International Journal of Educational Psychological Studies – Vol. 3, No. 2, 2018, pp. 552 -583
e-ISSN 2520-4149 , p-ISSN 2520-4130
Available online at http:// www.refaad.com

Professional Development of Mathematics Teachers in Integrating Digital Technology: Comparative Study

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Abstract:

This study investigates the ways that Saudi and English secondary mathematics teachers professionally develop themselves in terms of using digital technology. It also compares between the two groups regarding the same aspect. For this aim, a survey was conducted among 44 Saudi and English teachers. The results, which were quantatively processed, generally showed a similarity between Saudi and English teachers in terms of using digital technology. However, a few differences emerged between the two groups in the aspect of developing themselves.

Keywords: Professional Development, Mathematics Teachers, Digital Technology

1. Introduction- Research background

The government of Saudi Arabia, as other developed countries, has become aware of the importance of digital technology in education. As a result, it initiated a huge project in 2005 called ‘Jehazi’ (my Device), which is a part of a national educational reform, concerning about providing and improving educational digital technology and its use.

Believing that the educational digital technology will not be effective without the effective teachers’ use of it, the government has been spending enormous effort to enhance the teachers’ professional development in this aspect. One outcome of this effort is establishing ‘Tatweer’ project to develop teachers’ profession by offering for them plenty of training programmes. The main aims of the project are

“- To provide training programmes to the Saudis to be gainfully employed in any organization or be successfully self-employed

- To increase the number of educated, trained and skilled Saudi ICT professionals

- To expand the scope of advanced training and development of technology” (Al-madani & Allaafiajiy, 2014, p. 104).

In 2009, Saudi education ministry adopted the American curricula of mathematics and science as attempt to improve these subjects in Saudi education. McGraw-Hill textbooks, which follow NCTM criteria, were imported from USA. After they passed through process of translation and adaptation to Saudi culture, they were distributed to all secondary school in the country. One of the main advantages of these textbooks is that they support the use of digital technology either inside the classroom or outside by teachers and students as well. These three projects have empowered the use of digital technology in education generally and in mathematics education specifically.

This critical study attempts to investigate and compare the Saudi and English secondary mathematics teachers' use of digital technology and their professional development in this aspect.

Three studies have addressed the issue of teachers' use of digital technology in Saudi Arabia. Two of them addressed mathematics teachers while one of them tackled generally the issue of Saudi teachers' professional development on using digital technology. The first study is the one that was conducted by Alghadeer (2009). In her study of the employment of the new technologies in mathematics education in Saudi Arabia, she investigated the level of basic technological skills of Saudi female mathematics teachers. She made a list of 11 primary skills included 58 secondary ones ranging from browsing the internet to using Microsoft office (Word and PowerPoint programs) in planning and presenting the lessons through using emails to communicate with colleagues and students to developing and dealing with multimedia programs and the electronic textbooks.

The second study is Althubiani's (2010). The study focused on the availability of the digital technology in boys' secondary schools in Yanbu city and the level of mathematics teachers' use of this technology. It also measured the correlation between teachers' experience, training and educational qualification. Additionally, it investigated the challenges that affect the use of technology in Saudi school.

Both studies came out with similar main results: there is a very low use of and shortage in digital technology in the sample of schools. Moreover, the difficulties that restrict or prevent the use of technology in these schools are very high level. However, an important thing about these two studies is that none of them discussed those types of technology that relate to mathematics teaching and learning i.e. programs or software that deal directly with mathematical concepts.

The third study is conducted by Al-madani & Allaafiajiy (2014), their study discuss the Saudi framework of teachers professional development on ICT. In addition, it discuss the challenges of the Saudi framework and propose suggestions to improve it. Having examined the relative literature, Al-madani and Allaafiajiy identified the main challenges as follows:

"some of the challenges faced by the Kingdom in the way of achieving this development are highlighted as large of amount of monies needed to fully implement the framework into its full potential, cultural environmental shock, little teacher's preparation and training for technology use, teacher's self confidence to use ICT after training, competent professionals that will ensure teachers' CPD" (Al-madani & Allaafiajiy, 2014, p. 105).

Their proposed solutions to government and stakeholders were:

- improving the training programmes to include digital technology training programmes.
- provide schools with more high security network to protect users from non-culturally accepted websites and application.
- motivating teachers to enrol in ICT training programmes.
- support schools financially.
- make exchange programmes with foreign expert institutes.

Although Al-madani and Allaafiajiy's study does not address the mathematics education in specific, it reflects the situation of professional development on digital technology in Saudi Arabia.

1.1 Aim of research

This study aims to investigate the types of digital technology that are used by Saudi and English secondary mathematic teachers and the kinds of professional development they have on digital technology. It also aims to compare these issues between the two groups of teachers.

1.2 Research questions

To achieve the research's aims, the study seeks to answer the following questions.

1. What types of digital technology do Saudi and English mathematics use?
2. How do they use them?
3. What kinds of professional development they receive or do by themselves in terms of using digital technology?
4. What kind of barriers are they face regarding the use of digital technology?
5. Are there any differences between Saudi teachers and English teachers in the previous aspects?

1.3 Structure of the study

This study comprises five main sections in addition to the introduction above: Saudi educational context, the literature review, research methodology, results and discussion and finally the conclusion

2. Saudi educational context:

In this section, Saudi educational context is discussed with relation to teachers' use of digital technology and their professional development.

2.1 Saudi educational system

It is important to take a quick glance at the education system in Saudi Arabia before discussing the main issues of this study. Actually, Saudi education system is considered as a young system if it is compared to other systems of other countries like UK for example. The Ministry of Education was established recently in 1952 (Saudi Ministry of Education, n.d.). One of the main characters of this Saudi education system is being centralised. The power and decisions are in the hand of the government, which is represented by the Minister of Education. Public schools, as a result, have to implement all Ministry decisions ranging from planning curriculum and appointing teachers through choosing textbooks to assessment.

There are three levels of Saudi general schools: the primary school (Grades 1 to 6), the low secondary (Grades 7 to 9) and the high secondary (Grades 10 to 12). The age of enrolment in the first grade is 7. Another distinctive feature of the Saudi education system is that all educational departments and schools are single-sex.

It is worth mentioning that Saudi education system throughout the 20th century was based on the traditional methods of learning and teaching, where rote learning is the main method of education. Moreover, teachers are the centre of the instruction process. It is believed that this traditional practice is a manifestation of the traditional Hijaz/Bedouin culture in Saudi Arabia. However, in 2006 there was a revolutionary reform of the education system to shift from the traditional rote learning to more holistic education. This reform is aimed at changing curricula, in several stages, to fit the modern teaching and learning approaches, which one of them is integrating digital technology in the process of teaching and learning (Alshehri, 2014).

2.2 Digital technology in Saudi Arabian education

Digital technology was introduced for the first time to Saudi education system in the 80s of the last century. Although it had small existence, it's good results has been noticed in the education, which motivated the Ministry of Education to decide to make information and communication technology (ICT) as a part of the curriculum in 1991 (Oyaid, in Al-madani & Allaafiajiy, 2014, p. 103). In 2006, under the umbrella of the national educational reform, the Jehazi project was launched to provide teachers with digital technology tools, specifically computers laptops, to improve their skills in using these tools and to integrate digital technology in teaching and learning process (Ministry of Education, n.d.).

Nevertheless, as mentioned in the introduction (subsection 1.1), studies (Althubiani, 2010; Alghadeer, 2009; Bingimlas, 2009) has shown that the implementation of this project has not brought about the desired results. Integrating digital technology in education still face challenges and barriers.

2.3 Professional development in Saudi Arabia

> "Successful integration of ICT into teaching and learning processes requires developing teachers' knowledge, confidence and skills on ICT use as well as providing them the hardware and software. The quality of school's ICT equipment becomes irrelevant if teachers do not have the required competencies and not well trained to handle and have appropriate skills with regard to the equipment" (Al-madani & Allaafiajiy, 2014).

Since the 1970s, the Saudi ministry of education has devoting a lot of finance and effort to provide teachers with the suitable professional training programmes (Al-madani & Allaafiajiy, 2014). Its objectives are to "provide standard education in meeting the social needs of the country and of the people so as to compete in the global labour market" (ibid. 2014, p. 103). Another outcome of the national educational reform is Tatweer project. This project is aimed at planning teacher professional development programmes and making them available for the teachers (Ministry of Education, n.d.).

Regarding the digital technology, Saudi teachers usually receive compulsory computer skills courses in their pre-service education. Moreover, they receive ongoing in-service training programmes in this aspect. Although outcomes of this project has not been that successful (Al-madani & Allaafiajiy, 2014), efforts are spent by government to improve the professional development of teachers.

3. Literature Review:

This section is concerned with two issues: the integration of digital technology in mathematics education and the professional development of mathematics teachers. The first subsection outlines the main approaches of using digital technology in teaching and learning mathematics and the important theory of technology complexity in mathematics education. The second subsection explores the concept of professional development, the meaning of CPD and teacher development in mathematics education in general and in using digital technology in particular.

3.1 Integrating digital technology in mathematics education

By digital technology, it is meant:

The “wide range of devices which combine the traditional elements of hardware (processing, memory, input, display, communication, peripherals) and software (operating system and application programs) to perform a wide range of tasks. They include: technical applications; communication applications; consumer applications and educational applications” (Joint Mathematical Council of the United Kingdom (JMC), 2011, p. 4).

In terms of using digital technology in teaching and learning mathematics, it is important to discuss the main three approaches in this aspect. The first approach is the one that deals with digital technology in a classic way. Teachers in this approach usually use technological tools as in a traditional manner. I call this approach the ‘neutral approach’ because neither teachers nor students benefit from the technological features of the tools they use. For example, when using interactive white board (IWB), teachers tend to use it in a similar way of using the classic blackboard. They often write on it only without taking the advantage of utilising its distinctive technological features. Another example, when the teachers present e-exercises for students, they use those exercises that need to be solved by paper and pencil before the right answer can be chosen. According to Abboud-blanchard (2009), most teachers who practise this approach are less experienced teachers.

In this approach, using digital technology does not add to the learning outcomes. Actually, it does not affect it negatively or positively. However, it may help to minimise the time spent in writing in the board or to display the lesson in a more attractive way.

The second approach is considered as a progressive one. Generally, it aims to abolish completely the paper-and-pencil calculating and substitute it with computerised calculators (Wolfram, 2011). It is believed in this school of thought that teaching students calculating is kind of isolating them from the real world wherein people do calculations by computers and technological devices. In addition, it is seen that the time spent in teaching calculating should be offered to students to know the mathematical problems, which can result in exploring deeper and more sophisticated mathematics. Although this approach tends to be extremely progressive, I believe it will be more realistic in the near future when digital technology becomes dominant.

The third approach, which is adopted in this essay, is in the middle of the two previous approaches. It aims to integrate digital technology effectively into mathematics education taking into account the obstacles and affordances of this integration. Researchers and theorists of this approach focus on the integration that can bring about positive outcomes in pupil’s conceptual understanding, in problem solving skills and in real-life mathematics (Drijvers et al., n.d.). Teachers play a considerable role in this integration by choosing the proper tool in the proper time. Nevertheless, researchers and theorists of this approach believe that digital technology should not substitute the students’ knowledge and skills.

The use of technology cannot replace conceptual understanding, computational fluency, or problem-solving skills. In a balanced mathematics program, the strategic use of technology enhances mathematics teaching and learning. Teachers must be knowledgeable decision makers in determining when and how their students can use technology most effectively (National Council of Teachers of Mathematics, 2008).

3.2 Complexity of digital technology integration in education

Complexity of integrating digital technology in educational in general and in mathematics teaching and learning is very important issue. Although theoretically digital technology has many advantages, using it in education did not bring about the desired or the expected successful results.

It is worth mentioning that most digital technological tools used in mathematics education were not initially invented for this purpose (Artigue, 2002). Therefore, teachers often adjust the features of the application or device to meet their lessons objectives. The process, in which teachers as well as students attempt to master a digital tool, is usually complex. This process is known in the literature as the 'instrumental genesis' (ibid., p. 252). In the beginnings of this genesis, the 'instrumentation phase', teachers and students find some difficulties to adapt the use of a new digital tool. They might need time to discover the tool and get used of it. This is why it is called the 'discovery phase' (Guin & Trouche, 1999).

In the 'discovery phase', the activity of teachers and students is controlled by the tool they use (Bueno-Ravel & Gueudet, 2007). For example, students get confused when the symbols used in the digital tool are different from those in the textbook and they will take time until they become familiar with it. In fact, this complication can affect negatively the students' conceptual understanding and the teacher's management of the class. Therefore, researchers see that this complexity of the technical activities can exclude the conceptual understanding of the students (Ruthven, 2002). This complexity theory is important to analyse and interpret the reasons for the failure of the big number of experiments of integrating digital technology in mathematics education.

One of the manifestations of the *instrumentation* complexity that observed in technology-based classrooms is the time-management issue. Due to (Abboud-blanchard, 2009), teachers often encounter difficulty in managing the time of the class whether they are expert in dealing with digital technology tools or less expert. Technology-based lessons in reality usually take more time than expected by teachers in their planning. As a result, teachers might do tasks quickly in order to complete the planned lesson without taking into account the outcomes of the students' conceptual understanding.

Another critical obstacle generated by the *instrumentation phase* is the decrease of the 'effective interaction', on the one hand, between the teacher and the students and, on the other hand, between the students themselves (Klien et al. in Alshehri, 2014, Monaghan, 2004, Bueno-Ravel & Gueudet, 2010, Wright, 2010). In the learning theories developed by Vygotsky (1972) and Bruner (1986), interactive social situations can enhance the learning and broad thinking of the students (in Alharbi, 2014). Unfortunately, using devices individually by students (i.e. each student use one device or as maximum three) can cause the lack of interaction between them. Abboud-blanchard (2009) notices that this phenomenon transforms the class, in terms of the didactic interaction, into multiple "mini classes". She also notices that the type of interaction changes too. Instead of discussing the content of the lesson, teachers and students usually interact about issues that relate to technical problems.

Although it is known that the problem of interaction deficiency is associated with the instrumentation phase or the discovery stage, Monaghan (2004) indicates that this problem can occur in any stage of the lesson; not necessarily in the 'instrumentation stage'. After comparing the behaviour of teachers in technology-based and non-technology-based classes, he found that this phenomenon might refer to different reasons such as the attitude of the teacher and the institutional situations. He explains this as follows:

First...teachers who may be described as 'didactic' in non-technology lessons, remain didactic in technology lessons. Second, although there are some commonalities in non-technology lessons there was no common pattern to social interactions across all the observed technology lessons…Third, many of the noted differences in social interactions in technology lessons appear for very obvious reasons, e.g., less time spent on whole class exposition due to having booked a computer room (Monaghan 2004, p. 45).

Bueno-Ravel & Gueudet (2010) likewise point out to those kinds of challenges that stem from factors that are different from the issue of technology complexity. They indicate that schools rules sometimes restrict or prevent teachers from making a successful integration of digital technology in teaching mathematics. The researchers give examples of these challenges such as the class period length, the content amount and the curriculum nature.

To conclude this section, I want to say that although integrating digital technology in mathematics education does not always bring about positive outcomes in students' attainment, most researchers and educationalists keep on supporting this integration because of two reasons. First, they believe that sometimes this failure is often because of the methodology of using the digital tools not because of deficiency of the tools themselves. Therefore, they believe that the way in which these tools are used by teachers should be modified in order to gain positive results. Second, they accept the fact that the use of digital technology in school mathematics can produce some complexity. Thus, they persist on studying and understanding this complexity so they can reduce as possible its negative results.

3.3 Professional development and CPD in education

It is believed that teachers play a key role in education.

> Teachers do not merely deliver the curriculum. They develop, define it and reinterpret it too. It is what teachers think, what teachers believe, and what teachers do at the level of the classroom that ultimately shapes the kind of learning that young people get (Hargreaves 1994, cited in Mcdonough, Clarkson, & Scott, 2007, p. 391).

Because of the importance of teachers' role, there is considerable care of their profession.

In fact, teaching is just recently deemed as a profession where pupils and their parents are considered as clients and satisfying them is the main goal of this profession (Earley, 2005). In the seventies of the last century, the new term 'professionality' came out to indicate and confirm the 'profession nature' of teaching. This term was coined by Hoyle (in Evans, 2008, p. 26) to show specifically those elements of the job that constitute the knowledge, skills and processes that teachers use in their work along with their commitment levels'. According to this view, professionality can be seen as the abilities that teachers carry and use in the workplace. On the other hand, Hoyle describes 'those strategies and rhetorics employed by members of an occupation in seeking to improve status, salary and conditions' (ibid, p. 26) as professionalism. It can be said that professionalism in Hoyle's account is what teachers do to improve their position in the workplace.

It is obvious that the teachers' professional improvement has an obvious impact on students' learning. Therefore, research in the teacher professional development is hugely increasing to know its nature and to find out how it occurs and how it can be gained.

Perceptions on professional development of teachers has been changing since the forties of the last century. In the beginning it was considered as a dose of medication that should be offered to weak teachers to improve their teaching (Clarke & Hollingsworth, 2002). Nowadays, it could means intended learning (ibid, 2002), informal learning (Eraut, 2004) or training received by teachers (Al-madani & Allaafiajiy, 2014). In general, professional development is often regarded as a vital continuous part in the teacher's professional life (ibid. 2002).

However, throughout the relative literature, there is no agreed stipulative definition of professional development. Evans (2002) notices that authors deal differently with this issue. Some of them define it according to their perceptions, which might differ from one individual to another while others may leave the definition to be concluded by the reader. Another group of researchers may declare explicitly that it is hard to define stipulatively this concept (Rempe-Gillen, 2012).

In the literature, there are two famous definitions of professional development that are used widely by researchers. The first definition is the one that is articulated by Evans (2011, p. 867). She defines professional development as 'the process whereby people's professionalism may be considered to be enhanced, with a degree of permanence that exceeds transitoriness'. As it can be seen, this definition depends on the term professionalism, which she views as:

> 'professionality-influenced practice that is consistent with commonly-held consensual delineations of a specific profession and that both contributes to and reflects perceptions of the profession's purpose and status and the specific nature, range and levels of service provided by, and expertise prevalent within, the profession, as well as the general ethical code underpinning this practice (Evans, 2008, p. 29).

However, professionalism in Evans' perception depends on professionality, which she defines as: "an ideologically-, attitudinally-, intellectually- and epistemologically-based stance on the part of an individual, in relation to the practice of the profession to which s/he belongs, and which influences her/his professional practice" (ibid., p. 26)

Evans in her definition of professional development focuses on the time factor. She emphasises on the fact that the enhancement should be permanent. She believes that a short-lived improvement cannot be considered as professional development.

Fraser et al. (cited in Mitchell, 2013, p. 3) share Evans' view on time factor. They emphasise the importance of time period length to gain a proper professional development. They define professional development as 'broader changes that may take place over a longer period of time'.

The second famous definition of professional development is Day's (cited in Rempe-Gillen, 2012, p. 9) definition. He believes that professional development is more than process of learning; he believes that teacher professional development should be holistic change:

> "professional development consists of all natural learning experiences and those conscious and planned activities which are intended to be of direct or indirect benefit to the individual, group or school and which contribute, through these , to the quality of education in the classroom. It is the process by which, alone and with others, teachers review, renew and extend their commitment as change agents to the moral purposes of teaching; and by which they acquire and develop critically the knowledge, skills, and emotional intelligence essential to good professional thinking, planning and practice with children, young people and colleagues through each phase of their teaching lives"

As it can be noticed, he regards the 'moral purposes of teaching' as a part of the professional development. This view is criticised by Mitchell (2013) because he thinks that teaching morals are 'inherent' in the education in general. Thus, there is no need to mention this aspect in professional development definition. To some extent, I disagree with Mitchell's opinion. Even though teaching morals are intrinsic parts of teaching, I believe that they can be changed and developed.

On the other hand, English government (cited in Earley, 2005, p. 232) defines professional development in more procedural manner: "By professional development we mean any activity that increases the skills, knowledge or understanding of teachers, and their effectiveness in schools". In this definition, there is no consideration to the time factor or the impacts on the students. Moreover, there is no clarification of the 'effectiveness' of the teachers.

Another important issue in professional development is its association to the term of CPD (continuing professional development). These two terms are usually used interchangeably by authors even though the former is seen as an umbrella term that comprises different types of professional development, which CPD is one of them. CPD as professional development has different definitions due to different perspectives or purposes. One of CPD' definition is Stevenson's (cited in Mitchell, 2013, p. 2): 'The continuation of a teacher's professional development beyond their initial training, qualification, and induction'.

It is worth declaring that all mentioned perspectives and definitions of professional development are coming from the western culture. This culture has its distinctive, social, cultural and political characters. Thus, western educational systems tend to differ from those of other cultures. In Saudi Arabian culture, for instance, professional development is commonly preserved as training programmes that should be provided by the government to be presented to teachers. Usually, Saudi teachers, educationalists and stakeholders put emphasis on the extrinsic training programmes or sessions when they discuss the issue of professional development or CPD. They mostly neglect the other parts or kinds of professional development such as intrinsic personal development, collaborative professional development or other types.

Moreover, 'Tatweer', which is the Arabic equivalent of the term 'professional development', means literally 'developing' not 'development' as in English. This Arabic term, which is used officially in Saudi context, can give the 'extrinsic agent' notion. In other words, the Arabic term reflects that teachers are merely passive recipients who receive the training from extrinsic agents like government and programmes providers.

However, after showing several definitions of professional development, I offer my definition of professional development in relation to CPD as "any continuous change that occurs by formal or informal activities, which improve teachers' teaching'

3.4 How CPD occurs

In fact, there is no agreement amongst researchers and theorists on how the professional development occurs in teachers (Munby, Russel, & Martin in Justi & van Driel, 2006, p. 437) or why it succeeds in some parts and fail in others. Researchers have discussed the domains in which professional development occurs. Guskey (2002) sees that the change of the teacher should be evident on his/her students learning. He proposes a model of professional development (see Figure 1) wherein the change of the teachers' practice in the classroom leads to change in students' learning, which in turn affects the teachers' beliefs and attitudes and causes their change. He came up with this model as a critical reaction to the wide known model that considers the change in students' learning as a result of the change of teacher's practice, which happens as an outcome of the change of their knowledge and beliefs. This view of Guskey has been criticised for several reasons. First, he puts the emphasis on the outcomes of pupils' learning as a major goal of teachers' professional development. Even though learning of students is a key goal of education, it might become a secondary one in some situations depending on the cultural contexts (Lumby et al. in Mitchell, 2013). Second, there are some changes that happen in the teacher's attitude or beliefs and cannot be noticed directly in the students' learning (Cordingly in Rempe-Gillen, 2012).

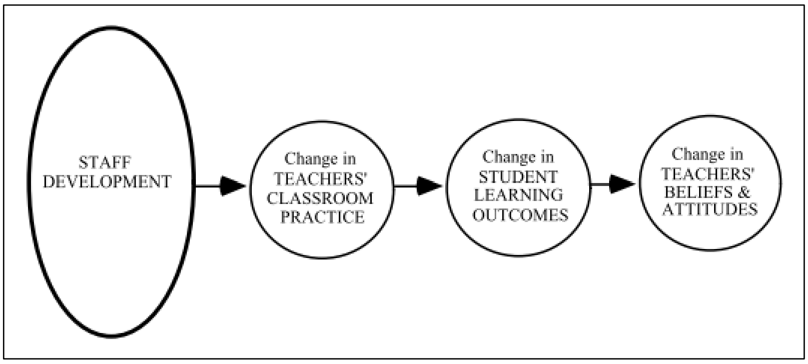

Figure 1: Guskey's model of teacher CPD (from Clarke & Hollingsworth, 2002)

Clarke & Hollingsworth (2002) criticise the linearity of Guskey's model. They, because of that, propose an alternative model where Guskey's and others' models are included and presented in a 'non-linear' and 'interconnected' manner (see Figure 2). Their model "took account of four distinct domains that encompass the teacher's world. The model assumes that change occurs through the mediating processes of reflection and enactment. One of the outcomes [of this] model is that the validation of the veracity of different beliefs for teachers' needs to be through observation of positive student learning" (Mcdonough, Clarkson, & Scott, 2007).

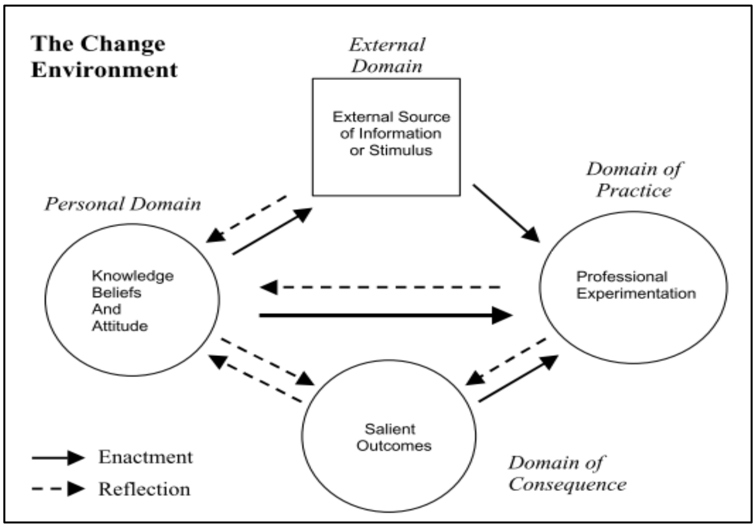

Figure 2: Clarke & Hollingsworth's model of teacher change (from Clarke & Hollingsworth, 2002)

Evans (2011), on the other hand, sees that there are three components where CPD occurs: the behavioural components with four elements, the attitudinal with three elements and the intellectual with four elements (as illustrated in Figure 3).

Figure 3: Evans' taxonomy of teacher professional development (from Mitchell, 2013)

Bill & Gilbert (1996) see that professional development should take place in three elements of teacher development. The three elements are professional, personal and social development. Professional development is the one that relates to thinking and activities, personal development is associated to feelings and social development is related to collaborating with others.

However, all these different models of professional development and CPD are not necessarily independent; they can be interconnected (Clarke & Hollingsworth, 2002).

3.5 Professional development in mathematics education

Until the last decade, there has been shortage in the research into the use of digital technology from the teacher development perspective. Lagrange et al. (2003) noticed this lack in their exploration of an international corpus of technology in mathematics education, which were published between the years 1994 and 1998. Of the 79 selected research papers that addressed the integration of technology in teaching and learning mathematics, only two papers articulated this topic with respect to teachers' use.

However, a considerable growth has happened in the last ten years in the number of the articles written in the aspect of teacher use of technology. In her review of the relative literature, Rempe-Gillen (2012) found that the number of those articles, which were published in journals like the International Journal for Technology in Mathematics Education (IJTME), increased nearly tenfold from one article in the issues of 1997-1998 to 11 articles in the issues of 2008-2009.

One of the first articles in this aspect is Michele Artigue's that published in 1998 (Artigue, 1998). In this article, Artigue points out to the slow improvement of the technology integration in mathematics education although there are considerable efforts to provide the computer applications in schools. She sees the reason behind that is the lack of the adequate training of teachers, which can make them aware of the potential struggles that can result from technology integration in teaching and learning. She attributes this problem to a main issue that is not taken into account in teacher training. She believes that ICT is usually presented to teachers by 'promoting' its advantages and 'hiding' its complications that might be faced by teachers in teaching. This situation, in Artigue's point of view, cannot bring out sufficient integration of digital technology in mathematics education.

Since Artigue's study, complexity of technology integration has been being studied by researchers. These studies, as a result, brought about the 'complexity theory', which is previously discussed in subsection 3.2

Many studies, later, focused on teachers' behaviour either inside or outside the classroom or both situations. One of the studies that investigated the teacher's behaviour inside he classroom is Monaghan's study in (2004). The study concentrated on teachers' activities while they are using new technology tools in the classroom. Monaghan's main aim of the study is to "present an holistic account of factors influencing teachers' practice" (Monaghan, 2004, p. 327). He stressed on the impact of technology complexity and students role on teachers' behaviour.

Having inspired by the instrumental genesis approach, Gueudet & Trouche (2008) conducted an empirical study to explore the behaviour of secondary school experienced mathematics teachers in and outside classroom. Specifically, they observed the teachers' documentation work during long period of time. The researchers in their study have developed a 'documentation approach'. They consider resources that are used by teachers as artefacts. These artefacts become documents after a while of use. This ongoing process is called the documental genesis. As in the instrumental genesis, two possible phases can result. The 'instrumentation phase', which is brought about by the control of using resources in teachers' work. The other phase is the 'instrumentalisation phase', which happens when the teacher can shape the use of these resources. The development of this documentation work by teachers can create a 'documentation system', which reflects and affects the teacher's professional development. Gueudet & Trouche consider the 'documentation work' as the centre of the teachers' development. However, their study has established a framework for the analysis of teachers' development in documentation work.

4. Methodology

This section discusses the research method of this study and its research design. The research questions of this study were answered by using quantitative method. A questionnaire was the tool of this method. Piloting, sampling and data collection and analysis are explained in this section.

4.1 Quantitative method

This study was conducted by using quantitative method. It is mostly common to use quantitative methods in social research in general and in educational research in particular (Fraenkel, Wallen & Hyun,1993). Quantitative research, according to Creswell (2003, p. 18) "employ strategies of inquiry such as experimental and surveys, and collect data on predetermined instruments that yield statistical data". However, it is worth mentioning that this method, though, has advantages and disadvantages as Denscombe (2010) stated:

"Advantages of Quantitative Methods:
Confidence: Statistical testing can achieve greater credibility from results.
Measurement: The analysis of quantitative data provides a basis to answer research questions.
Analysis: Quantitative data can be analysed quickly, largely irrespective of scale.
Presentation: Tables and charts provide an effective way of communicating results
Disadvantages of Quantitative Methods
Quality of data: quantitative data is bound by the quality of the questions being asked and the methods used to ask them.
Technique: There a danger of researchers being obsessed with technique as opposed to the aims of the research.
Data overload: Large datasets, whilst improving confidence, can burden the researcher.
False promise: Decisions made during the analysis or interpretation of quantitative research can have huge impacts on the outcomes or findings"(Denscombe, 2010, 283).

In fact, this research method was chosen for this study because a comparison was made between two groups of people i.e. Saudi teachers and English teachers and the quantitative method tends to be more accurate to do the comparison.

4.2 Questionnaire design

Generally, a questionnaire is a "written list of questions, the answers to which are record by respondents. In questionnaires respondents read the questions, interpret what is expected and then write down the answers" (Kumar, 2005).

It is known that the validity of the questionnaire could be affected by different issues such as careless or extreme responses, social interests and acquiescence of respondents (Oskamp, 1977). Nevertheless, questionnaire has several advantages. According to Gray (2009) questionnaire is financially low in cost, more convenient to deal with as respondents and relatively easier to analyse its data.

Components of the questionnaire

It was attempted to make the design of the questionnaire (the actual English questionnaire can be found in Appendix 1) consistent with the rules for questionnaire construction and layout (Sarantakos, 2005; Boynton & Greenhalgh, 2004). It was basically sought to design the questionnaire with a moderate length as the large amount of questions may annoy the respondents and lead them to leave some questions without answers.
Since the study aims to investigate (1 the mathematics teachers' use of digital technology and (2 the kinds of their of professional development on digital technology, the questionnaire comprised two parts. The first one was concerned with the use of the digital technology by teachers while the second was devoted to the professional development of the teachers in this aspect.
There were 12 questions. The first part included seven questions and the second comprised four questions (the first question was to ask for the participants consent).
All the questions were closed-ended questions. In some questions, respondents were allowed to give answers that are different from the choices in the closed-ended questions.
In the following, a clarification of the questionnaire parts and their questions;

The questions of the first part, which addresses the nature of teachers' use of digital technology, were as follows:

1. One closed question with four-response alternatives to know the background of the teachers. In specific, to know the range of work years of the teachers.
2. One closed question with three-response alternatives to investigate the teachers' perspectives on the integration of digital technology in teaching mathematics
3. One question with three-response alternatives to investigate the frequency of the use of certain types of digital technology. These types were chosen due to their usage popularity in education by teachers.
4. One question to know how these mathematics teachers use the same digital technology types in the previous question. Five different kinds of digital technology usage were presented in this question and respondents were able to choose more than one response.
5. One question with three-response alternatives to know how these mathematics teachers use five kinds of mathematical software. These five kinds of mathematical software were presented in this question due to their usage popularity in education field.
6. One question to identify the teachers digital resources, which they utilise in their 'documentation work' (Gueudet & Trouche, 2008). The question asks teachers to name at least one educational website they use frequently.
7. One question to know the strength of four barriers in limiting or preventing the use of digital technology in mathematics education.

The questions of the second part of the questionnaire, which investigates the teachers' professional development in digital technology, were as follows:

1. One yes-or-no question to know if teachers have attended training programmes in digital technology.
2. One question to identify the names of the training programmes. The goal of this question is to tell the differences between Saudi teachers and English teachers in the type of training programmes that are presented to them.
3. One question with three-response alternatives to investigate the teachers' opinions on the effectiveness of these training programmes.
4. One question with six choices to know how teachers develop themselves in using unfamiliar digital tools.

4.3 Piloting

The questionnaire was pilot-tested by the mathematics education, MA students. There were six students, who completed the pilot questionnaires. They took seven to 10 minutes to complete the questionnaires. They were asked for their comments on the questionnaires immediately after they completed them.

There were comments on the English language vocabularies in Question 12 and the lay out i.e. the design of the tables. All comments and notes were taken into account in writing the actual questionnaires.

4.4 Sampling

"A sample is a portion or subset of a larger group called a population" (Fink, 2003, p. 1). Secondary mathematics teachers of Saudi Arabia and England were the intended population of this study. The sample of this population was 32 teachers from Saudi Arabia and 12 teachers from England, which made the sample size as (n=44).

Due to cultural obstacles, the sample from Saudi Arabia was limited to female teachers only because I, as a female researcher, was able to access female schools only. All the teachers were in schools in Riyadh city, the capital of Saudi Arabia.

On the other hand, the sample of the English teachers comprised only 12 teachers. All members of this sample were secondary mathematics teachers who were attending Teaching Advanced Mathematics (TAM) program in Leeds University. This program was presented to teachers who were expected to teach A-level mathematics. Therefore, this sample may be biased and not representative because its members are almost similar (Cohen & Crabtree, n.d.). It is worth considering that this was the only group of secondary mathematics teachers I was able to find because of difficulties in contacting schools and teachers in England. As opposite, in Saudi Arabia, it only needed me to take an official permission from the education department in Riyadh city to be allowed to visit schools and distribute the questionnaires (the actual permission can be found in Appendix 2).

4.5 Data collection

Since the sample of this study comprises two groups of people i.e. Saudi teachers group and English teachers group, the data were collected in two stages:

Data collection from Saudi Arabia:

The survey was conducted in 11 secondary female schools in Riyadh after the official permission from the city educational department. It took place from 6th to 14th April 2015. The questionnaires either handed directly to the teachers or deposited in the head teachers' office. The collection of questionnaires was either directly from the teachers after they completed them or from the head teachers' office next day. Thirty four 34 hard copy questionnaires were distributed, two of them were excluded from the data analysis because they were not completed.

Data collection from England:

As mentioned previously, the English secondary mathematics teachers were members of the TAM program in Leeds University. The first step was to get their consent by signing a consent form (the actual consent form can be found in Appendix 3). After collecting 18 signed consent form, a link to on-line questionnaire was sent to their emails. Out of 18, only 12 teachers completed the questionnaires. The emails were sent on early June 2015.

4.6 Data analysis:

The data were analysed by using the Statistical Package for the Social Science (SPSS 21). P value test was used to test the null hypothesis, which is there are no differences between the two groups of teachers.

5. Results and discussion:

This section shows the results of this study accompanied by discussion of these results taking into account that 'Too often, researchers report only procedures and findings, not the model or world view. The findings of any particular study are interpretable only in terms of the world view' (Romberg, 1992, p.53).

5.1 Teachers' experience

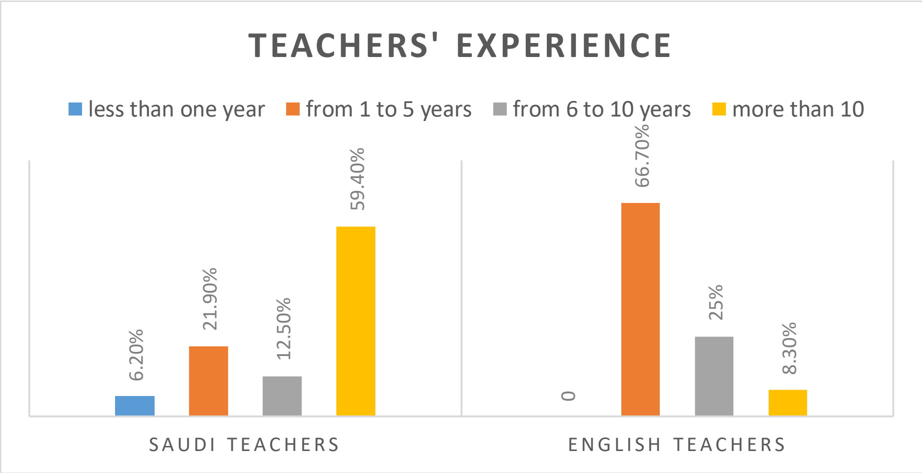

Figure 4: Description of the sample according to the nationality and the work experience

As illustrated in the figure above most Saudi sample have long experience in teaching mathematics that exeeds ten years. On the other hand, the majority of teachers of the English sample have less experience than Saudi teachers.

5.2 Teachers' perspectives on the importance of digital technology

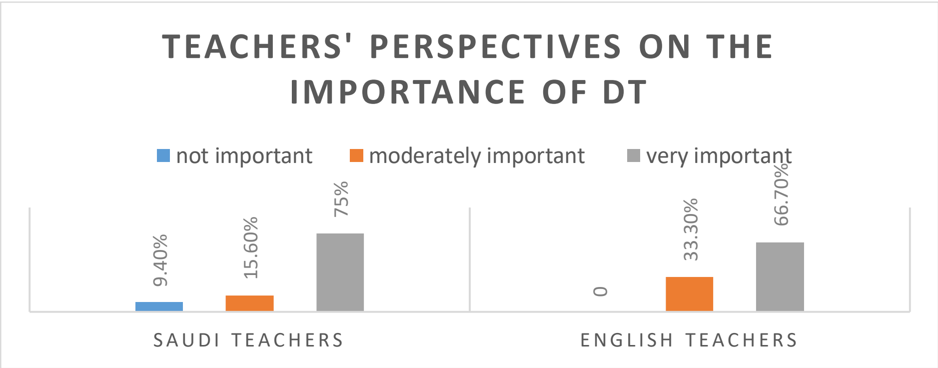

Figure 5: Teachers' perspectives on digital technology importance according to the nationality

As shown in the figure above, it is obvious that the majority of teachers of both groups perceive digital technology as very important although less than 10 percent of Saudi teachers saw it not important.

5.3 Relationship between teachers' experience and their perspectives on digital technology importance

Table1 in Appendix 4 shows that there is a negative correlation between experience and perception on digital technology importance amongst English teachers. Yet, it is not significant one.

On the other hand, there is no correlation between the two variables in the Saudi teachers group.

5.4 The use of digital technology types amongst teachers

Seven types of digital technology were put in the questionnaire and respondents were asked to identify how they use these seven types. Five ways of use were in a table in the questionnaire and **respondents were able to choose more than one way of use**. The ways of use are: personal use, planning lessons, preparing worksheet, assessing students and lesson illustration (See Appendix 5, Tables 2, 3, 4, 5, 6, 7, 8 for more details). By personal use, it is meant the use the digital technology types outside the classroom either for the mathematics teaching and learning purposes or for the teacher's personal purposes.
The following results has revealed:

5.4.1 The use of presentation applications

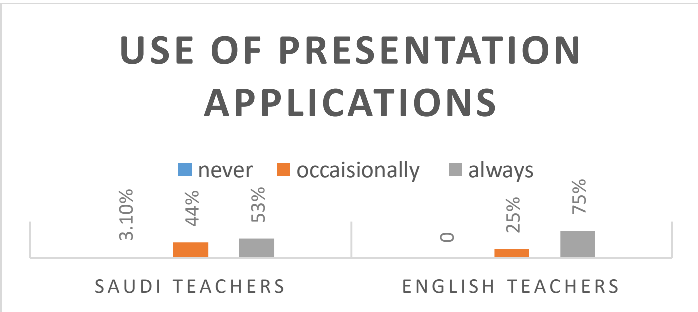

Figure 6: frequency of using presentation applications by Saudi and English teachers

As can be seen in the figure above, nearly half of Saudi teachers indicated that they always use presentation applications, 43.8% do this occasionally and only one teacher who never use them.

According to Table 2 in Appendix 5, the most common three uses of presentation applications among Saudi teachers are lesson illustration followed by planning lessons then preparing worksheets.

On the other hand, three quarters of English teachers showed that they always use presentation applications and the rest quarter use it occasionally. Lesson illustration is the most used way of utilizing presentation applications amongst English teachers then planning lessons followed by preparing worksheet.

Overall, the two groups of teachers tend to use presentation applications in similar ways. Nevertheless, English teachers seem to use these applications more frequent than Saudi do.

This result, which show the high use of presentation applications amongst Saudi and English teachers, is not surprising. This type of digital technology is usually used to present the content of the lesson. According to Joint Mathematical Council of the United Kingdom (JMC) (2011b, p. 6) most usage of digital technology amongst teachers is presentation applications:

> "Usage of digital technology within school mathematics has been predominantly teacher-led and mainly focused on presentational software such as PowerPoint and interactive whiteboard software".

5.4.2 Use of interactive whiteboard (IWB)

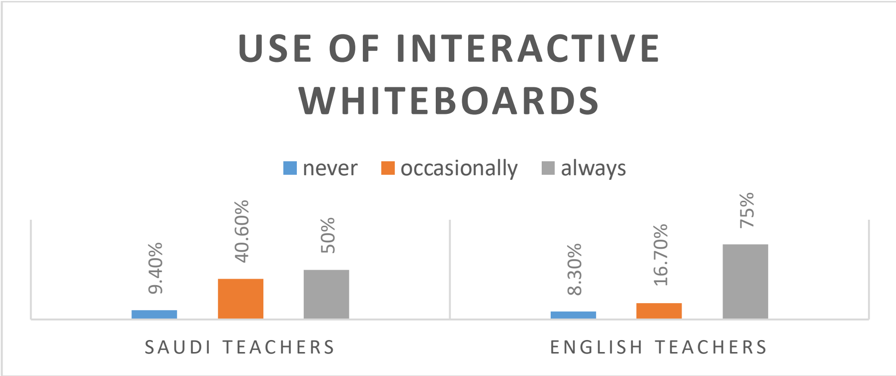

Figure7: frequency of using IWB by Saudi and English teachers

As can be seen in the figure above, the frequency of using the interactive whiteboard is almost similar to the frequency of using presentation applications in both groups. Interactive whiteboard is always used by the half of Saudi teachers and occasionally by 40.60% of them. 9.40% of them declared that they never use it. On the other hand, three quarters of English teachers declared that they always use it, 16.70% use it occasionally and 8.30% stated that they never use it.

According to Table 3 in Appendix 5, the most common uses of interactive whiteboard in the Saudi teachers group are lesson illustration, then planning lessons followed by the personal use. On the other hand, lesson illustration is in the first place of the English teachers' use of Interactive whiteboard, assessing students is in the second place and planning lessons becomes in the third place.

The explanation of this result is similar to the explanation of the use presentation applications. As mentioned previously, teachers tend to use digital technologies for presentation purposes.

Another notable thing in this result is the high usage of IWB by English teachers. this may be referred to the reason that "the UK has been the major adopter" of this type of technology as stated in the report of Joint Mathematical Council of the United Kingdom (JMC) (2011, p. 10).

5.4.3 Use of mathematics software

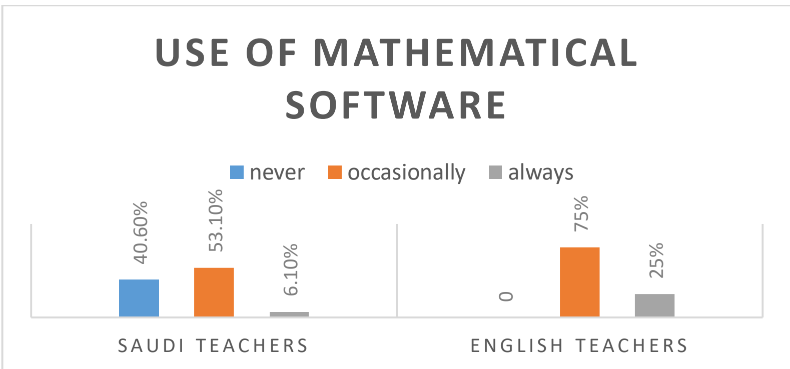

Figure 8: Frequency of using mathematical software by Saudi and English teachers

As shown in the figure above, more than half of Saudi teachers (53.10%) indicated that they use mathematics software occasionally, 40.60% of them never use it and only 6.20% always use it. None of English teachers declared that he or she never use mathematics software. Three quarters of them use it occasionally and the quarter of then always use it. Statistically, there is a considerable difference between the two groups in the frequency of using this type of technology due to the P-Value.

In terms of the way in which the teachers use mathematics software (Appendix 5 Table 4), the results show that the most common use of it amongst Saudi teachers lessons illustration, followed by the personal use then planning lessons.

In terms of English teachers' use, the most common uses are lesson illustration then planning lessons followed by the personal use.

As mentioned above, Saudi teachers showed lower use of mathematical software than English did. According to Althubiani (2010) and Alzahrani (2012), none-Arabic-language mathematical software programmes can create barrier that prevents Saudi teachers, who cannot read or understand English, from using them.

5.4.4 Use of graphing calculators

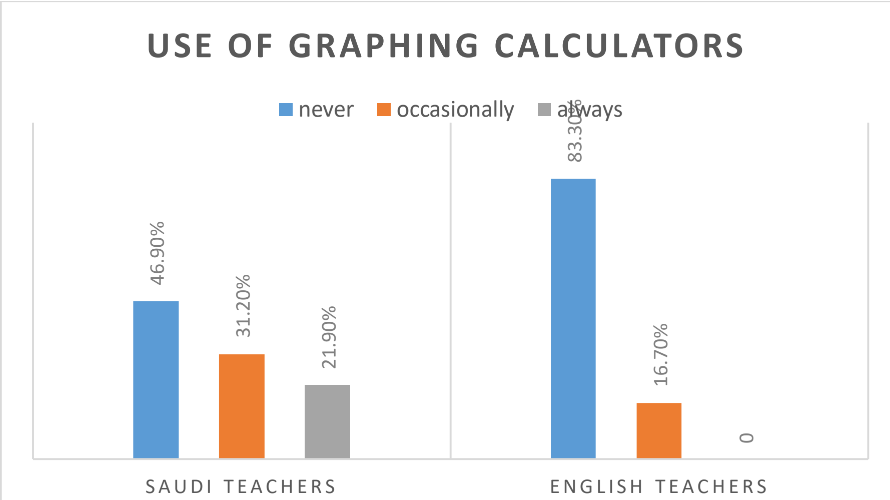

Figure 9: Frequency of using graphing calculators by Saudi and English teachers

As illustrated in the figure above, graphing calculators have *never* been used by nearly the half (46.9%) of Saudi teachers and the majority (83.30%) of English teachers. Yet, it is used *occasionally* by 31.20% of Saudi teachers and 16.70% of English ones. While almost 22% of Saudi teachers responded that they *always* use them, none of English teachers did so.

Regarding the nature of using this type of digital technology (Appendix 5 Table 5), the top use amongst Saudi teachers is lesson illustration followed by personal use then lesson planning. However, personal use, assessing students and illustrating lessons have the same proportion of use by English teachers.

In fact, prior to the recent mathematics curriculum reform, graphing calculators were considered as unfamiliar type of technology in Saudi education. They were introduced to Saudi mathematics teaching and learning through the American mathematics textbooks, which were adopted in 2009. Moreover, according to Alshehri (2014, p. 51) "calculator technology has not been encouraged despite the strong research evidence of the positive impact of calculators in instruction". This may explains why the use of graphing calculators tends to be low in Saudi Arabia.

The situation in English context is slightly different. Although graphic calculators are used by mathematics teachers, their way of use was criticised in the Joint Mathematical Council of the United Kingdom (JMC) (2011, p. 19) report. Mathematics teachers usually use these devices as “presentational, visual and computational aids rather than as instruments to facilitate mathematical thinking and reasoning”.

5.4.5 Use of social networks

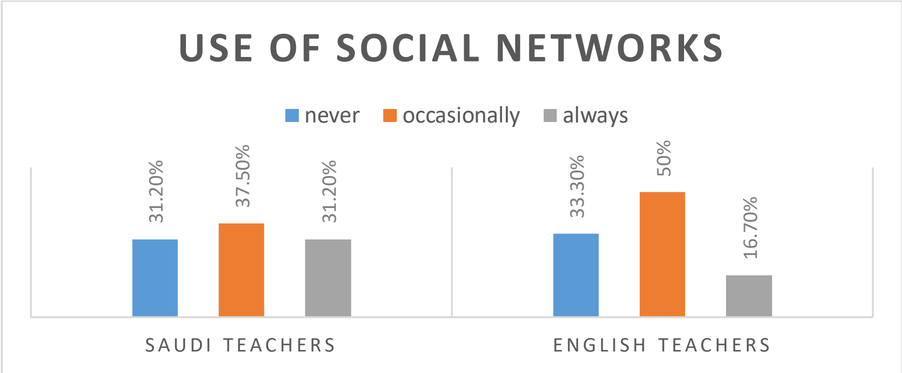

Figure 10: frequency of using social networks by Saudi and English teachers

As shown in the figure above, social networks such as Twitter and Facebook are never used by almost the third of Saudi and English teachers as 31.20% and 33.30% respectively. Moreover, they are occasionally used by nearly 38% of Saudi teachers and half of English teachers. Almost the third of Saudi teachers showed that they always use social networks and nearly 17% of English teachers do the same.

According to Table 6 appendix 5, the main three uses of social networks amongst Saudi teachers are personal use followed by lessons illustration then lessons planning. Within English teachers, the main three uses are personal use, then planning lessons followed by preparing worksheets.

Overall, there are no significant differences either in the frequency or in the way of using social networks between the two groups. Only that the amount of English teachers who use it occasionally as personal use is higher.

5.4.6 Use of educational websites

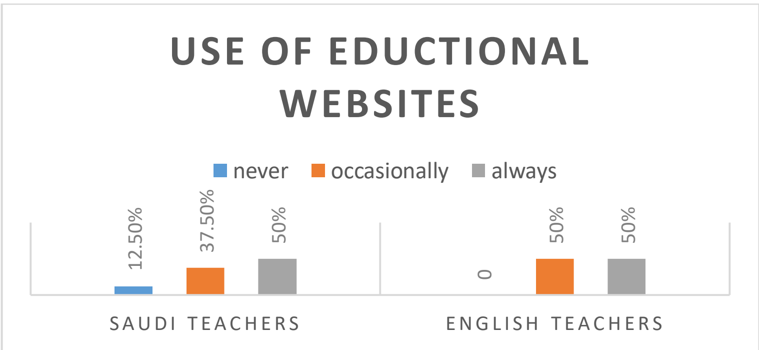

Figure 11: Frequency of using educational websites by Saudi and English teachers

As in can be seen in the figure above, half of Saudi teachers and English teachers indicated that they always use educational websites. The other half of English teachers use them occasionally while 37.50% of Saudi teachers do so. However, 12.50% of Saudi teachers never use educational websites.

As shown in Table 7 in Appendix 5, amongst Saudi teachers, educational websites are mainly used personally and to prepare worksheets, then to plan lessons.

On the other hand, the three main uses of educational websites amongst English teachers are planning lessons, and then preparing work sheets followed by illustrating lessons.

Overall, using educational websites is highly used by English teachers. More details about this aspect will be discussed in subsection 5.6.

5.4.7 Use of virtual learning environment (VLE)

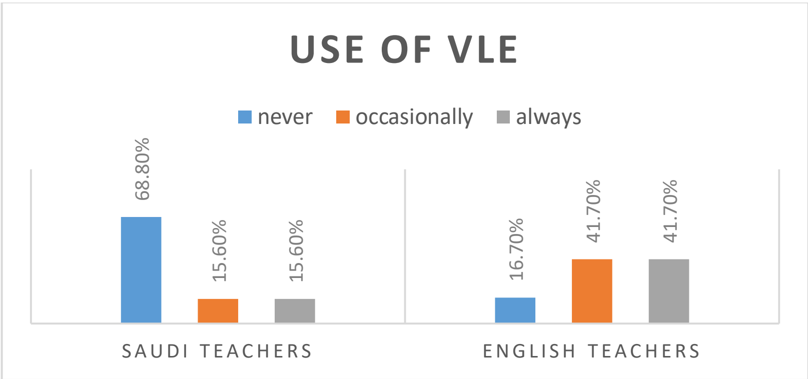

Figure 12: Frequency of using VLE by Saudi and English teachers

From the data in the figure above, virtual learning environment (VLE) is more used by English teachers than it is used by Saudi teachers. P-value shows a significant difference between the two groups of teachers in using this type of digital technology. While the majority (68.80%) of Saudi teachers declared that they never use the VLE, only 16.7% of English teachers declared so. Moreover, nearly 42% of English teachers stated that they always use VLE whereas 15.6% of Saudi teachers stated so.

Regarding the way of using VLE (see Appendix 5 Table 8), English teachers use it in assessing students, then in planning lessons and preparing worksheets. Saudi teachers, on the other hand, mainly use it in illustrating lessons, then for personal use, then planning lessons.

The large amount of Saudi teachers who stated that they never use VLE may reflect that this kind of technology is not popular in Saudi education.

5.5 The use of mathematics software

The respondents were asked about their use of five types of software, which are:

5.5.1 GeoGebra

"Free dynamic mathematics software for all levels of education that brings together geometry, algebra, spreadsheets, graphing, statistics and calculus in one easy-to-use package. Interactive learning, teaching and evaluation resources created with GeoGebra can be shared and used by everyone at tube.geogebra.org" ("GeoGebra," 13 Aug. 2015).

The result of using this software amongst the two groups of teachers were as in the figure below:

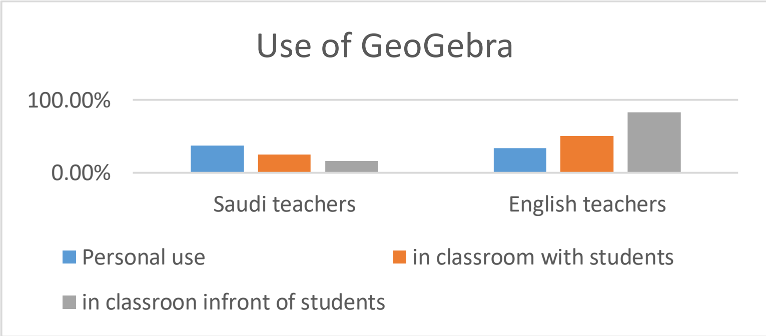

Figure 13: use of GeoGebra amongst Saudi and English teachers

5.5.2 Autograph

"A dynamic PC program operating in three modes:
- Statistics & Probability
- Graphing, coordinates, transformations and bivariate data
- Graphing, coordinates and transformations. It is designed to help teachers and pupils visualise mathematics at secondary/college level, using dynamically linked 'objects'" ("Autograph.com," 13 Aug. 2015).

The results of using this software amongst the two groups of teachers were as in the figure below:

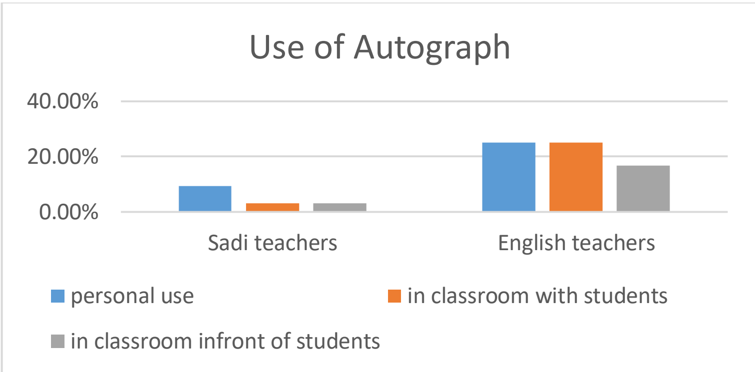

Figure 14 ways of using Autograph amongst Saudi and English teachers

5.5.3 Excel

"Microsoft Excel is a spreadsheet application, developed by Microsoft, allows one to enter numerical values or data into the rows or columns of a spreadsheet, and to use these numerical entries for such things as calculations, graphs, and statistical analysis" ("What is Excel," 20 Aug. 2015).

The results of using this software amongst the two groups of teachers were as in the figure below:

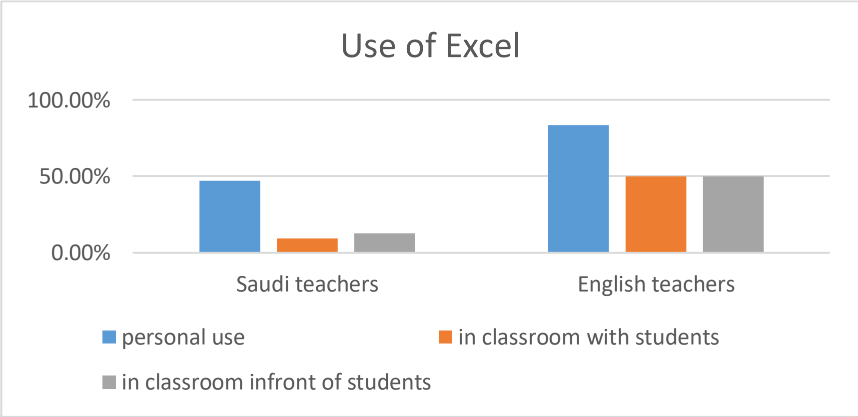

Figure 15: ways of using Excel amongst Saudi and English teachers

5.5.4 Cabri

"A commercial interactive geometry software produced by the French company Cabrilog for teaching and learning geometry and trigonometry" ("Cabri," 13 Aug. 2015).

The results of using this software amongst the two groups of teachers were as in the figure below:

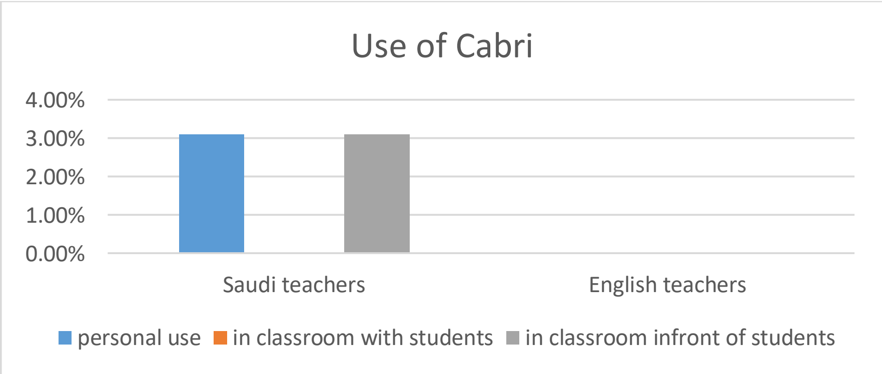

Figure 16: ways of using Cabri amongst Saudi and English teachers

5.5.5 Geometer's Sketchpad

"A popular commercial interactive geometry software program for exploring Euclidean geometry, algebra, calculus, and other areas of mathematics" ("Geometer's Sketchpad," 13 Aug. 15).

The results of using this software amongst the two groups of teachers were as in the figure below:

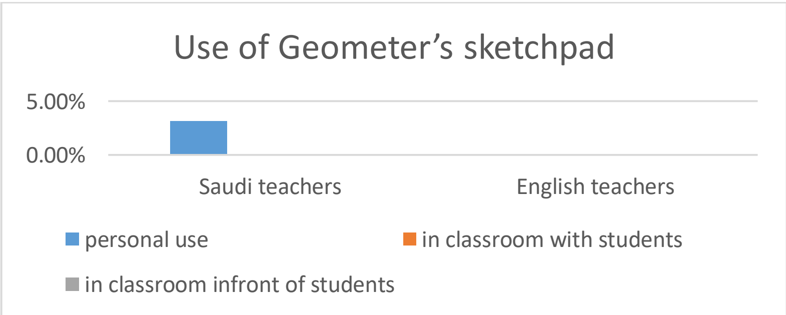

Figure 17 ways of using Geometer's sketchpad amongst Saudi and English teachers

The discussion of the previous results:

As can be seen in the figures above, Cabri and Geometer's sketchpad are almost not used by either Saudi or English teachers. However, Excel, is the most common mathematical software that is used by Saudi and English teachers followed by GeoGebra then Autograph.

Although Excel is the most popular software among the teachers of two groups, it is more popular among English teachers. For the personal use, 83.30% of English teachers use it personally while around 47% of Saudi teachers do so. Using it in classroom with students got 50% of the English teachers and only 9.40% of Saudi teachers. For the third usage, 50% of English teachers use Excel in classroom in front of students (i.e. it is only used by teachers not the students) while 12.50% do so from Saudi teachers.

Moreover, the results reveal that there is a huge difference between Saudi teachers and English ones in the way they use GeoGebra software. While the personal use gets the highest percentage amongst the Saudi teachers (37.50%), using it in classroom in front of the students has the largest proportion (83.30%) of the English teachers' preferences.

Autograph is less popular than Excel and GeoGebra amongst both Saudi and English teachers. Additionally, there are no significant differences between the two groups of teachers in the way they use this software.

5.6 Educational websites used by teachers

Educational websites used by teachers can be considered as resources that can reflect the documentation work of teachers, which in turn reflects their professional development (Gueudet & Trouche, 2008). In the questionnaire, teachers asked to write down the educational website they use in order to investigate their resources. Figure 18 shows the results of Saudi teachers' data whereas Figure 19 illustrates the results of English teachers' data.

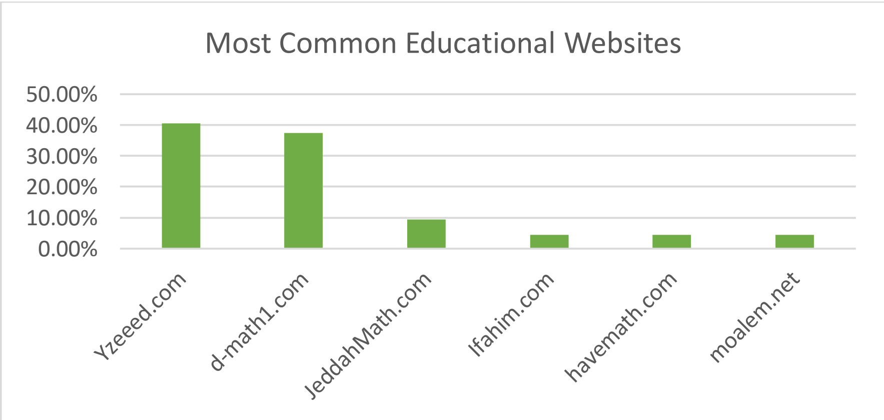

Figure 18: The most common used mathematics websites among Saudi teachers

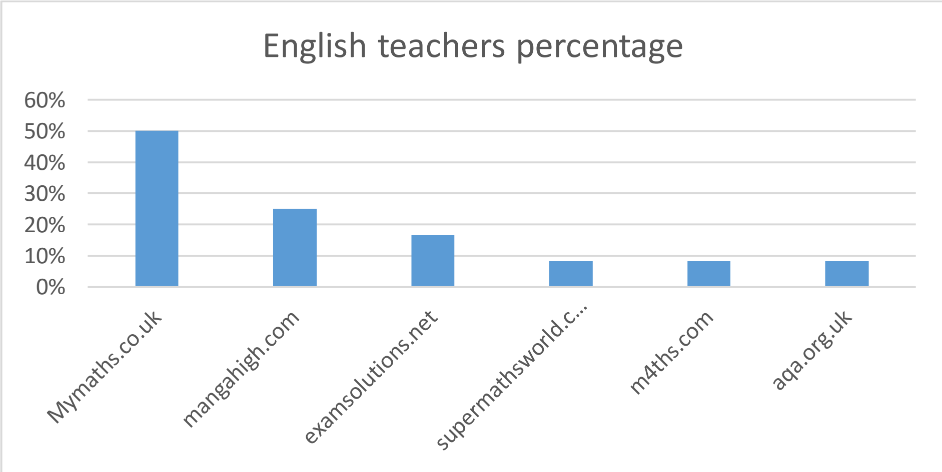

Figure 19: The most common used mathematics websites among English teachers

There are no websites that are used by both groups of teachers. Saudi teachers use local websites while English teachers use British and international websites. The most common website amongst Saudi teachers are Yzeeed.com and d-math1.com. The former is an open forum where teachers of all subjects gather and exchange their knowledge and expertise including lessons plans, worksheets, quizzes, games and so on. The latter is a website founded by a mathematics teacher to provide all-level mathematics teachers with lessons plans, worksheets and explanations for all lessons of mathematics textbooks. All other websites used by Saudi teachers are similar to these websites.

On the other hand, the most used websites by English teachers are mymaths.co.uk followed by mangahigh.com. The former is a website founded by Oxford press. It serves students and parents as well as teachers. It presents electronic self-assessment lessons for students. The latter is specialised in mathematical games and quizzes.

Overall, English teachers tend to use websites more than Saudi teachers do as mentioned in Subsection 5.4.6 and illustrated in Figures 18 and 19. Moreover, English teachers tend to use websites that interested in games and quizzes whereas Saudi teachers tend to use websites that provide lessons plans and worksheets. As former mathematics teacher, I think the Saudi teachers' tendency to this kind of resources is brought out by the routine rules that obligate teachers to write lesson plan for each lesson and present it to the head teacher. Therefore, teachers prefer to get ready lesson plans from websites to save their time.

5.7 Barriers to use digital technology from teachers' perspectives

The aim of asking teachers about the barriers of integrating digital technology into mathematics education is to compare the challenges in the Saudi context and the English one from the teachers' perspectives. Figures 20, 21, 22, 23 show the results of this question.

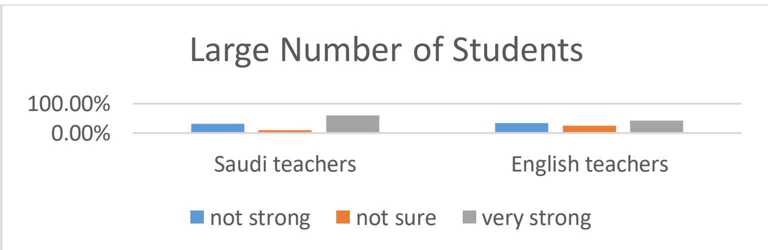

Figure 20: teachers perspectives on students' large amount as a barrier from integrating DT in mathematics education

As shown in Figure 20 above, the large number of students was perceived as a very strong barrier for more than half of Saudi teachers (59.40%) and for 41.70% of English teachers. However, almost the third of Saudi and English teachers considered this barrier as not strong.

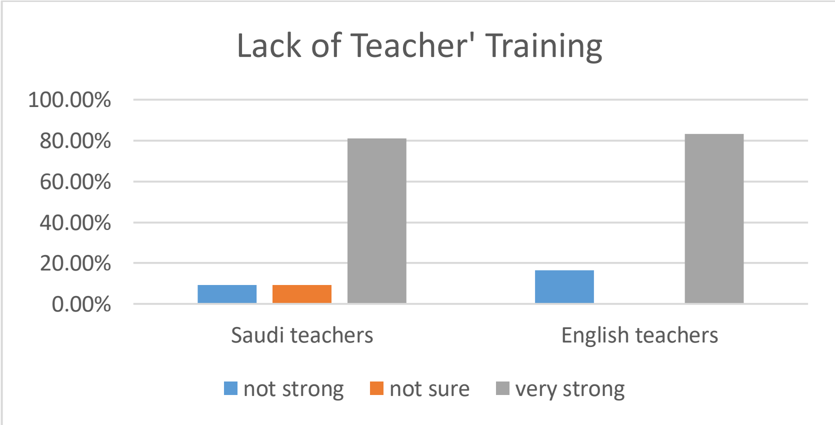

Figure 21: Teachers' perspectives on the lack of training as a barrier from integrating DT in mathematics education

In Figure 21 above, the lack of teachers' training was a strong barrier for the majority of teachers of both groups with nearly similar percentages; 81.20% for Saudi teachers and 83.20% for English teachers. This result reflects the need of teachers in both groups to training programmes, which means that what they receive is not enough.

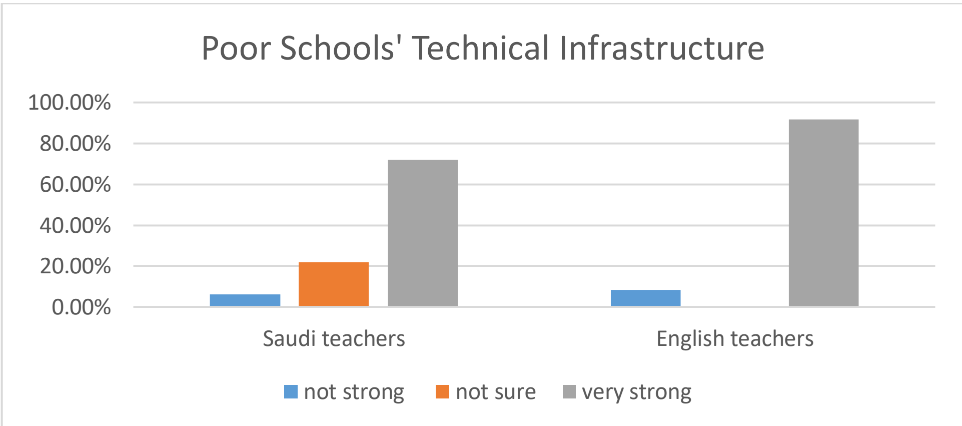

Figure 22: Teachers' perspectives on poor schools' technical infrastructure as a barrier from integrating DT in mathematics education

As shown in Figure 22 above, the poor technical infrastructure of the school was perceived as a very strong barrier by most of both groups' teachers: 91.70% of English teachers and 70.90% of Saudi teachers. Only 8.30% of English teachers and 6.20% of Saudi teachers saw this barrier as not strong one.

Although this result is not surprising from Saudi perspective. There is a consensus amongst Saudi researchers on the insufficiency of technological infrastructure of Saudi schools (Alghadeer, 2009; Alhasan, 2004; Alshehri, 2014; Althubiani, 2010). However, the very high number of English teachers who saw this barrier as very strong is surprising because schools in England, generally, are well equipped technologically.

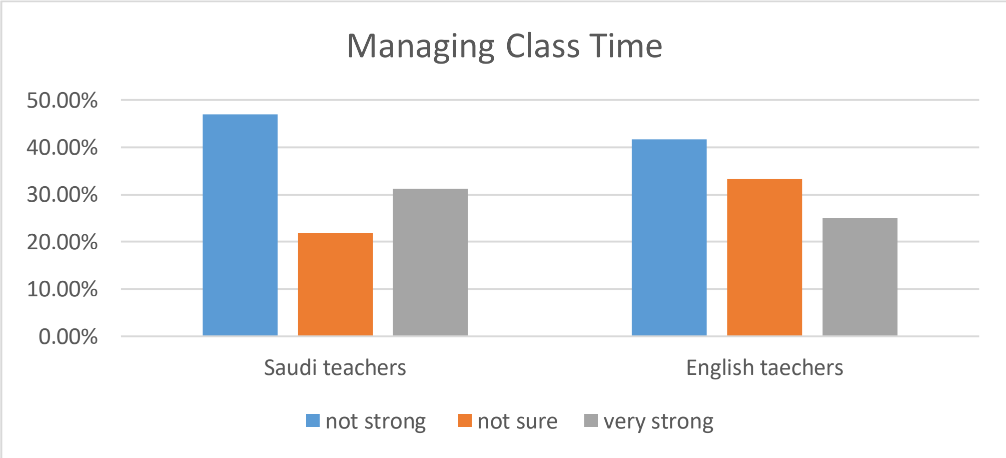

Figure 23: Teachers perspectives on managing class time as a barrier from integrating DT in mathematics education

As can be seen in Figure 23 above, managing the class time was not seen as strong barrier by nearly half of teachers of two groups; 41.70% of English teachers and 46.90% of Saudi ones. Nevertheless, the quarter of English teachers and around the third of Saudi teachers preserved it as very strong barrier.

This result tends to be surprising. While in the relative literature managing the class time is considered as a major complexity of using digital technology in teaching mathematics (Abboud-blanchard, 2009; Monaghan, 2004), nearly half of them viewed it as not strong difficulty and less than the third of the teachers of both groups preserved it as a very strong one.

5.8 Teachers' attendance to DT training programmes

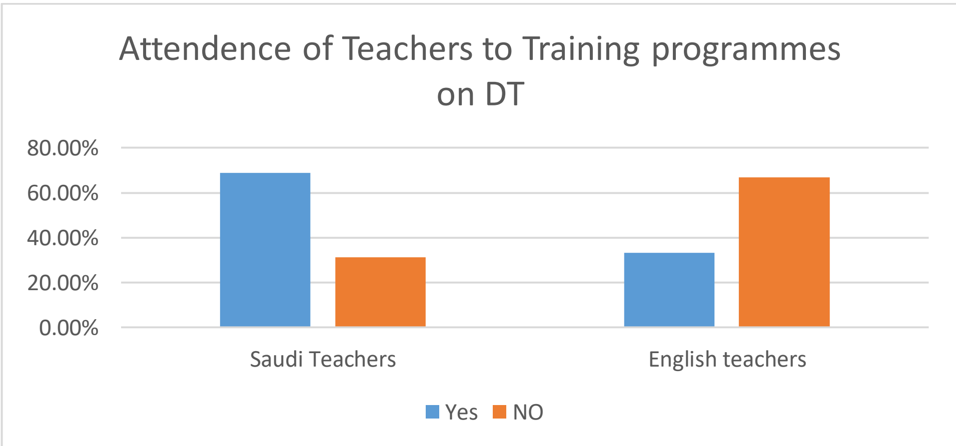

Figure 24: Percentage of Techers' attendance to DT training programmes

As shown in the Figure above, there is a significant difference between Saudi and English teachers in attending digital technology training programmes. It is clear that the percentage of English teachers who have not attended training programmes in digital technology is extremely high. Moreover, the percentage of those English teachers who have attended DT training programmes is considerably less than the percentage of Saudi teachers who have done so.

The high number of attendance by Saudi teachers may be a result of the Saudi government professional development project mentioned in the introduction of this study, which aims to provide teachers with in service training.

5.9 Teachers' Perspectives on provided DT programmes' effectiveness

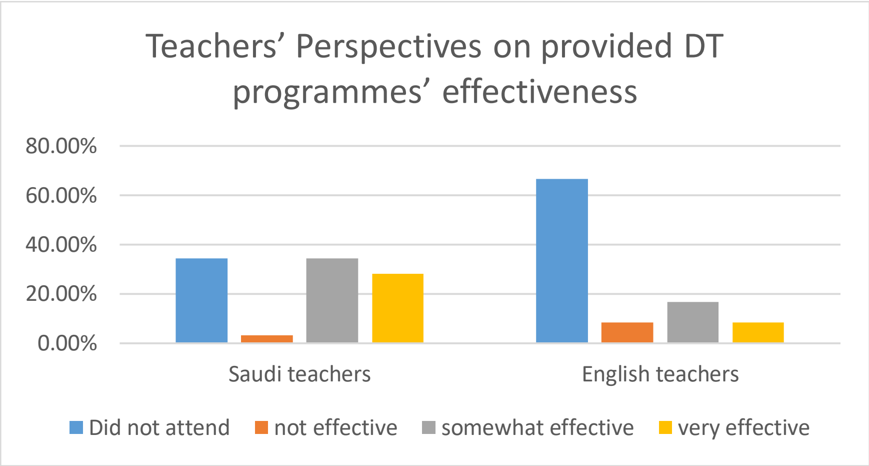

Figure 25: Teachers' Perspectives on provided DT programmes' effectiveness

As can be seen the Figure 25 above, digital technology training programmes were seen somewhat effective by almost half of the English teachers who have attended these programmes. However, the proportion of English teachers who saw these programmes very effective is equal to the proportion of those who perceived them as not effective. In the Saudi sample, the teachers who perceived the training programmes as very effective are around nine times greater than those who saw them not effective.

Overall, Saudi perspective towards DT training programmes is more positive than English teachers' perspective.

5.10 How mathematics teachers develop themselves regarding digital technology

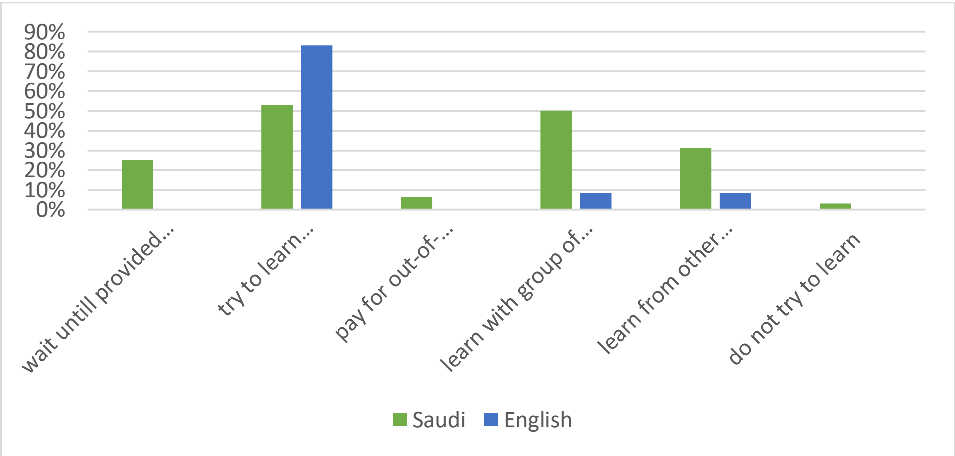

Figure 26: How Saudi and English teachers develop themselves regarding DT

Teachers were asked to tell what they *usually* do if they are not familiar with a certain type of technology. The results of this question, as shown in Figure 26 above, revealed the following:

- None of the English teachers declared that they wait until they provided with a suitable training programme by their schools. However, the quarter of Saudi teachers declared they do so.
- While most English teachers (83.30%) try to learn independently, nearly half of Saudi teachers do so.

- None of English teachers pays for out-of-school training programmes whereas 6.20% of Saudi teachers do so.
- With a considerable difference, exactly half of Saudi teachers learn with group of colleagues in school and only 8.30% of English teachers do so.
- Learning online from other teachers is used by only 8.30% of English teachers and nearly the third of Saudi teachers.
- None of English teachers declared that they do not try to learn how to use unfamiliar type of technology. Yet, only 3.10% of Saudi teachers declared that they do so.

Overall, English teachers tend to be more independent in developing themselves in using digital technology. Saudi teachers, on the other hand, prefer to learn with group of teachers whether online or inside the school.

6. Conclusion:

The results of this study, in general, showed a similarity between Saudi teachers and English teachers in most of its parts although few differences emerged in some places.

Saudi and English teachers similarly perceive the importance of digital technology in mathematics education. They, commonly, tend to use the seven types of digital technology in almost the same frequency except for virtual learning environment and mathematical software where English teachers showed higher usage.

In addition, the five mathematical software types had the same popularity among the two groups i.e. Saudi and English teachers use the same types of mathematical software and avoid the same of them. The differences emerged in this issue were in the way of using these types.

There were no significant differences in the teachers' perceptions on the barriers of integrating digital technology in mathematics education.

The two groups have nearly similar opinions about the effectiveness of the digital technology training programmes. However, the difference was in the amount of attendance of these programmes where Saudi teachers showed higher attendance.

In terms of self development, Saudi and English teachers were almost similar in their practices except for learning with group of teachers in the school which had higher practice by Saudi teachers.

Due to the teachers' perspectives, there is demand to in-service training programmes on digital technology and a need to improve the technological infrastructure of schools in the two countries.

However, it is worth mentioning that this study did not intend to generalise its results due to, on the one hand, the small size of the sample and, on the other hand, the type of the English teachers sample, which is opportunistic. Therefore, the results of this study are not representative for neither Saudi teachers nor English teachers in respect to professional development on digital technology. Moreover, "Real situations are rarely well-defined and are often embedded in an environment that makes it hard to obtain a clear statement of the situation" (Romberg, 1992, p. 51).

References:

[1] Abboud-blanchard, M. (2009). TECHNOLOGY AND MATHEMATICS TEACHING PRACTICES : ABOUT IN-SERVICE AND PRE-SERVICE TEACHERS. In Proceedings of CERME 6 (pp. 1880–1889). Lyon, France. Retrieved from www.inrp.fr/editions/cerme6

[2] Alghadeer, F. (2009). Employing the new technology in teaching in Saudi Arabian schools. Cairo University. In Arabic

[3] Alharbi, E. (2014). A Study on the Use of ICT in Teaching in Secondary Schools in Kuwait. Cardiff Metropolitan University.

[4] Alhasan, I. (2004). A study of the situation of computers labs of the pioneer schools from teachers, educators and principals' perspectives. King Saud University. Saudi Arabia. In Arabic
[5] Al-madani, F. M., & Allaafiajiy, I. A. (2014). Teachers ' Professional Development on Ict Use : a Saudi Sustainable Development Model. In Proceeding of the Global Summit on Education GSE (pp. 100–109). Kuala Lumpur, Malaysia.
[6] Alshehri, Z. F. (2014). Integrating Technology into Mathematics Education in the Saudi Context. Global Educational Research Journal, 2(4), 50–53.
[7] Althubiani, A. (2010). The Situation of Using Technology in Teaching Secondary Mathematics from the Teachers' Perspective. Um AL Qura University, Saudi Arabia. In Arabic
[8] Alzahrani, A. (2012). Evaluation of mathematics teachers' use of computers in teaching from the teachers' and educators' perspectives. Ismaelia College of Education Journal, (22), 215–254. In Arabic
[9] Artigue, M. (1998). Teacher training as a key issue for the integration of computer technologies. In Tinsley & Johson (Eds.), Information and Communications Technologies in School Mathematics (pp. 121–129). IFIP. Champan & Hall.
[10] Artigue, M. (2002). Learning Mathematics in a CAS Environment: The Genesis of a Reflection about Instrumentation and the Dialectics between Technical and Conceptual Work. International Journal of Computers for Mathematics Learning, 7(3), 245–274.
[11] Autograph. (n.d.). Retrieved from http://www.autograph-maths.com/about_autograph/ in 13 Aug 2015.
[12] Bill, B., & Gilbert, J. (1996). Teacher development: a model from science education. London: RoutledgeFalmer.
[13] Bingimlas, K. (2009). Barriers to the Successful Integration of ICT in Teaching and Learning Environments: A Review of the Literature. Eurasia Journal of Mathematics, Science and Technology Education, 5(3), 235–245.
[14] Boynton, P. M., & Greenhalgh, T. (2004). Hands-on guide to questionnaire research Selecting, designing, and developing your questionnaire. BMJ: British Medical Journal, 328(7451), 1312–1315.
[15] Bueno-Ravel, L., & Gueudet, G. (2007). Online resources in mathematics: teachers' genesis of use. CERME 5, 1369 – 1378.
[16] Cabri. (n.d.). Retrieved from http://www.cabri.com/ in 13 Aug 2015.
[17] Clarke, D., & Hollingsworth, H. (2002). Elaborating a model of teacher professional growth. Teaching and Teacher Education, 18(8), 947–967. http://doi.org/10.1016/S0742-051X(02)00053-7
[18] Cohen, D., & Crabtree, B. (n.d.). Qualitative Research Guidelines Project. Retrieved from http://www.qualres.org/HomeOppo-3815.html
[19] Creswell, J. (2003). Research design: Qualitative, quantitative and mixed methods approaches (2nd ed.). Thousand Oaks, CA: SAGE Publications.
[20] Denscombe, M. (2010). The Good Research Guide. Maidenhead: The Open University Press.
[21] Drijvers, P., Monaghan, J., Thompson, M., & Trouche, L. (n.d.). Use of Technology in Secondary Mathematics. Final Report of the International Baccalareate.
[22] Earley, P. (2005). Continuing professional development: The learning community. In M. Coleman & P. Earley (Eds.), Leadership and Management in Educatio Cultures, Change, and Context (pp. 227–249). London, New York: Oxford university press.
[23] Eraut, M. (2004). Informal learning in the workplace. Studies in Continuing Education, 26(2), 247–273.
[24] Evans, L. (2002). What is Teacher Development. Oxford Review of Education, 123–137.

[25] Evans, L. (2008). Professionalism, Proffesionality and the Development of Education Professional. British Journal of Educational Studies, 56(1), 20–38.
[26] Evans, L. (2011). The “shape” of teacher professionalism in England: professional standards, performance management, professional development and the changes proposed in the 2010 White Paper. British Educational Research Journal, 37(5), 851–870.
[27] Fink, A. (2003). The Survey Kit: How to sample in surveys (2nd ed.). London: SAGE.
[28] Fraenkel, J. R., Wallen, N. E., & Hyun, H. H. (1993). How to design and evaluate research in education (Vol (7)). New York: McGraw-Hill. Chicago.
[29] GeoGebra. (n.d.). Retrieved from https://chrome.google.com/webstore/detail/geogebra/bnbaboaihhkjoaolfnfoablhllahjnee?hl=en in 13 Aug 2015
[30] Geometer’s Sketchpad. (n.d.). Retrieved from http://www.dynamicgeometry.com/ in 13 Aug 2015
[31] Gray, D. (2009). Doing Research in the Real World. California: Sage Publications Ltd.
[32] Gueudet, G., & Trouche, L. (2008). Towards new documentation for mathematics systems teachers ?, 71(3), 199–218. http://doi.org/10.1007/sl0649-008-9159-8
[33] Guin, D., & Trouche, L. (1999). THE COMPLEX PROCESS OF CONVERTING TOOLS INTO MATHEMATICAL INSTRUMENTS: THE CASE OF CALCULATORS. International Journal of Computers for Mathematics Learning, 3(3), 195–227.
[34] Guskey, T. (2002). Professional Development and Teacher Change. Teachers and Teaching: Theory and Practice, 8(3/4), 381–391. http://doi.org/10.1080/135406002100000512
[35] HWS: Math & CS. (n.d.). Retrieved from http://math.hws.edu/javamath/ryan/ChiSquare.html in 20 Aug 2015
[36] Joint Mathematical Council of the United Kingdom (JMC). (2011a). Digital Technologies and Mathematics Education, (September), 1–34. Retrieved from http://cme.open.ac.uk/cme/JMC/Digital Technologies files/JMC_Digital_Technologies_Report_2011.pdf\nwww.jmcuk.org.uk
[37] Joint Mathematical Council of the United Kingdom (JMC). (2011b). Digital Technology and mathematics education. UK.
[38] Justi, R., & van Driel, J. (2006). The use of the Interconnected Model of Teacher Professional Growth for understanding the development of science teachers’ knowledge on models and modelling. Teaching and Teacher Education, 22(4), 437–450. http://doi.org/10.1016/j.tate.2005.11.011
[39] Kumar, R. (2005). Research Methodology. New york City, NY: Sage Publications.
[40] Lagrange, J., Artigue, M., Laborde, C., & Trouche, L. (2003). Technology and Mathematics Education: A Multidimentional study of the Evolution of Research and Innovation. In A. J. Bishop, M. A. Clements, C. Keitel, J. Kilpatrick, & F. K. s. Leung (Eds.), Second Handbook of Mathematics Education. (Vol. 10, pp. 237–269). Drdtrecht, The Netherlands: Kluwer Academic Publishers.
[41] Mcdonough, A., Clarkson, P., & Scott, A. (2007). Teacher Change in Response to a Professional Learning Project. In L. Sparrow, B. Kissane, & C. Hurst (Eds.), Proceedings of the 33rd annual conference of the Mathematics Education Research Group of Australasia. Fremantle: MERGA (pp. 391–398). Fremantle.
[42] Ministry of Education. (n.d.). jehazi Project. Retrieved from http://www.jehazi.org
[43] Mitchell, R. (2013). What is professional development, how does it occur in individuals, and how may it be used by educational leaders and managers for the purpose of school improvement? Professional Development in Education, 39(3), 387–400. http://doi.org/10.1080/19415257.2012.762721
[44] Monaghan, J. (2004). Teachers’ activities in technology-based mathematics lessons. International Journal of Computers for Mathematical Learning, 9(3), 327–357. http://doi.org/10.1007/s10758-004-3467-6

[45] National Council of Teachers of Mathematics. (2008). The role of technology in the teaching and learning of mathematics. Retrieved from http://www.nctm.org/about/content.aspx?id=14233
[46] Oskamp, S. (1977). Attitudes and Opinions. London: Prentice Hall.
[47] Rempe-Gillen, E. (2012). Technologies in Mathematics Teachers Cross-Phase and Cross-School Collaborative Professional Development. University of Leeds.
[48] Romberg, T. A. (1992). Perspective on scholarship and research methods. In Handbook for research on mathematics teaching and learning (pp. 49–63). NCTM.
[49] Ruthven, K. (2002). Instrumenting Mathematical Activity: Reflections on Key Studies of the Educational Use of Computer Algebra Systems. International Journal of Computers for Mathematics Learning, 7(3), 275–291.
[50] Sarantakos, S. (2005). Social Research (3rd ed.). Hampshire: Palgrave Macmillan.
[51] Saudi Ministry of Education. (n.d.). Retrieved from http://he.moe.gov.sa/en/aboutus/Pages/default.aspx
[52] What is Excel. (2015). Retrieved from http://serc.carleton.edu/introgeo/mathstatmodels/UsingXL.html in 20 Aug 2015
[53] Wolfram, C. (2011). Stop Teaching Calculating, start Lrearning Maths. Retrieved from http://www.computerbasedmath.org/resources/Education_talk_transcript.pdf\npapers2://publication/uuid/7D82215B-8D53-4F06-8925-744B77944A02
[54] Wright, D. (2010). Orchestrating the instruments: integrating ICT in the secondary mathematics classroom through handheld technology networks. Technology, Pedagogy and Education, 19(2), 277–284. http://doi.org/10.1080/1475939X.2010.491239

International Journal of Educational Psychological Studies – Vol. 3, No. 2, 2018, pp. 552 - 583
e-ISSN 2520-4149 , p-ISSN 2520-4130
Available online at http:// www.refaad.com

التنمية المهنية لمعلمي الرياضيات في دمج التكنولوجيا الرقمية: دراسة مقارنة

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الملخص:

يهدف هذا البحث إلى دراسة الطرق والوسائل التي يتخذها معلمو مادة الرياضيات للمرحلة المتوسطة والثانوية في المملكة العربية السعودية وانجلترا في سبيل تحقيق التنمية المهنية في مجال استخدام وسائل التكنولوجيا. بالإضافة إلى ذلك تقارن الدراسة بين سلوك أفراد المجموعتين من هذه الناحية. وقد تم تحقيق هذا الهدف بتطبيق استبانة بين ٤٤ معلم سعودي وانجليزي وقد تم التوصل من خلال التحليل الكمي لبيانات الدراسة إلى أنه لا يوجد فروقات كبيرة بين المجموعتين من ناحية استخدام وسائل التكنولوجيا الرقمية إلا أنه توجد اختلافات قليلة بينهما من حيث التنمية المهنية.

الكلمات المفتاحية: التنمية المهنية، معلمو الرياضيات، التكنولوجيا الرقمية
