

## **Gaps in Understanding and Implementing Connectedness in Mathematics Teaching by Saudi Student Teachers**

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### **Abstract:**

This paper reports on a study using the Productive Pedagogies framework with a group of final year student teachers at a teacher education college in Saudi Arabia. The students were introduced to the framework in a unit of study on mathematics education and were observed during the following semester's field work experience to ascertain their level of understanding of Productive Pedagogies and their ability to implement it in their teaching. In particular, the discussion here concentrates on the Connectedness dimension of the framework. The results showed that while the student teachers were unanimous in their views that the framework was useful in their planning for teaching, some misconceptions remained. Similarly, contextual factors implied that their teaching practice showed limited ability to teach mathematics in a connected way which is a goal of the framework.

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.

In spite of decades of attempted reform in both curriculum and pedagogy in mathematics education around the world, the subject remains a mystery to many students, is detested, and can be a source of anxiety. Here we propose that 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 life 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 and Richard, 2010). As the authors argue, educational reform to improve teaching and learning is not likely to have long term impact if students don't value mathematics. The authors point to previous studies that show that "the perceived value was more important than expectations for success in keeping students cognitively engaged" (p.144).

When teachers attempt to argue for the value of mathematics with their students, their arguments are frequently constructed in terms of the future – that they will need mathematics for jobs or for future studies. Very rarely do mathematics classroom activities involve current concerns and experiences of the students. Hence, mathematics is presented in, what appears to the student, a decontextualised, abstract and meaningless way. Similarly, mathematics is often presented in isolation from capacities and knowledge

developed in other subject areas. Christie (2005) argues that "current times require the consideration of both universalistic, abstract knowledges and particularistic, contextualised knowledges" (p.244).

This paper reports on a study conducted in the context of a doctoral research project with pre-service students in one teacher training college in Saudi Arabia. The project employed the Productive Pedagogies framework (Lingard et al. 2001) in a mathematics education subject during the last year of the student teachers' training. In particular, it focuses on the development of the students understanding and ability to implement the Connectedness dimension of the Productive Pedagogies.

The following section outlines the theoretical background of the project. This is followed by a discussion of the context and design of the study. The major findings of the study as they relate to the student teachers' views of the usefulness of Productive Pedagogies and the Connectedness dimension in particular, as well as difficulties encountered is its implantation will be elaborated. The paper concludes with general conclusions and recommendations.

### **Theoretical Background**

Based on the Queensland School Reform Longitudinal Study (QSRLS) (Education Queensland, 2001), a comprehensive framework known as Productive Pedagogies was developed in Queensland to describe essential features of effective teaching. In one way the Productive Pedagogies framework was an adaptation and extension of a similar framework developed by Newman and his associates called Authentic Pedagogies. Newmann and Associates (1996) warned that even highly active students may produce work that is intellectually shallow. Shallow understandings of concepts may mean a student is not able to apply his/her understanding. There may be a gap 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 and his colleagues to refer to a framework of teaching which introduces higher standards for intellectual quality. The notion of "Authentic Pedagogy" is based on a tripartite definition: 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; and (3) when the knowledge has value beyond the school (Newmann, Marks & Gamoran, 1996).

As a model, Authentic Pedagogy has had a mixed acceptance and was a highly theoretical model aimed at high achieving student populations. In particular, Ladwig (1998) highlighted that Authentic Pedagogy was difficult to utilize as a teaching framework for teachers and was seen to be in need of further elaboration. Similarly, it did not comprehensively articulate effective teaching practice and it was, hence in need of further extension. The classroom practice consequently became a central focus of the QSRLS research team (Ladwig 2004). While they agreed with the tenets of Authentic Pedagogy, the team felt the notion needed to be "unpacked" for school teachers (Lingard, Hayes, & Miles, 2003). 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). The new approach was described as "a balanced theoretical framework enabling teachers to reflect critically on their work" (Education Queensland, 2002, p. 2). The new framework has a focus on the improvement of student intellectual reasoning and makes teaching and learning in schools more applicable to the students' everyday lives. The developers of Productive Pedagogies postulated that there were four dimensions that characterised effective teaching: Intellectual Quality, Connectedness, Supportive Classroom Environment, and the Recognition of Difference.

In this study, we focused on one of these four dimensions; namely Connectedness. 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. We posited that 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 such as Dewey in 1916". The concept of connectedness includes linking new knowledge with students' background knowledge as well as connectedness to the world outside the classroom through a focus on identifying and solving intellectual and/or real world problems (Education Queensland, 2002), thus allowing learning to occur more easily and meaningfully (Moulds, 1998).

### ***Productive Pedagogies and Teacher Education***

The notion of 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". There are several studies highlighting Productive Pedagogies in teacher education and training. A number of studies attempted to model Productive Pedagogies in pre-service teachers programs to 1) change pedagogic practice, 2) increase students' awareness of teaching pedagogy and 3) implement critical reflection for their understanding of the framework (Wilson & Klein, 2000; Sorin & Klein, 2002; Zyngier 2005; Aveling & Hatchell, 2007). Other studies prepared a series of professional development activities focussed on Productive Pedagogies to train in-service teachers (Gore, Griffiths & Ladwig, 2002) and followed the pre-service teachers in their field experience (Gore, Griffiths & Ladwig, 2004).

### ***Productive Pedagogies and mathematics education***

While some of the above studies have involved mathematics as a part of the reflection and discussion regarding Productive Pedagogies, there has been a limited focus on Productive Pedagogies in mathematics education. There are few researches who clearly link mathematics with Productive Pedagogies. For example, Cronin and Yelland (2004) demonstrated how a focus on Productive Pedagogies has proved to be a powerful tool in achieving positive outcomes in numeracy for young indigenous Australian students. Similarly Productive Pedagogies has been used with a networked online learning environment in mathematics to established a powerful learning environment (Chinnappan, 2006). A study by Atweh (2007) explained how the two dimensions of the Productive Pedagogies, Intellectual Quality and Connectedness, played a major role of teaching mathematics to support the development of a Socially Response-able Mathematics Education. Finally, 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.

### **Context and Design of the Study**

This study was located with the context of a teacher training college in Saudi Arabia. For the sake of international audience, perhaps is it useful to provide some background information about the country, its education system, and about the college and the student teachers involved.

The Kingdom of Saudi Arabia occupies almost 80 percent of the Arabian Peninsula, an area approximately a quarter the size of the United States, and is situated in the south-western part of Asia. The country has an estimated population of 27 million including about 31% non-Saudis working or living in the country (The Central Department of Statistics & Information, 2010). Since the Kingdom of Saudi Arabia was founded in 1932, education has been the main focus of Saudi leaders. With the rapid development of the country's infrastructure in the early 1970s, Saudi Arabia has given wide attention to promoting 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. Today, Saudi Arabia had a nationwide educational system providing free education from kindergarten through university to all citizens. The education system in Saudi Arabia is largely public and consists of four levels: primary, years 1 – 6; middle, years 7 – 9; high school, years 10 – 12; and tertiary. One of the characteristics of Saudi Arabia's system is that the genders are segregated at all levels.

In the past decade, there was a national initiative to renew teaching and learning in Saudi Arabian schools. A report prepared by a team of educator supervisors in the Ministry of Education stated 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). For the advancement of the educational process, the report recommended that there be a focus on the quality of teaching. Slim (2004) commented that for a long time, teachers have been the centre of blame for the failure of education. The focus has been on the teacher as the primary person involved in the improvement and development of teaching. In response to the report, Riyadh Teachers' College engaged in promoting major changes to improve teaching practices in mathematics education. It began focusing on more student-centred approaches. This change occurred at the same time as similar mathematics education reforms around the world advocating change from the traditional teacher-centred approach towards a more active involvement of the learners in mathematics classrooms. A search for the best strategies to be implemented during the years of study and training in the college programs led the researcher, the first

author above, to adopt Productive Pedagogies as a framework for pre-service teachers in mathematics education.

During their previous study at the teachers' college, the pre-service teachers involved engaged in a range of courses that addressed learning theories, curriculum and teaching strategies. Pre-service teachers had been exposed to different models for teaching and had explored teaching pedagogies as part of their studies. At the stage they were at of their professional development when they engaged in this particular research, they were expected to become familiar with teaching strategies and students' needs in the specific area of mathematics education.

The development of Productive Pedagogies came at a time when the Riyadh Teachers' College was strongly advocating a student-centred approach to teaching and learning. Students in the mathematics education program study for four years, with eight semesters. They take a unit called "Mathematics Teaching Methods" in their seventh semester. The unit contact time is 2 hours each week for 14 weeks. In this unit, the students learn some mathematics teaching methods and their applications. The following semester, their last semester of study, they are sent to schools to teach mathematics for a minimum of eight lessons per week for the whole semester. During their field experience, students are expected to spend the whole school day at the schools and to perform as official teachers. For this study, two phases were designed for achieving the study objectives.

In phase one 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 taught with altered methods of teaching to enhance pre-service teachers' engagement within 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. The data collection from this part of the study was obtained through three focus group interviews with pre-service teachers and from their reflective journals.

In phase two, six pre-service teachers were followed during their field experience in two primary schools. Each one was observed five times during their teaching practice for evidence of the four elements of the Connectedness dimension; the five-point scale from the QSRLS code manual (Education Queensland, 2001) was used to score their practice. The coding sheet contains each element of the Connectedness dimension, together with five standards on a Likert scale, where 1 was the lowest and 5 was the highest. For example, in the Knowledge Integration element the lesson will be rated as 1 if all knowledge strictly restricted to that explicitly defined within a single school subject area and no intrusion of other content permitted. The lesson will be rated as 5 if there is complete integration of subject area knowledge to the degree that subject area boundaries are not recognisable. In addition to the observations described above, semi-structured interviews were conducted with three participants to investigate their understanding and implementation of the Productive Pedagogies in their practice. One focus group interview was also conducted with all six pre-service teachers at the end of their field experience.

## Findings

### ***Students Teachers' Views on the Use of Productive Pedagogies***

Overwhelmingly, the student 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 student 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 through the right steps to become a successful teacher in the future. (PT1, Phase 1, 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 about strategies teachers may apply in specific lessons. One student 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 1, focus group)*

Another student teacher, said:

*The model helped me to identify a range of activities before each lesson which all lead to positive student performance. (PT3, Phase 2, 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 student 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 2, 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 whole picture 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, reflection).*

In particular, the student teachers felt that the Connectedness dimension 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 1, focus group)*

They were able to identify two main reasons that attempts to make content connected to the real world of the student appropriate. One student 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 connectedness to the world encouraged me to apply this model. (PT8, Phase 1, focus group)*

Not only did the Connectedness 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 2, focus group)*

### **Change Towards Student-centred Teaching**

Arguably, the most effective way in which the focus on Productive Pedagogies influenced the student teachers was in challenging their views about their assumed learning theories.

There was an indication by the pre-service teachers that their views of learning and teaching had changed after studying and implementing the productive pedagogies framework. They stressed that good teachers need to replace traditional methods with more student-centred learning focuses. They commented that the framework could assist them achieve this shift. In relation to this, participating pre-service teachers noted how the framework becomes a good way to change traditional ways of teaching:

*With Productive Pedagogies I believe that knowledge must be expressed in various ways. I see us moving away from the traditional teaching process and we are trying to introduce new student 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 1, reflection)*

*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 2, 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 2, interview)*

### **Gap between Student Teachers Aspiration and Implementation**

During the observations by the researcher of the classroom practices of these student teachers by the first author, there was little evidence of attempts to connect the mathematics content under consideration as promoted by the Productive Pedagogies framework. Using the QSRLS code manual, Figure (1) illustrates the means of using Connectedness elements for all the 30 observations and shows the low and high scores for the participating student teachers. The data below represents the observed implementation 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.

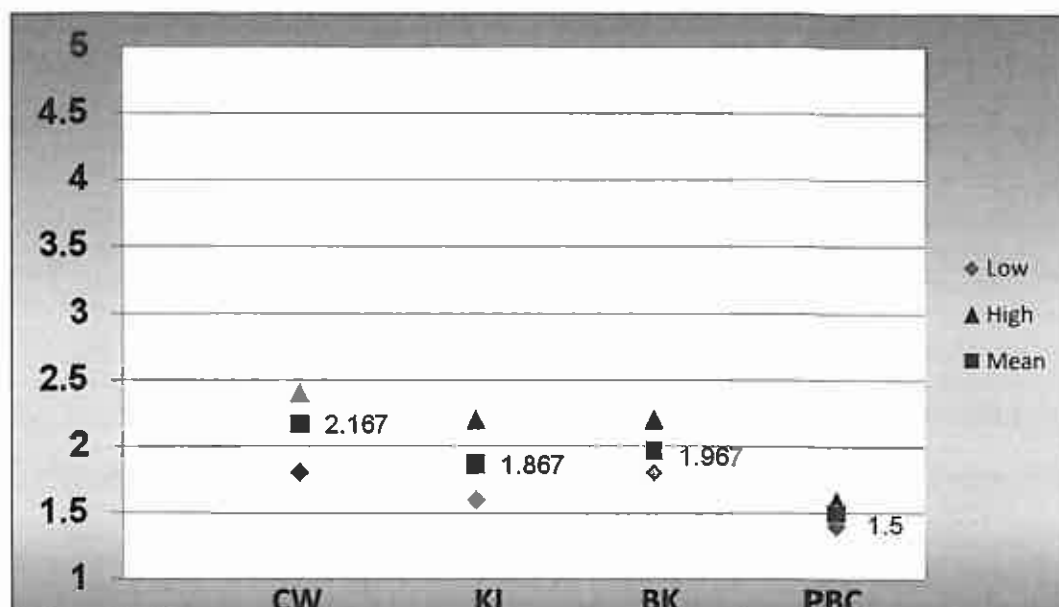


Figure 1: Pre-service teacher scores on the implementation of the four components of Connectedness of the Productive Pedagogies framework

Investigating this 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.

#### **Limited Understanding of Connectedness**

In spite of the lack of implementation of Connectedness as discussed by the Productive Pedagogies framework, 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, 14/4/2009)*

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. 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 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.

Another good example of implementing Connectedness that focused on knowledge integration and background knowledge was from a Year 3 lesson on mass.

*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 "Mass". In keeping with the Year 3 level of instruction, the lesson focused on the concepts of mass and related aspects. The teacher began to present different pictures and asked 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 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 how iron, paper carton or plastic could affect objects mass. Subsequently, the teacher raised some questions related to students' body mass asking who was heavier or lighter than the other. Then the teacher opened the floor to a discussion on questions such as what kind of food makes you fat? Or what kind of activities helps you to lose weight? Again at the end of the class questions were raised to explain the meaning of equal mass, lighter mass and heavier mass. (Research diary, 30/3/2009)*

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. 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.

However, most attempts by pre-service teachers to connect the lesson content with the real 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 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, differentiation 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, and 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, but did not provide students with adequate skills that they would need to face real-life issues that related to division.

Arguably, these attempts to implement the Connectedness dimension of Productive Pedagogies demonstrate some ambiguity, especially in the division example, about the difference between connectedness to real life activities and the more common attempts in mathematics classes to have concrete representation of mathematical concepts. While dividing whole apples into plates may be regarded as the use of a concrete example of the concepts, it fails to be an authentic task that students may encounter in everyday life. The limited understanding of the Connectedness dimension of the framework seemed to play a major role in the lack of its implementation in this situation.

### **Contextual Factors**

During my discussions with student 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, student 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 world experiences of the students. For these students it was difficult to find applications that are real and accessible for their students. One student 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 2, interview)*

Another student 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. (PT9, Phase 2, 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. 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. The pre-service teachers mainly worked with content limited to the textbooks. This put teachers under pressure to follow the tradition of the school and use the textbook as the main source of students' work.

*Completing students' text book questions with them and offering feedback while reviewing their work is important to my teaching" (PT6, Phase 2, reflective journal)*

As a supervisor of the student teachers' field experience, the first author was aware of being subject to this same limitation. As part of the traditional classroom observations required by the College, the supervisor is required check the students' textbooks to see how the student teacher corrected the students' work. This practice itself tends to reinforce the focus on textbooks and limits student teachers' thinking required to create different and rich activities that might help them to apply the Connectedness dimension at a higher level.

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

### **Discussion and conclusion**

The aim of the study was to introduce pre-service teachers to the concept of Productive Pedagogies, through a series of activities within the unit of mathematics education. Through the pre-service teachers' field experience, an understanding of the implementation of the framework was developed. Analysis of the data supports two arguments. Firstly, the evidence gathered indicates that the student teachers found the Productive Pedagogies framework to be a valuable model of planning for pre-service teachers. Second, in order to implement the Connectedness dimension more thoroughly, pre-service teachers need a higher level of support from the teachers' college where they learn the theory, and from the schools, where they implement the approach.

The results of this investigation suggest that Productive Pedagogies is a valuable framework for two reasons. First, it provides a useful guide for teaching practice. Gore, Griffiths and Ladwig (2004) stressed that there is strong evidence that pre-service teachers use the framework to guide their teaching. The participants felt that the different dimensions of Productive Pedagogies have helped to direct their teaching practice. Productive Pedagogies is largely asking the right question in the right way (O'Toole, 2006). Secondly, the framework has assisted a shift toward an increased teacher focus on student-centred learning. Teacher's beliefs appear to play an important role in classroom practices (Kagan, 1992). Teacher practice in the classroom is a reflection of what his or her beliefs related to learning theories and styles are. Applefield, Huber and Moallem's (2000, p. 1) state, "teachers' personal theories of learning have long been viewed as having considerable influence on virtually all aspects of teachers' decisions about instruction". Since the advantage of Productive Pedagogies is that it provides a more tangible means of promoting teacher understanding about student-centred learning and intellectual quality. It was expected that pre-service teachers in this study saw the framework as a guide towards a student-centred classroom. Earlier studies have found that the framework exposure does lead pre-service teachers to change their practices (Gore et al., 2002).

Other results of this study also suggest that increased efforts are needed from teachers' college and schools to help pre-service teachers to produce higher level of connectedness. Pre-service teachers' practices, in this study, show a lack understanding of how the Connectedness dimension was applied. Here we refer this lack to both the teacher's college on one hand to schools on the other. Pre-service teachers want more practical activities, lessons, ideas and examples to use in the classroom, while we, as teacher educators, believe that these should be a part of their work or assessment (Wilson & Klein, 2000). To get a better understanding of the framework, not only is the teaching practice important but the time that they engage with productive pedagogies is important also. Gore, Griffiths and Ladwig (2004) 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. Moving to the school environment, we found that pre-service teachers claimed there were no teachers' meetings or discussions about the classroom practice. 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 to increase the awareness of the quality of pedagogies. More time for teacher professional discussions with their colleagues about the framework will support and value their work (Lingard, Hayes, & Miles, 2003).

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