a favourable attitude towards Productive Pedagogies?

As mentioned earlier, one of the challenges teacher education faces is that pre-service teachers tend to teach in a traditional manner. Klein (1996) found that pre-service teachers tend to rely on transmission approaches of teaching when they teach their students in schools even when they had been exposed to constructivism during their study. In similar fashion, Foss and Kleinsasser (1996) concluded their study about pre-service teachers' beliefs and practices of mathematics teaching by noticing that in spite of pre-service teachers being exposed to constructivism during their study, their beliefs and practices about mathematics teaching had not changed.

The data collected from the student teachers in Phases I and II of the study showed the pre-service teachers' widespread approval of Productive Pedagogies. In general, many positive comments were made related to the use of the framework demonstrated in the different reflective journals and focus groups conducted in the project. In particular, the framework was perceived as an effective framework for teaching for two reasons. Firstly, it was found to be valuable as an overall guide for the pre-service teachers' practice. Secondly, it enabled them to adopt a shift towards student-centred teaching.

Valuable Overall Guide for Practice

The use of Productive Pedagogies as an overall guide to teaching practice was a common theme mentioned by several of the pre-service teachers. In interviews and focus groups, the majority of pre-service teachers stated that the framework was a highly helpful tool for good teaching practice. During their study at the college, these pre-service teachers experienced a range of courses addressing teaching and learning theory, curriculum, and educational philosophy. As part of their studies, the pre-service teachers had been exposed to different theories of teaching and learning and had explored a variety of teaching pedagogies. Although the framework does not provide a particular philosophy of education, a set of aims or a set of pedagogies, it provided these pre-service teachers with a tool for integrating the different knowledges they acquired in the course as well as a practical tool for

reflection and informing practice. Hence, it was seen as a useful tool for learning about teaching at their level of development. In the words of one student:

> *I saw the Productive Pedagogies principles as a key basic model for teaching; it is a tool that can lead pre-service teachers to the right steps to become successful teachers in the future. (PT1, Phase I, Focus group)*

Gore, et al., (2001) stressed that evidence suggests that pre-service teachers who introduced to the framework tended to find it useful to guide their teaching. The participants felt that the different dimensions of Productive Pedagogies helped direct their teaching practice. Becoming a good teacher is the goal of beginning practitioners, and the framework was seen as helpful in guiding them in strategies teachers might apply in specific lessons. Productive Pedagogies is largely about asking the right question in the right way (O'Toole, 2006). More specifically, the pre-service teachers identified the comprehensiveness and organisation of the framework as being particularly useful. The four dimensions of the framework; Intellectual Quality, Connectedness, Supportive Environment, and Recognition of Difference helped pre-service teachers focus on all aspects of the classroom practice. Overwhelmingly, they expressed very positive views about the potential of Productive Pedagogies as a model for teaching that provides comprehensive and organized aspects of teaching strategies. One participant mentioned that:

> *In my view, Productive Pedagogies is a complete model of teaching and it has all the elements of good teaching. (PT7, Phase I, Focus group)*

Another student put it this way:

> *Productive Pedagogies is well-organized model and I found*
> *that the four dimensions of the framework complement each*
> *other and must be applied in mathematics lessons in order to*
> *benefit all students. (PT6, Phase II, Reflection)*

Facilitating Change Towards Student-Centred Teaching

The framework helped facilitate a shift in teachers towards an increased focus on student-centred learning. The principle of student-centred education was not a new concept for these pre-service teachers. As previously discussed, this has been a focus of recent reforms at the college in which these pre-service teachers study. However, an apparent gap exists in acknowledging this as a general principle and a teacher's personal understanding and implementation. Previous research has indicated that pre-service teachers often revert to traditional theories of learning and teaching methods during their field experience and in their transition to the practice of teaching (Richardson, 1996). This project revealed strong evidence that participating pre-service teachers not only perceived the framework as being influential in challenging their personal theories of teaching and learning, but it also impacted significantly on their practice to effect more student-centred approaches.

Teachers' personal views on learning theories are important influences on classroom practice. One possible way in which student teachers can use the learning theories to inform their practices is by making a change in their own beliefs about teaching and learning mathematics (Ebby, 2000; Grootenboer, 2008; Lavy & Shriki, 2008). Mathematics teachers' beliefs influence their classroom teaching practices (Stipek et al., 2001). Teacher practices in the classroom are a reflection of individual beliefs related to learning theories and styles. Applefield, et al., (2000, p. 1) stated that "teachers' personal theories of learning have long been viewed as having considerable influence on virtually all aspects of teachers' decisions about instruction". Student-

centred teaching was found to be one of the central implications of the framework. Considerable evidence exists in this study that the consideration of Productive Pedagogies influenced participants by challenging their views about their assumed learning theories. The pre-service teachers indicated that their views of learning and teaching changed after studying and implementing the framework. Similarly, evidence indicated that the use of Productive Pedagogies in the course assisted the pre-service teachers in consciously thinking of means of replacing traditional and familiar teaching methods with more student-centred activities. The advantage of Productive Pedagogies is that it provides a more tangible means of promoting teachers' understanding about student-centred learning and intellectual quality. Thus, it was expected that pre-service teachers in this study would perceive the framework as a guide towards a student-centred classroom. Hayes et al. (2006) argued the Productive Pedagogies is constructed within the student centred approaches to teaching and learning. Earlier studies have found that exposure to the framework leads pre-service teachers to change their practices (Gore et al., 2002). Atweh (2010) in his critique on the student-centred approaches argues for the need to balance the focus on the student by looking deeply at the pedagogy used by the teacher and that the focus should be on the teachers as a crucial and effective agent in education. He calls for providing teachers with frameworks that allow them to reflect on their teaching and sees Productive Pedagogies as such a framework.

7.1.3 The third aim of this study

To investigate the pre-service teachers' ability to implement the Productive Pedagogies during their study of the unit.

The project embedded the Productive Pedagogies framework in the mathematics education component of the course during the last year of the pre-service teachers' course and utilised it in their field experience. In this section, the pre-service teachers' implementation of the framework in their field experience was highlighted. Some of the difficulties they encountered in the use of the Productive Pedagogies were also discussed.

Implementation of the Framework

During the field experience, the pre-service teachers consciously used the framework in the planning of their lessons. One student summarised his experiences as follows:

> *I always have the four dimensions in my mind in every lesson and try to apply some of the elements that facilitate teaching to achieve the lesson's objectives; [I find] this framework is the best way to improve my practice. (PT6, Phase 2, Reflection)*

In reflecting on their field experience, some students discussed how the model was useful for them in preparing for their teaching by planning activities that provided for a range of aims inspired by the model. Other students indicated that they were aware of the framework in conducting their classes and interacting with students. When possible, they employed open-ended questioning for the students. Finally, the reflective journals demonstrated that they were able to use the framework to reflect on their teaching towards a deeper awareness of their assumptions and practices. According to Zyngier (2005), the framework provides pre-service teachers who have no experience in teaching with intelligible language for thinking about teaching. The Productive Pedagogies framework provides teachers with a vocabulary to help them discuss their pedagogies and reflect upon them (Lingard, Hayes, & Miles, 2003).

The data collected from classroom observations suggested that attempts were made to implement the four dimensions (Intellectual Quality, Connectedness, Supportive Environment, and Recognition of Difference) by the various pre-service teachers in their teaching. These attempts were demonstrated and analysed in Chapter 6. The data from pre-service teachers' interviews and reflective journals revealed that they consciously attempted to apply many elements in their practices. For instance, they asserted that implementing higher order thinking and substantive

conversation elements helped students gain deeper understanding of the content discussed. These comments are in line with Newmann's (1990) finding that teachers who promote higher order thinking will enhance benefits for individual students. He argued that higher order thinking is important for all students' learning. Newmann and associates (1996) subsequently found that, when teachers provide students with intellectual challenges, students perform better in their assessment. In addition, pre-service teachers highlighted that connecting the mathematics lesson with the world beyond the classroom helped their students demonstrate a better understanding and increased their motivation to learn the content. In classrooms, pre-service teachers created activities to help students create links between mathematics and their background knowledge as well as between mathematics and other sets of subject area knowledge. The use of different questions and formats of explanations resulted in students generating more meaning of the mathematics at hand. Most students were involved in the task, and they showed enthusiasm by helping each other and raising questions as well as being focused and keen participants. According to Hayes et al. (2006), when teachers make the subject matter relevant, they connect classroom learning with real-world processes, thereby making learning more enjoyable. Furthermore, the observation results revealed that pre-service teachers were confident in their actual classroom environment as they provided frequent assistance for students. Pre-service teachers seemed to be interested in helping students whenever they have trouble with their work and appeared to consider their feelings. They like to move around the class to discuss matters with students and ask questions to help understanding.

The data collected from classroom observations also showed clear evidence of improvement in the implementation of Productive Pedagogies by student teachers over time. Figure 6.7 in Chapter 6 illustrates the change of means in all dimensions during the observation period. As can be seen from that figure, a considerable increase occurred in all dimensions during the observations. Pre-service teachers valued their progress in implementing the framework in their teaching practices. They felt that over time and with more

practice they could produce better teaching in line with the Productive Pedagogies principles. In addition, pre-service teachers used the framework to share their experience with their colleagues, which seemed to expand their understanding of the framework and develop their teaching skills. According to the pre-service teachers, the two-hour weekly meeting gave them the opportunities to discuss implications of the framework with me (as their supervisor) and their colleagues, which in turn helped them develop their understanding of the framework.

> *The experiences gained from the discussion with my supervisor and my colleagues in the weekly meeting, helped me in solving some of the problems that I faced in implementing the framework. (PT4, focus group 4, Phase 2)*

Discussion of the Hindrances

Despite the positive indicators of the effectiveness of the Productive Pedagogies framework in assisting these pre-service teachers in their understanding, planning and conducting of their teaching, two issues are worth noting based on the data in this study. Careful consideration of the data represented in Tables 6.2, 6.3, 6.4, 6.5 and 6.6 (in Chapter 6) indicate significant variation in the scores in many of the elements and considerable variation among the different elements. Each of these two patterns is discussed in more detail.

First, not all pre-service teachers demonstrated the same level of application of the framework in their teaching. Although the group averages in many of the elements indicate that attempts have been made to implement the principles of Productive Pedagogies in the different classes, some pre-service teachers did that more than others. To a large extent these variations can be explained by considering the level at which the pre-service teachers were teaching. Some of the participating pre-service teachers indicated that certain elements of the framework were not easy to apply because of the students' level of development. Some observable differences were evident in

the use of the framework between teachers at higher and lower levels. The interviews and focus group discussions indicated that pre-service teachers at lower levels in the school faced some difficulties in earlier years (i.e., years 1 through 3).

> *For students at the lowest stage, the activities that focus on higher order thinking can be difficult because they require high mental capacity. (PT6, Phase II, interview)*

Some pre-service teachers have attributed these difficulties to students' level of maturity and language abilities. They were concerned that a focus on higher order thinking would be challenging for the students; some students may find these tasks too frustrating and may not be able to cope with them, thereby resorting to copying the responses of other more capable students in class. These pre-service teachers appropriately concluded that higher order thinking tasks should be used judiciously when considering their appropriateness to the students' particular level of knowledge development. Pre-service teachers who teach students at lower levels seemed to experience some difficulties in posing questions that encourage their students to use higher order thinking in mathematics. They seemed to have less confidence in providing students with appropriate tasks to practice higher order thinking skills. According to Way (2008), many studies continue to show that teachers raise few questions to encourage children to use higher order thinking skills in mathematics because students are inexperienced in such tasks or questions or teachers have not yet developed their abilities in using higher order thinking skills in their teaching. Engaging students in higher order thinking was not an easy task for pre-service teachers, who needed to be certain that tasks and activities challenge students without disappointing them. They should focus on the level of students' thinking and capabilities and match the tasks to suit students' levels.

Similarly, pre-service teachers faced challenges in implementing substantive conversations with students at lower levels. Involving students in in-depth

discussions to understand mathematical concepts was challenging for these teachers. In traditional classes, students sometimes resisted sharing their mathematics thinking or were not comfortable expressing themselves. The classroom seemed to have fewer student-teacher interactions in these cases.

> *Applying substantive conversation with my students (Year 3) seemed to be difficult. I encouraged them to raise questions, but there were no more questions to be raised in the classroom. (PT6, Phase II, interview)*

Kitchen (2004) stressed that novice teachers may find it difficult to motivate quiet students to express their mathematical thinking practicality. Although many studies indicated that engaging students in exchanging ideas and opinions during class dialogue would help them grasp the complex relationships between the mathematics concepts, pre-service teachers who teach at lower levels found it difficult to focus on substantive conversations in their teaching practices. Pre-service teachers, and for that matter novice teachers, are often limited in their teaching by their previous experiences as students of mathematics. Traditional mathematics classrooms are known for presenting the context through teacher-centred approaches that involve limited engagement of students in dialogue and the raising of questions to understand the concepts. In addition, metalanguage, which refers to pedagogies that incorporate frequent discussion about talking and writing, had limited implementation in most mathematics lessons observed. One participant stressed the difficulty of incorporating discussions about talking and writing into the mathematical classroom:

> *Sometimes, in mathematics classrooms, it is hard to use alternative words to explain the mathematical concepts. In my class (Year 3) focusing on aspects of language or writing will use up too much teaching time. Students have difficulty in reading and writing because they are still young. I usually have to read the questions to them. (PT6, Phase II, Interview)*

The lack of experience in using higher order thinking or substantive conversation to illustrate mathematics concepts indicated that pre-service teachers at lower levels seem to provide limited opportunities for students to discuss, negotiate, explain and reflect their own ideas. It is worth noting that the field of early childhood education in Saudi Arabia is slowly evolving. According to Arab Human Development Report (2003) "despite major efforts to improve preschool education in some Arab countries, the quality of education provided in many kindergartens in the region does not fulfil the requirements for advancing and developing children's capabilities in order to help socialise a creative and innovative generation" (p.52). Considerable work needs to be done in this area to investigate what young students are capable of and how to provide them with challenging opportunities to promote their intellectual development.

In addition, it is worthwhile mentioning that this study has not looked to the individual differences between the participating pre-service teachers. While each pre-service teacher during his field experience was given the support that he needs to implement the framework successfully, the study did not go further to analyse the individual difference due to the time limitation of this study.

The second observation that needs to be made about the data from the previously mentioned tables is that not all elements of the Productive Pedagogies were demonstrated at the same level. In particular, the pre-service teachers did not seem to apply *knowledge as problematic*, *problem-based curriculum*, *knowledge integration*, *student direction*, *student self-regulation*, *narrative*, *group identity* and *active citizenship* at the same level as the other levels. The first five elements will be discussed in the fourth section in line with the fourth aim of the study. Here, some pre-service teachers reflected that certain elements of the framework were not easy to apply in mathematics lessons. For example, some student teachers claimed that teaching mathematics did not easily allow for the successful

implementation of the Recognition of Difference elements like *narrative*, *group identity* and *active citizenship*.

The use of narrative, which is a form of story-telling, and narrations as a teaching method is increasingly used in education (Dettori & Paiva, 2009). The use of narrative in the literature is not restricted to subjects such as writing, history, and language subjects; it also has some application to mathematics and science education (Bruner, 2004Burton; 1996). According to Burton, mathematics is a socio-cultural artefact, but the widespread acceptance of objective mathematics has enhanced the transmission pedagogy. Therefore, narrative is important as pedagogy for teaching mathematics and "[w]ith respect to the content of mathematics, instead of presenting it as 'objective', independent and fixed, we can tell its socio-culture story, seeing it as a solution to a social imperative of a particular culture. By engaging with narrative, we place the mathematics in its context and personalise it, making it come alive to the conditions of the time" (p. 32). She stressed that through narrative, learners can explore the meaning of their experience in mathematics classroom. Burton explained what a narrative approach to the learning of mathematics looks like by showing students' narratives in response to the challenge 'crossing the river', wherein two men and two boys want to cross the river with one canoe which will hold only one man or two boys. One group of students described their answer in a written form, while other group used carton pictures and words to explain their solution (see Burton, 1996). However, Solomon and O'Neill (1998) argued that Burton's two different narratives describing the solution to the crossing the river problem fails to clarify the benefits of using narrative in mathematics. They stressed that the first example (written in a personal style) described the circumstance around the solution to the problem not the problem itself and the second example (using pictures) used symbols instead of writing a text which in turn supported the opposite of narrative approach. Solomon and O'Neill (1998) argued that mathematics knowledge cannot be adequately conveyed in narrative form because it is structured around logical and not temporal relations. Healy and Sinclair (2007) clarified these two different views of narrative in mathematics by saying "while Burton seems to

concentrate on the construction of a personally meaningful mathematics, Solomon and O'Neill completely overlook the possible role of narrative in more personal acts of understanding in referring to the way mathematics can or cannot be communicated within the mathematical community" (p. 4). Arguably, more research in mathematics education is needed in this area in order to identify what narrative looks like in mathematics and what might be its characteristics. Telling stories as an introduction of mathematics lesson might be a worthwhile strategy, however considering mathematics as constituted by a logical structure and symbols is respected. Pre-service teachers asserted that narrative as a teaching approach might limit their teaching activities to provide their students with useful assistance to understand some mathematics concepts.

> *Usually telling stories, as a teaching approach, is not strong enough to help students to understand mathematics, for example, in geometry units (Year 4) students need to learn how to use math kits such as protractor and pencil compass properly to measure angles and draw circles, where narrative cannot help them to learn these skills. (PT4, Phase II, Interview)*

Not only was narrative poorly implemented in mathematics by pre-service teachers, active citizenship and group identity also were implemented less in mathematics lessons. It should be stressed that, traditionally, mathematics textbooks do not address social issues as contexts for problems, which is perhaps a reflection of the "objectivity" of mathematical knowledge and its strong relation to science and technology. Bishop (1991) argued that the mathematics curriculum in many countries have failed to emphasise the importance of the culture aspects of mathematics. Atweh and Clarkson (2001) stressed that "the debate of what is culturally bound and what is culture free in mathematics is an ongoing debate in mathematics education literature" (p. 90). Hence, a teacher who wants to encourage citizenship through mathematics needs to look for outside sources for inspiration. Perhaps pre-service teachers' ability to do so is limited. Some participants

believed that achieving active citizenship does not belong to the disciplines, but the school itself needs to be more involved in the effective facilitation of such elements of the framework.

> *I believe that the school administration should be*
> *responsible for the creation of activities that support active*
> *citizenship and group identity. (PT6, Phase II, Interview)*

Several studies have suggested that the Recognition of Difference elements such as narrative, active citizenship and group identity contribute to the academic performance of students from marginalised backgrounds (Hayes, Mills, Christie, & Lingard, 2006). However, in Productive Pedagogies, the recognition of difference dimension is an issue that has been highly debated (Milles at al., 2009) because the original QSRLS study lacked empirical evidence relating to the recognition of difference elements in the classroom observation (Hayes et al., 2006). Lingard (2007) suggested that the absence of certain elements of the dimensions in the QSRLS study might have reflected some technical issues to do with the scales of each element. Ladwing (2004) asserted that active citizenship was poor in the observations because very few teachers actually do anything recognizable as citizenship or the item itself was poorly defined. Mills at al. (2009) demonstrated the lack of evidence of active citizenship and group identity in classroom observation by saying that "certainly, our view is that they are applicable to all curriculum areas but that this may not be immediately apparent in the content of subject such mathematics" (p. 79).

7.1.4 The last aim of this study

To investigate socio-cultural factors related to the incorporation of Productive Pedagogies in a Saudi Arabian context.

Productive Pedagogies is a framework which describes the classroom practices that make a difference (Hayes et al., 2006). Making a difference to the performance of students from all different background is a major concern of many educators. According to Hayes (2000) the main questions which informed the development of the Productive Pedagogies framework were: 1) what forms of classroom practice contribute to more equitable student outcomes? and, 2) what forms of classroom practices contribute to increased student outcomes for all students? After analysing the literature and structured observation in almost one thousand Queensland schools, the twenty classroom practices that support enhanced students outcome both academically and socially were identified (Lingard et al., 2003). The framework was then widely accepted by researchers and teachers as a set of productive principles for quality teaching practices.

The quality of teaching practices and pedagogy in the classroom are usually seen as a social justice issue (Atweh, 2007; Lingard et al., 2001; Mills & Keddie, 2005; Mills & Goos, 2011). According to Allen (2003) the development of Productive Pedagogies was centred around issues of social justice, equity and inclusion. Hayes et al. (2006) argue that social justice is the foundation of Productive Pedagogies and not only for recognition of difference dimension. In this study using the Productive Pedagogies framework in teacher education in order to improve teaching practices highlighted some socio-cultural issues that need to be considered. In this section, these issues were discussed under the following four headings; 1) school environment, 2) citizenship, 3) lack of reform, and 4) lack of research on gender.

First, some elements were not easy to apply due to the school environment as a whole. The school environment seemed to limit student-teachers' ability

to apply the Problem-based Curriculum, Student Direction, Knowledge Integration and Student Self-regulation to a significant degree. In Saudi schools, each student is provided with free textbooks for all subjects. The textbooks contain the prescribed lesson content and specific exercises that the students should complete. Most of the lessons are not built on real-world problems or problems that require sustained attention beyond a single lesson. Each lesson has many traditional mathematics questions that require certain answers. The school's tradition of strictly following textbooks as guides for planning and assessment was found to restrict the teachers' ability to create activities that might help students combine mathematical knowledge and the real world outside the classroom. Teachers are thus pressured to follow the tradition of the school and use the textbook as the main source of students' work. Consequently, they sometimes tended to rely heavily on teacher-centred pedagogies. In addition, this is partly due to the inadequate primary-level lesson times of 45 minutes as teachers feel pressure to finish the lesson quickly and efficiently at the expense of sharing the direction of the class with students.

Given the school environment, knowledge integration was another element that student teachers faced difficulty in implementing in their field experience. The pre-service teachers were subject to the traditional disconnection between the different school subjects in terms of content reinforced by separately timetabled lessons taught by different teachers. However, a more interdisciplinary approach is essential to improve the teaching and learning of mathematics (Atweh, 2007). The idea of connecting subject areas comes from the fact that in the real-world-learner's lives are not separated into separate subjects, so it seems only logical that subject areas should not be separated in schools (Czerniak, Weber, Sandmann & Ahern, 1999). While there have been a number of attempts to integrate subject areas to build students' learning in many countries in the recent times (NSW, 2003), this is not the case in Saudi Arabia. Undoubtedly, this is, in part, a result of the lack of the pre-service teachers' experience and the limited possibilities of discussion with other teachers in other subjects taught at the school.

> *There are no opportunities for formal meetings or discussions about subject area integration, in our school. Whenever I attempt to establish a discussion about our practice with other teachers, they do not take it seriously because I am a new teacher. (PT9, Phase II, Interview)*

Commenting on the school environment, Hayes, et al. (2006) argued that schools played a role in the effectiveness of these pedagogies. Regular meetings between teachers in schools and reflection on their teaching practice might help increase the awareness of the quality of pedagogies. More time for teachers to engage in professional discussions with their colleagues about the framework will support and value their work (Lingard et al., 2003).

The pre-service teachers felt that they needed greater support from the school administration to help them to find ways to manage their classes. They were concerned about keeping the class quiet all the time. They would not allow their students to engage in discussions or talk with other students without the teachers' permission. This may have stemmed from pre-service teachers' lack of confidence and experience in sharing control with students. Hayes, et al. (2006) suggest that "in presenting the *Productive Pedagogies framework* we emphasise that in order to make a difference for students, our findings suggest that these classroom practices must also, be supported by leadership focused on learning, supportive and professionally enabling relationships among staff, and between staff and students" (p. 39). According to Tirosh and Graeber (2003), if the school environment is supportive, change in individual teacher teaching practice occurred.

The second socio-culture factor is that schools in Saudi Arabia provide limited space for democratic practices. In fact, many of the school principals generally are not involved in the decision-making processes as the central office system employs top-down decisions for schools. Indeed, teachers have no space to engage in a social dialogue which would enable full democratic communication and participation within the school. As could be

expected, this inevitably reflects on their interactions with students in the classroom. Perhaps this partly explains why some elements, such as active citizenship, were poorly observed during the classroom observations. The class where a teacher controls the room with no negotiation of rights or responsibilities attributed to students is an example of class with less active citizenship (Education Queensland, 2002). Skovsmoe and Valero (2005) argue that in mathematics education, citizenship involves a variety of forms of participation and this means not only receiving information from authorities but also means providing a "talking back" to authority. "Then it is important to ask whether a critical citizenship can be supported by the development of a critical mathematical literacy" (Skovsmoe & Valero, 2005, p. 64). Atweh (2007) stresses that as the nature of mathematics used in society has changed more rapidly than mathematics curriculum in schools, students need access to a large amount of mathematical knowledge for effective citizenship. In addition, pre-service teachers during the focus group interviews raised questions about the benefit of focusing on active citizenship in their mathematics lessons since their students take a unit called "national education". Even though students from Year 4 until Year 12 study national education for one lesson each week, they were required to just memorize some facts and general information about the country. It is doubtful that this subject would provide sufficient development of citizenship.

Here the blame should not just focus on schools, the whole community and policy makers should be aware of the lack of active citizenship in classroom practices. It is worth mentioning that in the education policy of Saudi Arabia, active citizenship was considered and has been highlighted by several articles in the education policy document. Some of the subjects addressed in these articles include the need to: provide students with the skills and knowledge necessary for being an active member of society; sharpen student's understanding of the cultural, society, and economic problems of society, and prepare them to participate in constructive solutions; and encourage social solidarity among members of the Muslim community through cooperation, love, fraternity, and placing the public good over private interests (Ministry of Education, 1980). However, these valuable principles

need to be observed in all curriculum and classroom practices, as well as in all school decision making processes. Lingard et al., (2003) stressed that teachers and schools carry some responsibility for student's outcome but not all - "contemporary social policy that exacerbates social inequalities renders the school's role and that of the teacher more difficult in this respect" (p. 419).

Third, other socio-cultural factors are likely to remain unchanged due to the lack of research on the learning and pedagogies and the absence of educational reform movements in the country, resulting in education remaining very traditional. According to Arab Human Development Report (2003), in the latter half of twenty century, the Arab countries had made great strides in the quantitative expansion of education, however, the general condition of education is still not adequate when compared to the achievement of other countries. Alhabob and Alhosini (2007) stressed that there is a need for more practical research to evaluate the educational reforms in Arabic countries. As previously discussed, the education reform in Saudi Arabia is mainly focused on changing and developing the curriculum; the reality is that mathematics education teaching remains dominated by the textbooks. The textbooks themselves present mathematics as abstract decontextualised knowledge, dominated by concepts and procedures with limited applications and problem-solving activities. The textbooks contain very limited and artificial real-world examples. Pre-service teachers and, for that matter, all novice teachers, are often limited in their teaching by their previous experiences as students of mathematics (Goos, 1999; Janvier, 1996; Triosh & Graeber, 2003). Perhaps this is one factor that partially explains why pre-service teachers may have found it difficult to implement the Connectedness dimension of the Productive Pedagogies.

This traditional context of education extends to methods of teaching into which the students and teachers are acculturated. Traditional models of teaching in Saudi are dominated by teacher centredness, with teachers as the source of knowledge and having the main responsibility for knowledge transfer. Teaching mathematics in Saudi classrooms is influenced by

teacher-centred approaches (Alfarhod, 2009; Bader, 2004). Providing information in an oversimplified way is the common teaching mode in Saudi classes. Students are accustomed to being spoon-fed by teachers. This teacher-centred environment limits opportunities for student negotiation, dialogue and experimentation. In addition, the classroom environment in primary school tends to encourage students to compete rather than cooperate with each other. Clearly, these traditional dominant practices hinder the application of models of teaching promoted by Productive Pedagogies.

Fourth, the lack of research on gender differences and mathematics achievement in the country is a socio-culture matter. Mills and Goos (2011) stressed that the quality of pedagogy experienced by students in mathematics classrooms is a social justice issue. Despite the fact that the genders are segregated at all levels of schooling in Saudi Arabia, and that it is the only country in the world with a 100% single-sex schooling system which is due to the social, cultural, and religious traditions (Wiseman, 2010), educators should put significant effort into researching and investigating gender differences in mathematics classroom practices. Being aware of the difficulty of doing qualitative research which involves boys and girls at the same time by a male or female researcher means that researchers will need to work together and find alternative ways to carry out such a research project. In a study used the TIMSS 2003 data for Saudi students, Wiseman, Alsadaawi and Alromi (2008) asserted that "the results indicate that being female is associated with a slight reduction in math score, whereas being female is associated with a slightly stronger increase in science score" (p. 8). The education policy of Saudi Arabia stresses the importance of offering equal opportunities for education (Ministry of Education, 1980). Promoting equal opportunities ensures that boys and girls are exposed to similar kinds of quality pedagogy during their school experiences. Atweh (2011) argued that raising the level of both equity and quality in mathematics education is not only essential but it is also possible.

Using Productive Pedagogies in this study highlighted the principles of quality pedagogy in mathematics teacher education. However, focusing only on male teacher education, without addressing aspects related to female teacher education is one of the limitations of this study. In turn, this raised a central issue in how female pre-service mathematics teachers experience the implementation of pedagogies in their teacher education program and how they might or might not benefit from these experiences in their teaching practices. In line with the Productive Pedagogies principles which stress the importance of enhancing student outcomes academically and socially for all students, these concerns should be addressed by teacher educators.

7.1.5 Conclusion

The research aims in this thesis were to investigate the incorporation of Productive Pedagogies framework within a teachers' pre-service unit in mathematics education, the pre-service teachers' engagement with the framework, their ability to implement the Productive Pedagogies' four dimensions in the field experience and socio-cultural factors in incorporating the framework in a Saudi context.

Overall, this study concluded that it is possible for the Productive Pedagogies framework to be incorporated into the pre-service teachers' unit on mathematics education in Saudi Arabia. The framework was clearly incorporated within the pre-service teachers' mathematics unit in the final year of the mathematics education course. Reflecting on the teaching process by using the framework helped pre-service teachers focus on different parts of classroom practices.

Productive Pedagogies was also useful for pre-service teachers in order to develop their understanding of teaching and learning mathematics. The results pointed out that Productive Pedagogies is a good framework for pre-service teachers in Saudi Arabia to assist them in reflecting critically on their teaching practice in order to improve it. Pre-service teachers experienced positive views of the framework and perceived it as a tool to help reflect

meaningfully upon their learning and teaching practices. They were more comfortable with the language of Productive Pedagogies as the project progressed. They showed their ability to implement most of the elements of the framework.

However, they experienced some potential challenges when they applied it in their teaching. Some of these difficulties pertained to teaching the mathematics subject, students' level of development, school environment and socio-cultural factors. Some elements, such as *narrative*, need further discussion to determine how they can benefit the mathematics class. Elements such as *group identity* and *active citizenship* might need further exploration to be able to fit with the mathematics curriculum to benefit the country. The *problem-based curriculum* and *student direction* elements need to be used moderately regarding the Saudi mathematics textbooks. Other elements, such as *student self-regulation*, *knowledge integration* and *connectedness to the world beyond the classroom*, need the school environment's support to help teachers implement them in their classroom teaching practices with a high level of success.

7.2 Limitations of the study

As in any study, this study has limitations; therefore, its findings should be generalized with caution. The first limitation was the short period allowed for the study. Due to the nature of the project being focused only on one subject in one semester, one cannot expect a comprehensive set of recommendations for the reform of teaching practices in the classroom. Traditions of teaching developed over a lifetime – if not generations – require more effort to expose and reform. However, the evidence derived from this study here indicates that adopting this framework might be a promising step in the desired direction.

A second limitation of the study was that conclusions drawn from this study related only to this sample. Any inferences made with regard to the wider

population of pre-service teachers in mathematics should be interpreted with care. This study used a sample of only 18 pre-service teachers from one teachers' college and this sample may not be representative of all mathematics pre-service teachers in Saudi Arabia. Although qualitative research primarily works with a small sample, it may be necessary to examine these findings more carefully before using them widely in the Saudi educational context.

A third limitation was the appropriateness of the language of the materials used. The Productive Pedagogies framework was developed in Australia, and all its documents are written in English language; it was not a realistic goal to translate all these materials into Arabic for the participants in this study. Even when the *Productive Pedagogies Classroom Observation Manual* was translated into Arabic, with permission from Queensland Education Department, the manual proved to not be enough information and pre-service teachers still needed more references, which were all in English, to fully understand the framework. As they have difficulties reading English, these references were of limited value.

Finally, the qualitative research design itself produced limitations. The use of qualitative inquiry informed by practical action research for the collection of data of this study was appropriate because it helps generate a more systematic and defensible reflection process; this in turn helped to reflect upon and improve students' learning as well as teaching practices. However, it is the nature of this type of research wherein the researcher plays two roles during the research process, namely, as a teacher and as the person collecting interview data from participants. This might affect participants' willingness to share information and they may feel pressure to do so just to please the teacher.

7.3 Contributions, Implications, and Suggestions for Future Research

7.3.1 Theoretical Implications

The present study makes several contributions to the literature. The major contribution of the thesis comes from the fact that this study was the first attempt to use the Productive Pedagogies framework in a non-western culture. While the framework has been developed in western countries, its usefulness in other contexts was not taken for granted. However, this research has argued that the framework is in line with Saudi Arabia policies of pedagogy and social justice. The experience of this selected group of pre-service teachers in using the Productive Pedagogies for planning and reflecting on their field experience demonstrated its overall usefulness. A significant increase in the use of practices encouraged by the framework occurred during the observation period. Pre-service teachers' interviews and focus groups indicated that they were appreciative of the use of such a framework in this part of their training. It also highlighted some of the hindrances of its full implementation.

Second, in the specific area of mathematics education, this study was the one of the first to use the framework in a mathematics education unit in pre-service teacher education. The findings of this study stressed that the framework is applicable in mathematics education, however there are two issues which need further research. First, the findings raise the need for educators to conduct more research about some elements of the framework not often seen as applicable to mathematics education, as discussed earlier in this chapter. Second, the results highlighted the difficulties that teachers, who teach a lower stage, might face in implementing some of the elements such as *higher order thinking* and *substantive conversation.*

Also, the thesis contributes to knowledge in the area of mathematics research in Saudi Arabia. This research identified several hindrances that the

pre-service teachers expressed as areas in need of attention to enable an increased use of effective pedagogies in the classroom. Many of these limitations may be due to a lack of knowledge by the teachers regarding how to implement these dimensions at an appropriate level for the development of the student or the subject of mathematics in particular. These noted limitations call for increased attention by teacher education courses on early childhood education as a whole and in mathematics education in particular. I remain committed to the idea that the Productive Pedagogies framework is useful across all school levels and in all subjects. However, the meaning of some of the identified dimensions and elements with specific age groups and specific school subjects may require further unpacking.

Third, although some of the hindrances identified relate to schools, educational systems or even society which cannot be easily changed by a single teacher, let alone a pre-service teacher. Teachers who can develop confidence in the implementation of these characteristics of quality teaching and have experience with how can they improve their practice are at least in a better position to negotiate the contextual constraints in order to achieve more productive teaching in the classroom. What can be done and what needs to be done are not universal givens; they are very much culturally determined. Hence, further research on what is needed and what is possible in the Saudi context is crucial. This research has indicated that the use of Productive Pedagogies is possible and useful with Saudi pre-service teachers. However, the problems that may be encountered with its use and how to support teachers to contribute to improving their practice should be the subject of future research and professional development

Fourth, as I mentioned above the framework has been developed in western countries, and its advantages in other contexts was not taken for granted. While the results of this study considered that many of the elements of the Productive Pedagogies are in line with Saudi Arabia policies of pedagogy and social justice, questions about the tension between the Productive Pedagogies as a social cultural framework and the Saudi social-cultural

context need to be examine in more depth in future research from the perspective of the critical social theory.

Fifth, the learning from this project raises some interesting areas for further investigation and action. The findings of this study clarified the previous research suggestions by Gore et al. (2001) that the framework, in order to be more fully integrated into pre-service teachers' knowledge base for teaching, needs to come early in the teacher education program. Similarly, Zinger (2005) stressed that exploring the metalanguage of the framework from an early stage of teacher education is important. This study illustrated that studying Productive Pedagogies in one unit was not enough to fully comprehend all the elements by pre-service teachers. It would be of great interest to investigate the possibility of adopting a framework such as Productive Pedagogies early in the course in an integrated manner across the different subjects taught at the college. However, for that to happen, the issue of current knowledge and understanding regarding pedagogy of all teaching staff at the college needs to be ascertained as well as their need for capacity building for pedagogical reform.

7.3.2 Practical Implications

Some of the possible implications of this study are made for teacher education in general and in-service teacher development programs. First, teacher educators have the responsibility of providing their students with the best pedagogies and learning tools possible to ensure that they achieve their academic objectives. Consequently, the results from the using of Productive Pedagogies as a framework for teaching and learning mathematics in this study call for adapting this framework by teacher educators in their classroom practices. The present study highlighted the effectiveness of the framework to improve students' learning environments.

Second, the use of pre-service teachers' reflection on their practice is an effective means of developing the professional practice of pre-service teachers. The use of the Productive Pedagogies framework and particular

tools such as the observation manual assisted these pre-service teachers in focusing their reflection and using it as a means through which to talk about it with others. In particular, the framework assisted them in focusing on their own practices and identifying ways in which they could be improved. Here, the attention is that focus on practices is more effective than a focus merely on their beliefs.

Third, this research shows that pre-service teachers saw the framework as an effective tool to focus on and improve their own practices. Therefore, it might be possible for in-service teachers, as well, to use the framework and benefit from it. Saudi teachers in schools need a comprehensive framework to help them reflect critically on their teaching practices. Using the Productive Pedagogies in professional development programs for teachers would help them review their teaching practices.

7.3.3 Strategic Implications

After discussing some theoretical and practical implications of this study, a number of strategic implications of the research are suggested below.

Consistent with polices in Saudi Arabia

This study highlighted the importance of Productive Pedagogies as a framework for pre-service teachers to reflect critically on their classroom practices. This research is consistent with polices in Saudi Arabia and in line with its educational goals and objectives. Saudi Arabia, in 2004, developed a ten-years plan (2004-2014) aimed to improve its education system and achieve its strategic goals for general development. The development of this plan comes from the fact that the education system in Saudi Arabia faced various challenges that are reflected from the international changes; therefore, there is a need to improve education in order to give students the opportunity to become competitors with their international counterparts (Ministry of Education, 2005). One goal of the Ministry of Education's ten-years plan was "[to] prepare students academically, and culturally at a local and international level to be able to achieve advanced posts internationally in

the fields of mathematics and science for various age categories, taking into account international tests' standards" (Ministry of Education, 2005, p.13). This research met this vision as the rationale for developing Productive Pedagogies was to provide a tool for teachers to use to increase learning outcomes both academic and social (Lingard et al., 2001).

Opening new areas for research

This research has brought to light a new range of research areas which have not been previously considered. Although educational research in Saudi Arabia is growing rapidly, not surprisingly, most of the research in the education felid are quantitative and descriptive studies that may or may not be connected to practice. This research is combining theory and practice providing a challenge for Saudi researchers to new and applicable research in the area. In mathematics education, there is a new trend of research that shifted from researchers studying teachers to a new model of teachers as professionals (Middleton, Sawada, Judson, Bloom & Turely, 2002). Middleton et al. (2002) stated that "under this model, teachers are seen as knowledge producers, curriculum designers, and policy analysts with a unique configuration of knowledge, skills, and practices that have merit in the larger order of knowledge production, curriculum design, and policy analysts" (p. 411). Malara and Zan (2002) stressed that most studies in the field of mathematics education are *about* teachers but not *with* and *for* teachers. This research, which was conceptualised to consist of two phases, involved the teacher as the researcher to carry out the investigations. Also, it highlighted the importance of critical reflection on teaching practices. This opens the doors for Saudi researchers to emphasize the importance of bridging the gap between theory and practice in mathematics research. This gap can be mended through reflection (Jaworski, 1998; Mason, 1998) and through the role of the teacher-researcher (Malara & Zan, 2002).

Linking with international movements of research

Similarly, this research is a similar reply to an international movement of research. Hence, it enhances the abilities of Saudi researchers to participate in international dialogue about education research reform and research activities. This research highlighted the importance of quality teaching

practices and pedagogies in classrooms as a social justice issue, encouraging Saudi researchers to participate effectively in this area of research. It also raises the awareness of the equal opportunities in learning and teaching mathematics for boys and girls in the country. This in turn will encourage the researchers to contribute to the growing body of literature on areas of equity and quality of mathematics education. Atweh (2011) argued that action to promote equity and quality of mathematics education is a challenge, but researchers should keep working on this area in order "to improve the status of the discipline in society and in promoting its power to improve society and the lives of all its members" (p. 604).

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Appendix A

REFLECTIVE BOOKLET

For pre-service teachers' reflective journal

Appendix A

PRODUCTIVE PEDAGOGIES

Teacher reflective journal

Productive Pedagogies is a framework to help you to reflect critically on your teaching practice in order to improve your skills of teaching

Productive Pedagogies dimensions
- Intellectual Quality
- Connectedness
- Supportive Classroom Environment
- Recognition of Difference

Teacher Name:
School Name:
Teaching Year Level:

Introduction

Dear pre-service teacher

This booklet aims to assist you in writing your reflective journals and contains most of the information that you will need to complete your reflections. Writing a reflective journal helps teachers to move beyond the routine response to classroom situations towards a higher level of awareness of how to teach in effective ways. It also assists teachers to evaluate their classroom decisions that they made regarding the teaching pedagogies. When a teacher observes and reflects on his own teaching and uses his reflections to make a positive change in his teaching pedagogies, his teaching will improve and in turn will benefit his students. This booklet contains two sections: a section that includes guided questions to help you to complete your reflection. Your efforts to identify your weak points in your classroom teaching practices will help you to improve them and become a better teacher. The second section explains the QSRLS Productive Pedagogies Classroom Observation Manual and your scores that your supervisor will make regarding your teaching episode.

Do not hesitate to contact me if you have any further questions

Khalid
2008

First Section

What is reflection?

Reflective teaching means you think about and critically analyse your own teaching practice in order to improve it. In this manner, you might use a process of self-observation and evaluation after your teaching episode to collect some information about your teaching practices. Ask yourself why you use a certain teaching strategy in illustrating your lesson. Does it work? How was the students' reaction to your method of teaching? Your teaching skills will improve as you continue reflecting on your teaching practice. .

Reflection

Use the next pages to write your reflective journals (Remember: the more you write reflective journals, the more you improve your teaching practices). The following questions might help you to write your reflections:

Reflection on your teaching practice
- Which of the four dimensions of productive pedagogies facilitates your teaching today?
- Which elements of the framework do you think are important to your lesson?
- Did you achieve your learning objectives in your lesson by implementing the framework elements?
- What did you do to ensure all the students participated in the classroom tasks?
- What kind of interaction exists between you and your students?
- Which elements of the framework did you find difficult to implement in your teaching practices?
- Did you use new teaching strategies today?
- Is there any kind of connectedness to the world beyond the school in your teaching activities?

Reflection on your students
- Did you teach for all students today?
- Did your students participate effectively in today's lesson?
- Did the lesson challenge your students?
- From your point of view, what did students learn from today's class?
- What did they like most?
- Is there anything they did not respond well to?

Reflection on yourself

- What are my strengths as a teacher?
- What are the current obstacles?
- How can you improve your teaching practices?
- How can you help your students to learn?
- What level of satisfaction did you get from your teaching today?

Reflective journal (1)

Reflection on your teaching practice

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Reflection on your students

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Reflection on yourself

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Second Section

Evaluation

This section is linked to your evaluation scores that your supervisor makes on each visit. The aims of this evaluation are to identify your weak points in order to pay attention to improve them. It also will identify your strengths to keep you using them. After each visit you need to write your plans to improve the weak points that your supervisor mentions in your score sheet.

Name:	Visit no:
Number:	Day:
School:	Year level:
Supervisor name:	Time:

Dimension	**Items**	**1**	**2**	**3**	**4**	**5**
Intellectual Quality	**Higher order thinking**					
	Deep knowledge					
	Deep understanding					
	Substantive conversation					
	Knowledge as problematic					
	Meta-language					
Connectedness	**Background knowledge**					
	Connectedness to the world					
	Problem-based curriculum					
	Knowledge integration					
Supportive Classroom Environment	**Student direction**					
	Explicit criteria					
	Social support					
	Academic engagement					
	Student self-regulation					
Recognition of Difference	**Cultural knowledge**					
	Group identities					
	Representation					
	Narrative					
	Active citizenship					

Plans and procedures that you will use to improve your practices:

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Appendix B

Letters for Permission and Support

Appendix B

Letters seeking permission
[mailto:k.al-sharif@postgrad.curtin.edu.au]
Sent: Saturday, August 30, 2008 4:15 PM
To: WALTON, Patrea
Subject: Seeking a permission

Dear Patrea Walton
Assistant Director General - Student Services
Education Queensland

I am a doctoral student at the Curtin University of Technology undergoing my research under the supervision of Associate Professor Bill Atweh.

I am writing to you today to seek your permission to paraphrase and translate a part of some copyrighted material from your Website for my doctoral research.

My research topic is "Productive Pedagogies as a framework for Saudi Pre-service Teachers Training in mathematics education" and it will be conducted at a university in Saudi Arabia. To support my research I require segments of your "Productive Pedagogies: Classroom Observation Manual" translated into Arabic to assist my preservice students to understand and adopt Productive Pedagogies.

I have included an electronic copy of the manual that I downloaded from your website and have indicated the sections that I am interested in translating into Arabic. The translation will be more of a paraphrase to suit the context of the students.

Please, be assured that this material will not be used for dissemination or publication outside this research project and will only be used, free of charge with the students involved in the research.

If you are kind enough to give me your permission to undertake the translation, I would appreciate that very much.

If you need further clarification about my research project and this request, please don't hesitate to let me know.

Regards
Khalid Alsharif
PhD Student
Curtin University of Technology, Perth
Email: k.al-sharif@postgrad.curtin.edu.au

From: LIBKE, Rebecca [...@deta.qld.gov.au]
Sent: Tuesday, 20 January 2009 1:35 PM

To: Khalid Mohammed Al-Sharif
Subject: RE: Seeking a permission

Dear Khalid

Thank you for contacting the department to gain permission for the translation of one of our documents to be used in your research project. I sincerely apologise in the delay in responding to your request. As you may be aware your request was quite unique and there was no precedence for departmental officers to follow. I am the senior research officer within Strategic Research and I generally handle all external research requests. Your email has been forwarded to me to action.

As you are seeking to translate a publicly available document for the purpose of your research study, I believe that an official application will not need to be lodged with the department. You may proceed with the translation and paraphrasing of the document under the condition that you appropriately footnote the version of the document that you will use. The footnote will need to include a statement along the lines of "this document has been translated and paraphrased with the permission of the Department of Education, Training and the Arts for the purpose of this research project only, and any reproduction or distribution of this document in its current form is in violation of the copyright terms"

If you need any further assistance please do not hesitate to contact me.

Kind regards

Rebecca Libke ♦ Senior Research Officer ♦
Strategic Policy & Performance ♦ **Department of Education, Training & the Arts** ♦
Phone: …♦ Fax: …♦
PO Box 15033, City East Brisbane, QLD 4002 ♦
Web: http://education.qld.gov.au/corporate/research/

Participant Information Sheet

Productive Pedagogies as a framework for Saudi pre-service teacher training in mathematics education

Chief Investigators:

Khalid Alsharif, King Saud University, Teacher College, Phone: 0505271918, Email: k.alsharif@curtin.edu.au

Description:

The objectives of the project are to:
1. Investigate the incorporation of Productive Pedagogy framework within a teachers' pre-service unit in mathematics education in Saudi Arabia.
2. Investigate the pre-service teachers' engagement with Productive Pedagogies.
3. Investigate the pre-service teachers' ability to implement the Productive Pedagogies.
4. Investigate socio-cultural factors related to the incorporation of Productive Pedagogies in a Saudi Arabian context.

What is required of the participants:

Pre-services teachers are required to participate, with their consent, in a learning program taught via Productive Pedagogies method. After that, participants will be required to join a focus group interview about their understanding of Productive Pedagogies. Participants will also be required to keep a participant journal and have 5 volunteer observations taken of their teaching.

Expected benefits

Students will be able make more useful links with the material studied in school and their lives beyond the school. For mathematics teachers, Productive Pedagogies offers more worthwhile teaching strategy for teachers. Teachers are more able to teach content which is related to the students interests.

Risks

There are no risks associated with participation in this project.

Confidentiality

All comments and responses are anonymous and will be treated confidentially. The names of individual persons are not required in any of the responses.

Voluntary participation

Participation in this project is voluntary. If you do agree to participate, you can withdraw from participation at any time during the study without reason or penalty. The decision to participate will in no way impact upon your current or future relationship with the teacher college.

Questions / further information

Please contact the researcher if you require further information about the project, or to have any questions answered.

Concerns / complaints

Please contact the Research Ethics Officer on 92662784 or hrec@curtin.edu.au if you have any concerns or complaints about the ethical conduct of the project.

***Productive Pedagogies as a framework for Saudi pre-service teacher
training in mathematics education***

Statement of Consent

By signing below, you are indicating that you:
- have read and understood the information sheet about this project;
- have had any questions answered to your satisfaction;
- understand that if you have any additional questions you can contact the researcher
- understand that you are free to withdraw at any time, without comment or penalty;
- understand that you contact the researcher if there any questions about the project, or the Research Ethics Officer on 92662784 or hrec@curtin.edu.au if they have concerns about the ethical conduct of the project; and
- agree to participate in the project.

Name: …………………………………

Signature: ………………………………….

Date: /   /

Chief Investigators:

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