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Emerging Trends in Research on Math Teacher Professional Development

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The goal of this study was to analyse international journals and conference proceedings published from 2012 to 2016. The main results indicated that the gap between the Arab Gulf Countries (GC) and the rest of the world regarding the amounts and trends of professional development (PD) research is too wide. At the global level, the initial scanning analysis showed the publication of 161 articles on math teacher PD, including 121 articles or abstracts published in conference proceedings and 40 articles published in journals. The number of articles on math teacher PD in the GC conference proceedings and journals was only 11. The results indicated that there is growing interest in research on PD in math and pedagogical content knowledge (PCK). The results also showed that descriptive research received the most attention, followed by developmental and evaluative research. Most of the English-language research used qualitative methodology and mixed methodology, and hence, used observations and interviews to collect their data. At the level of Arabic-Language, GC, research, the results indicated that developmental research received the greatest attention; however, all the data collected were quantitative because the survey was the most commonly used tool in these research studies.

Keywords: professional development, programme evaluation, research trends, in-service math teacher education, teacher education

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INTRODUCTION

Reviews of research on mathematics teachers' CPD have been attracting mathematics educators (Back, Hirst, Geest, Joubert, & Sutherland, 2009; Joubert, & Sutherland, 2008; Karimi, 2011; Simon, 2006; Cordingly, Bell, Rundell, & Evans, 2003; Potari, 2011; Roth, & Radford, 2011). These educators have concluded that CPD had an important impact on classroom practice. Other studies such as Sugrue (2009) conclude that teachers' professional learning opportunities positively influence classroom practices and, ultimately, student learning.

For CPD to be effective, it should concentrate on the renewal of teachers' knowledge and skills related to teaching the specific subject matter. In this regard, Shulman (1986, p. 9-10, 1987, p. 9) and his colleagues and students (e.g., Carlsen, 1987; Gudmundsdottir & Shulman, 1987; Marks, 1990) addressed three categories of teaching content knowledge: subject matter (content) knowledge, instructional methods (pedagogical knowledge), and a new category named pedagogical content knowledge (PCK). Shulman (1986) stressed that PCK is a special kind of content knowledge "which goes beyond knowledge of subject matter per se to the dimension of subject matter knowledge for teaching" (p. 9). He added, "I still speak of content knowledge here, but of the particular form of content knowledge that embodies the aspects of content most germane to teachability" (p. 9). Effective CPD should be accompanied by an evaluative model such as that created by Guskey (Guskey, 2000), which consists of the following five areas:

1- Participant reaction
2- Participant learning
3- Organizational support and change
4- Participants' use of new knowledge and skills
5- Pupil learning outcomes

Regarding types of CPD, studies have reported a wide variety of teachers' CPD programmes (McNamara, Jaworski, Rowlan, Hodgen, & Prestage, 2002; Millett, Askew, & Simon, 2002), CPD frameworks and models (Kennedy, 2005; Mullins, Lepicki, & Glandon, 2010; Sailors, & Price, 2015), specialized training (Purrazzella, & Mechling, 2013; Martin-Dorta, Saorin, & Contero, 2011), short workshops (Butler, & Schnellert, 2012; Darling-Hammond, Chung Wei, Andree, & Richardson, 2009), coaching (Edwards, & Newton, 1995), one-day conferences, workshops lasting a week or two and multi-year advanced degree programmes. These types of CPD may be provided on site, inside or outside the school, or online. All these forms of PD are intended to improve teachers' professional knowledge, skill, and competencies.

The approach of research trend studies has also attracted the attention of many scholars within the academic and scientific communities (Chiappetta, 1976; Cavas, 2015; Cavas, Cavas, Ozdem, Rannikmae, & Ertepinar, 2012; Lee, Wu, & Tsai, 2009; Arvind, & Shahid, 2013). Scholars believe that interdisciplinary represents an important approach to addressing increasingly complex problems (Millar, Dillman, 2010; Millar, 2011; Menand, 2010; Wagner, Roessner, Bobb, 2009; Jacobs, Frickel, 2009; Falkenheim, 2010). They think that research trend studies may enhance the quality and measurements

of research, satisfying the demands of all stakeholders. Therefore, in-service teachers and other education practitioners should use evident from reviewing research in the field of their profession to get more knowledge about others CPD experiences and adopt them to their context (Guskey, 1986; Watkins, & Mortimore,1999; Cordingley & Bell, 2002). This new experience would increase their motivation and makes them more enthusiastic about mathematics teaching. This improvement may help students be more productive in mathematics and mathematical skills. Regarding studying research trends in the field of mathematics education Sánchez, (2011) argued that this type of studies represent the main research topics that are currently addressed by mathematics teacher educators' community. He also stressed that the review of research trends in the field of in-service mathematics teachers contributed to the identification of new research trends such as online mathematics teacher education, and the design and role of tasks in mathematics teacher education that have not been previously reported.

To publish an article in well-respected international journals, such as the Journal for Research in Mathematics Education, Educational Studies in Mathematics, and the Journal of Mathematics Teacher Education (JMTE), one must be skilful. Similarly, participation in international conferences organized by well-known organizations such as the National Council of Teachers of Mathematics (NCTM), the International Group for the Psychology of Mathematics Education (PME), and the Mathematics Education Research Group of Australasia Incorporated (MERGA) requires magnificent research skills. Prominent researchers from all countries compete to publish in such journals and to participate in such conferences, either for the purposes of academic promotion (Henson, 2001) or for scientific reputation. These journals and conferences focus on research related to math education or to math teacher education. Therefore, analysing the research published in these sources is very important. Doing so, will provide us with rich information that might help us in developing our students' research skills and help us plan more effective CPD for math teachers. In addition, trend studies are undertaken through documentary analysis or surveys at repeated intervals, which can help in predicting what is likely to take place in the future. Furthermore, studying the trends of articles published in these sources is of great importance to scholars and researchers around the world. It will provide them with the core of the experience of the most prominent schools that have published in these journals or that have participated in these conferences with regard to their experience with PD approaches or their research experiences.

Our study examines studies and literature from around the world. We argue that doing so can lead to the identification of many factors that can support the successful implementation of new approaches to teacher CPD in Saudi Arabia, the Gulf countries (GC), and the rest of the world (researchers from all over the world published in the targeted journals or participated in analysed conference). First, this examination might provide us with a clear vision of effective CPD. Second, it can provide valued information that can convince concerned officials about the type of programmes that are needed for effective and sustainable CPD for in-service mathematics teachers. Third, it might provide a basis for the allocation and arrangement of all necessary resources, guaranteeing the effectiveness of all types of teacher CPD.

It should be noted that this study covers articles published in a wide range of journals and conference proceedings from around the world, whereas other studies have covered articles published in either one region or a specific journal or a limited number of journals or conference proceedings.

Focal questions

To identify and describe the research trends related to in-service mathematics teachers' CPD, the following main focal questions and sub questions were posed.

1- What are the prevalent general trends in research related to in-service mathematical teachers' CPD in the selected journals and conference proceedings from 2012 to 2016?

- What subjects and issues did CPD activities and programmes emphasize?
- What are the types of CPD activities and programmes?
- What are the contexts of CPD activities and programmes?

2- What are the prevalent general methods used in research related to in-service mathematics teachers' CPD in the selected journals and conference proceedings from 2012 to 2016?

- What are the purposes of the analysed research on CPD activities and programmes?
- What are the tools used in the analysed research on CPD activities and programmes?
- What are the types of data collected in the analysed research on CPD activities and programmes?

METHOD

In this trend analysis study the following major themes were covered. First, the trends in the analysis of these journal publications, particularly comparing journals and the years from 2012 through 2016 were identified. Next, we compared the trends in articles published in English-language journals and conferences proceedings with the trends in articles published in Arabic-language journals and conference proceedings. Finally, an analysis was conducted to look for the variables specified in the focus questions of this study. By answering these questions, we may uncover trends that might help us in the following ways: first; they might help us to propose solid, effective, and sustainable CPD programmes for mathematics teachers. Second, they might help us in proposing a systematic research map for the Excellent Research Centre of Science and Mathematics Education and for our graduate students who are willing to conduct research studies in the field of mathematics teachers' CPD.

Selection strategy

A search of the SDL, Dar Almandumah, EduSearch, and Scopus databases from 2012 through 2016 was done to find the targeted journals and conferences proceedings. Three English-language journals (Research in Mathematics Education, Educational Studies in Mathematics, and the JMTE), and three conferences (the NCTM, the PME, and the MERGA) were selected from various parts of the world (see Table3). In addition, the following eleven Arabic-language journals were selected: (1) Message of the Arabian Gulf, (2) Message of Educational & Psychological Sciences, (3) the Journal of Educational Sciences (KSU, SA), (4) the Journal of Education & Psychology (KSU,

SA.), (5) the Journal of Educational and Psychological Studies (SQU), Oman, (6) the Journal of Educational Studies (UQU, SA), (7) the International Journal of Educational Research (EU, UAE), (8) the Journal of Tybah University for Educations Sciences (TU, SA), (9) the Journal of Educational & Psychological Sciences (QU, SA), (10) the Saudi Journal of Higher Education (MOE, SA), and (11) the Educational Journal (KU, Kuwait). Six conferences (the Saudi Society for Educational & Psychological Sciences Conference (JESTEN), the Excellence Conference in the Teaching and Learning of Science and Mathematics (ECSME, SA), the Umalqura University Conference (UQU, SA), the King Khalid University Conference, and the Baha University Conference) have been selected from the GC (see Table 2). Only the sixth Arabic conference (the Saudi Association for Mathematical Science Conference, KSU, SA) specializes in math education, while the other conferences are general. To identify and collate articles to be analysed, the terms ‘mathematics', ‘teacher', ‘continuous professional development (CPD)', 'professional growth', and ‘professional training’ were used. The search resulted in 161 English-language articles related to math teacher CPD but only 11 articles in the Arabic-language sources. Finally, the analysis tool was used to explore the following categories: the focus of CPD, the types of CPD, the context of CPD, the purposes of the research, the research tools, and the types of data collected. More Arabic-language journals had been chosen because they are not specialized in one subject of a specific discipline; instead, most of them publish articles from various educational disciplines. Similarly, most of the conferences accept papers from various disciplines. It is worth clarifying that during the analysis of some papers, we could obtain some of the information from the abstract and other information from the text. However, for most of the needed information from the analysed research papers, the whole article must be read to obtain all the information or data.

Sample

The selection of the sample was performed in three steps: first, we selected 3 international conferences and 3 well-known journals from different parts of the world, as well as 6 conferences and 11 journals from the Arabian GC. Second, we scanned the contents of all selected journals and conferences to search for studies that address math teacher CPD. The total number of articles scanned was 3619, including 3086 articles or abstracts published in conference proceedings and 533 articles published in journals, in addition to 1740 articles published in Arabic-language journals (302) and conference proceedings (1438). Third, the scanning resulted in 161 English-Language articles on math teacher CPD, and only 11 articles on math teacher CPD were published in conference proceedings and journals in the GC. In approaching the task, we decided to investigate the trends in articles related to CPD published in three English-language journals and three international conference proceedings from 2012 to 2016 based in Europe (Educational Studies in Mathematics), America (the Journal for Research in Mathematics Education), and East Asia (the JMTE) to compare the citations of CPD in the regions mentioned above and in the GC. The number of samples from journals and conference proceedings published in the English language is presented below.

Table 1
Total articles and professional development (PD) articles in the samples taken from English-language journals and conference proceedings

Journal & conference	Year												% 0f PD papers
	2012		2013		2014		2015		2016		Total		
	All	PD	All	PD	All	PD	All	PD	All	PD	All	PD	
JERME-J	23	4	23	0	17	0	18	1	22	0	103	5	4.85
ESM-J	69	0	77	2	44	1	60	3	64	0	314	6	1.91
JMTE-J	25	5	19	7	21	5	26	3	25	9	116	29	25
NTCM-C	60	8	61	4	79	0	98	11	89	13	387	36	9.30
PME-C	303	10	456	17	603	20	321	6	440	11	2123	64	3.01
MERGA-C	1217	5	108	1	126	4	119	6	96	5	576	21	3.65
Total	1697	32	753	31	2030	30	642	30	736	38	3619	161	4.45

Then articles published in six Arabic-language journals and the proceedings of eleven regional conferences based in the GC region were selected. The number of samples from journals and conference proceedings published in the Arabic language is presented below. The total number for the 5 years had been presented because PD research papers for every year could not be found, i.e., most of the PD columns over the years would have recorded zero.

Table 2
Total articles and professional development (PD) articles in the samples taken from Arabic-language journals and conference proceedings

Journal &conference	All	PD	% 0f PD
Message of the Arabian Gulf Journal	124	1	.8
Journal of Educational & Psychological Sciences (Bahrain)	300	1	.03
Journal of Educational Sciences (KSU, SA)	155	1	.6
Message of Education & Psychology (KSU, SA)	148	1	.7
Journal of Educational and Psychological Studies (SQU, Oman)	176	1	.3
Journal of Educational Studies (UQU, SA)	26	0	0
The International Journal of Educational Research (EU, UAE)	83	0	0
Journal of Tybah University for Educations Sciences (TU, SA)	23	0	0
Journal of Educational & Psychological Sciences (QU, SA)	84	1	.9
Saudi Journal of Higher Education (MOE, SA)	85	0	0
The Educational Journal (KU, Kuwait)	234	0	0
Saudi Society for Educational & Psychological Sciences Conference (JESTEN, SA)	59	1	1.7
The Excellence Conference in Teaching and Learning of Science and Mathematics (ECSME, SA)	25	1	4
Saudi Society for Math Sciences Conference (JESR, SA)	37	1	2.7
Umalqura University Conference (UQU, SA)	94	2	2.5
King Khalid University Conference (SA)	15	0	0
Baha University Conference (SA)	72	0	0
Total	1740	11	.6

Validity and reliability

The researchers prepared the initial version of the analysis tool. It consisted of nine areas: the dependent and independent variables, the focus of PD, the types of PD, the context of PD, the purposes of the research, the research tools, the types of data collected, the number of researchers, and the number of samples. To ensure the validity of the analysis tool, it was submitted to a number of specialized experts from the

department of curricula and instruction, and it was adjusted based on their remarks. According to the experts' feedback, the tool was modified, and some parts were altered. For example, some areas, i.e., the dependent and independent variables, the number of researchers, and the number of samples, were removed, and some wording was modified. The final version of the tool consisted of six areas: the focus of PD, the types of PD, the context of PD, the purposes of the research, the research tools, and the types of data collected. Then, to ensure the reliability of the analysis, about 15 articles (3 from each year), which represents approximately 10% of the English-language research articles, and all 11 of the Arabic-language articles were selected. Then, to ensure reliability, four experienced ratters were assigned to analyse these articles, two for the articles published in English and two for the articles published in Arabic. The values of the coefficients for the English-language articles fall between .74 and .89, and for the Arabic article, the kappa values were between 0.71 and .80. According to Altman (1991), the extent of agreement is very good if the kappa values fall between .81 and 1.00, good if they fall between .61 and .80, moderate if they fall between .41 and .60, and poor if they are less than .20. Accordingly, the levels of agreement between each of the two ratters of the English-language articles was between very good and good, and it was good for the Arabic-language articles.

Two ratters coded the selected sample of articles from each year. The inter-ratter reliability values were determined using kappa reliability coefficients (Table 3).

Table 3
Cohen's kappa values for inter-rater reliability coefficients

Source	Years				
	2012	2013	2014	2015	2016
English	.74	.83	.84	.79	.89
Arabic	.79	.71	.80	.78	.73

These results indicate that the agreement values between the two ratters in both the English and Arabic sources were high enough to allow us to use the analysis tool for the analysis of the selected articles.

FINDINGS

The following themes dominate the analysed studies on in-service math teacher PD: the focus of PD, the types of PD, the context of PD, the objective of the research, the research tools, and the types of data collected. The results of the analysis of research in GC and the rest of the world, including different regions of non-Arabic-speaking foreign countries (F) that publish in the English language are presented below.

Table 4 includes the frequencies of the categories under the first theme (focus of PD) in the GC and the F. Only 11 CPD articles were found in the GC publication sources compared to 161 articles in the F publication sources. Approximately 29 articles concentrated on constructivist approaches (inquiry, problem-solving, learning cycles, thinking skills, and other strategies and teaching methods), compared to zero articles in the GC publication sources addressing these issues. Similarly, 27 English-language articles address lesson study and PCK, compared to only 2 Arabic-language articles from the GC.

Table 4
Focus of professional development

Focus of professional development	Year											
	2012		2013		2014		2015		2016		Total	
	F	GC	F	GC	F	GC	F	GC	F	GC	F	GC
Inquiry, problem-solving and thinking	21	0	6	1	2	0	3	1	6	0	29	1
PCK	11	0	15	0	16	0	13	1	22	2	77	4
Lesson study	7	0	3	0	6	0	7	0	4	2	27	2
Action research	2	0	0	0	0	0	2	0	3	0	7	0
Communities of practice and learning	1	0	0	0	1	0	5	0	1	0	8	0
Beliefs and perspectives of teachers and students	0	2	6	0	5	1	0	1	2	0	13	4
Total	32	2	31	1	30	1	30	3	38	4	161	11

Regarding the second theme, namely, the types of PD, it was found that there were four types of CPD, as shown in Table 5. As found with the previous theme, only 11 articles from GC sources were located, while 161 articles addressing the CPD types were located in the sources from the rest of the world. It can also be noted that 34 training programmes and workshops were located in the sources published in the English language while only two were published in the Arabic language journals. Similar results were observed regarding the other three types of CPD.

Table 5
Types of professional development

Types of professional development	Year											
	2012		2013		2014		2015		2016		Total	
	F	GC	F	GC	F	GC	F	GC	F	GC	F	GC
Training programmes and workshops	5	0	9	0	10	0	4	1	66	1	34	2
Professional development models	9	0	8	1	10	0	6	0	14	2	47	3
CPD programmes (community of practice, action research, teacher research)	11	1	10	0	5	0	11	0	9	0	46	1
Characteristics of PD (teacher needs, teachers' perspectives on PD)	7	2	4	0	5	1	9	1	9	1	34	5
Total	32	2	31	1	30	1	30	3	38	4	161	11

Table 6 includes the context of the CPD, which includes the location of the CPD (in or outside the school, on-site or distance learning), the time at which the CPD was held (summer or during the school year), and the period (the length of time consumed in conducting the CPD). The data in Table 6 show that most of the CPD programmes in foreign countries were conducted in school or in and out of the school (99), while the rest (25) were held out of school or were distance programmes. By contrast, all of the CPD programmes were held out of school. Regarding the time when the CPD activities were held, it is clear that almost all CPD activities (122) were held during the school year. In addition, Table 6 shows that all CPD programmes in foreign countries were of either long or medium duration, whereas all CPD programmes in the GC were of short duration. This finding indicates that no CPD programmes in the GC are well planned and that they are conducted as short and unconnected training sessions. The research related to CPD in the GC is scarce because most of the PD programmes are very short

and because no research, whether descriptive, developmental, or evaluative, on these CPD activities has been conducted.

Table 6
PD context (location, time, and period)

Domains	PD context	Year										Total	
		2012		2013		2014		2015		2016			
		F	GC	F	GC	F	GC	F	GC	F	GC	F	GC
Location	Out of school	11	0	0	1	6	1	1	3	5	3	23	8
	Inside school	13	0	17	0	16	0	18	0	22	0	86	0
	Inside and outside school	3	0	5	0	4	0	0	0	1	0	13	0
	Distance	0	0	0	0	0	0	0	0	2	0	2	0
	Not determined	5	1	7	0	4	0	11	0	9	2	37	3
	Total	32	1	31	1	30	1	30	3	38	5	161	11
Time	During the school year	25	0	24	1	26	1	19	3	29	3	122	8
	Summer	2	0	0	0	0	0	0	0	0	0	2	0
	Not determined	5	1	7	0	4	0	11	0	9	2	37	3
	Total	32	1	31	1	30	1	30	3	38	5	161	11
Period	Short	0	0	0	0	0	0	0	2	0	2	37	4
	Medium	12	0	5	0	5	0	5	0	15	0	53	0
	Long	13	0	18	0	21	0	13	0	6	0	33	0
	Not determined	7	2	7	1	4	1	11	1	9	2	38	7
	Total	32	2	31	1	30	1	30	3	38	4	161	11

Regarding research purposes, Table 7 shows that most of the research was descriptive, with 103 articles published in English and only 5 in Arabic. The rest of the research articles were either developmental (30 E. & 6 Ar.) or evaluative (21 E. & 0 Ar.).

Table 7
Research purposes

Research purposes	Year										Total	
	2012		2013		2014		2015		2016			
	F	GC	F	GC	F	GC	F	GC	F	GC	F	GC
Developmental	7	0	5	1	9	1	2	1	7	3	30	6
Evaluative	3	0	5	0	5	0	4	0	5	0	21	0
Descriptive	22	2	19	0	15	0	22	2	25	1	103	5
Not determined	0	0	3	0	1	0	2	0	1	0	7	0
Total	32	2	31	1	30	1	30	3	38	4	161	11

In accordance with the results shown in Table 7, it is clear from Table 8 that observations (65), interviews (22) and analysis (44) research tools dominated the surveys (27) and tests (26) research tools. It is also clear that observations increased over the years (from 7 in 2012 to 21 in 2016).

Table 8
Research tools

Research tools	Year										Total	
	2012		2013		2014		2015		2016			
	F	GC	F	GC	F	GC	F	GC	F	GC	F	GC
Observation	7	0	12	0	14	0	20	1	21	0	65	1
Survey	6	2	5	1	4	1	4	2	8	0	27	5
Test	5	0	7	0	6	0	3	0	5	2	26	2
Interview	8	0	4	0	1	0	3	0	6	0	22	0
Analysis	6	0	9	0	9	0	5	1	16	2	44	3
Not determined	8	0	5	0	1	0	10	0	1	0	25	0

Table 9 includes the type of data collected by the research studies. In accordance with the data presented in Tables 4 and 5, it is shown that most of the studies (103) were of a qualitative nature (69) or were mixed (34). The rest (58) were either quantitative (28) or not determined (30). Again, the total number of qualitative methods and mixed methods for data collection is 69+34=103.

Table 9
Types of data

Types of Data	Year											
	2012		2013		2014		2015		2016		Total	
	F	GC	F	GC	F	GC	F	GC	F	GC	F	GC
Quantitative	5	2	7	1	7	1	4	3	5	2	28	2
Qualitative	14	0	14	0	17	0	7	0	17	2	69	0
Mixed	4	0	3	0	5	0	9	0	13	0	34	0
Not determined	9	0	7	0	1	0	10	0	3	0	30	9
Total	32	2	31	1	30	1	30	3	38	4	161	11

DISCUSSION

The aim of this study was to analyse research articles related to in-service math teacher PD published in well-known English-language journals and conference proceedings from 2012 to 2016 in order to understand the trends of this research. We were specifically looking for the trends of the following subjects: the focus of PD, the types of PD, the context of PD, the objective of the research, the research tools, and the types of data collected. We presented the results of the analysis of research in GC and the rest of the world, including different regions of non-Arabic-speaking foreign countries (F) that publish in the English language.

Focus of professional development: The results show that most of the PD programmes that were targeted by the research studies concentrated on lesson study and constructivist-related approaches, such as inquiry, problem-solving, learning cycles, thinking skills, and the other strategies and teaching methods category. These issues fall into PCK according to Shulman (1986) and his colleagues and students (e.g., Carlsen, 1987; Gudmundsdottir & Shulman, 1987; Marks, 1990). There are three categories of teaching content knowledge, namely, the subject matter (what teachers should know about what they teach), the instructional methods (pedagogical knowledge), and a new category named pedagogical content knowledge (PCK). Shulman stressed that PCK is a special kind of content knowledge. Under PCK is knowledge related to the mathematical concepts and skills needed to teach the subject. In addition, PCK includes (content) knowledge and general knowledge related to instructional methods (pedagogical knowledge). Pedagogical content knowledge is a type of knowledge that is necessary for teacher knowledge (what teachers should know about what they teach). PCK is the combination of the two types of knowledge. The inquiry, problem-solving and thinking approaches, in addition to lesson study, can be placed under PCK, but we highlighted them to assert their importance in teaching mathematics and to inform teachers and researchers that these types of knowledge are currently attracting CPD providers as well as researchers around the globe.

Types of professional development: The results indicated that most of the PD programmes were delivered as training programmes and workshops, PD models, and CPD programmes (communities of practice, action research, and teacher research). Examining the results, it was found that most of the CPD programmes in the GC are in the form of short training sessions and workshops, while most PD in the the rest of the world is delivered as long-term programmes.

This result can be explained by the fact that CPD programmes in the GC are normally designed and conducted by the Ministry of Education rather than by experts from local society, as is the case in the rest of the world. GC CPD programmes are centralized, which means that they are provided or conducted in a top-down manner. The implication is that these programmes and training sessions may not tackle the real needs of math teachers. No bottom-up activities are performed. Studies (Fullan, 1993, Stern, 2007) have indicated that none of these forms alone can generate fundamental changes in either a school system's or a teacher's performance. Rather, a balanced combination of both bottom-up and top-down strategies that view teachers as "change agents" can result in the desired change. As a result, most CPD programmes are not subject to any type of evaluation, and hence, no research on these programmes or other CPD activities has been conducted.

Context of the CPD: The context of the CPD includes the location of the CPD (in or outside the school, on-site or distance learning), the time at which the CPD was held (summer or during the school year), and the period (the length of the time consumed in conducting the CPD). The results show that most CPD programmes in foreign countries were conducted in school or in and out of school, while the some of these programmes were held out of school or through distance programmes. By contrast, all of the CPD programmes in the GC were held centrally out of the school. Regarding the time when CPD activities were held, it is clear that almost all CPD activities were held during the school year. In addition, the results show that all CPD activities in foreign countries were of either long or medium duration, whereas all CPD activities in the GC were of very short duration. This finding indicates that no CPD programmes in the GC are well planned and that they are conducted as short and unconnected training sessions. Research related to CPD in the GC is scarce because most of the PD programmes are very short and because no research, whether descriptive, developmental or evaluative, on these CPD activities has been conducted. It can be argued that using developmental research is useful, because it might have positive effect in the development of mathematics teachers' profession.

Research purposes: The results show that, in general, most of the research was descriptive and that the rest of the research articles were either developmental or evaluative. These results are reasonable because a descriptive study "describes, interprets, and clarifies what in the present – often done with surveys – may be done by observation or an observational instrument", whereas developmental research is "one common type of descriptive research, but it involves the study of changes in behaviour over a period of time". Therefore, it needs more time to be completed. Evaluative research (Suchman, 1967) is one descriptive research method and is used to evaluate the results against hypothesized standards. It is also used to gather the necessary information

for judging whether the curriculum and educational practices are aligned with standards. Evaluations should accompany each CPD programme's activities to evaluate the programme's impact and keep it on track (Weiss, 1998). Guttentag and Struening (1975) indicate that evaluation research keeps stakeholders informed and satisfied.

Descriptive research (Creswell, 2008; Cohen, Manion, & Morrison, 2007) is used to depict the participants in an accurate way. It is important for the gathering of information about prevailing conditions or situations for the purpose of description and interpretation (Aggarwal, 2008). Descriptive research includes three types: observational, case study, and survey. Gay, Mills, & Airasian (2006) criticize descriptive research by insisting that it involves "poor planning, poor implementation of research methods, and poor development of research instruments".

Research tools: The results show that observations, interviews, and analysis research tools were used more than surveys and tests. This finding indicates that observation is that the most suitable tool for the evaluation of the effectiveness of CPD or the effectiveness of teachers in the classroom. It might also indicate that qualitative research or mixed method research dominated research studies related to CPD. Studies have also indicated that these types of methods are important because they deepen our understanding of CPD and of any phenomena related to teachers' knowledge, competencies, skills, views or needs for CPD (Hancock, 1998).

Types of collected data: The results show that most of the studies were of a qualitative nature or were mixed and that a small portion of the studies were quantitative. This finding indicates that researchers who publish in English-language journals or conference proceedings prefer in-depth investigation, which widens our understanding of the phenomena related to teachers' professional skills and knowledge, CPD, or their need for CPD. As indicated by Hancock (1998), the importance of these types of qualitative and mixed methods lies in the notion that they deepen our understanding of teachers' situation and their real needs for CPD, in addition to the understanding of the real impact of the various forms of CPD conducted.

CONCLUSION AND IMPLICATIONS

The main results indicated that there is growing interest in research on PD in math and PCK., and that descriptive, developmental and evaluative research received greater attention from researchers. The results have also revealed that most of the researchers used a qualitative methodology. The identification of emerging trends that resulted from this study can be beneficial in several ways. First, math teachers worldwide need to learn about emerging teaching approaches. Second, they should critically analyse the value and appropriateness of these trends with respect to their discipline, courses, students, teaching styles and classroom experiences. Third, CPD providers should benefit from the trends in CPD by changing their current CPD approaches, activities and environments and balancing them with successful approaches to ensure the effectiveness of their programmes. Fourth, the research trends coming out of this study can be utilized to help us select CPD programmes that enhance the learning of both teachers and students (Cox, 1995). Fifth, researchers should benefit from these trends by changing their behaviours and choose subjects that tackle real problem approaches and use

research methods that make their research results more productive and more generalizable. Finally, the community is the optimal target of the study, science the development of CPD with result in the improvement of students' achievement and skill, which in turn may improve the community as a whole.

The research articles were analysed in order to extract the value and appropriateness of the trends with respect to the focus, types, and context of the evaluated PD, the research goals, the research tools, and the types of data collected. Based on the findings of this study, we offer the following recommendations:

- To achieve optimal benefits from the current emerging trends, math teachers and CPD providers need to learn about the successful CPD programmes, frameworks, approaches, and models that are emerging, and design their CPD programs accordingly
- Effort should be made to focus on how best to provide PD activities and models for mathematics teachers. These efforts should recognize the factors or features of more effective CPD programmes, which would ensure attaining positive outcomes on the student, teacher, and school levels.
- CPD for math teachers should be held in the school, and teaching staff in the colleges of education should be closely associated in planning the CPD content.
- Future research should consider the following points. First, it is necessary to conduct detailed research that captures CPD experiences by observing the interaction between the provider and teachers, between teachers and students, and among teachers. Moreover, it is important to investigate policy makers' views of what is considered effective CPD and their vision for PD in Saudi Arabia to identify future trends and directions.

The limitation of this study lies in the fact that research in other main languages such as French, Chinese, have not been considered in this analysis because we are not aware of these languages, But this limitation may not prevent us from comparing the Gulf Countries research in CPD with the rest of the world, because researchers from all over the world participated in the targeted journals or conferences, which publishes in the English-Language.

REFERENCES

Aggarwal, Y. P. (2008). *Statistics of Education*. (2nd Ed.) Delhi: Sterling.

American Federation of Teachers. (2011). Recommendations of the AFT Ad Hoc Committee on Standards rollout. Washington, DC.

Back, J., Hirst, C., De Geest, E., Joubert, M., & Sutherland, R. (2009). *Final report: Researching effective CPD in mathematics education* (RECME). url: https://www.ncetm.org.uk/files/387088/NCETM+RE CME+Final+Report.pdf (Accessed: Nov. 22, 2013)..

Butler, D. L., & Schnellert, L. (2012). Collaborative inquiry in teacher professional development. *Teaching and Teacher Education,* 28:1206-1220.

Cavas, B. (2015) Research Trends in Science Education International: A Content Analysis for the Last Five Years (2011-2015). *Science Education International, 26*/4, 573-588.

Cavas, B., Cavas, P., Ozdem, Y., Rannikmae, M., & Ertepinar, H. (2012) "Research Trends in Science Education from the Perspectives of Journal of Baltic Science Education: A Content Analysis from 2002 to 2011. *Journal of Baltic Science Education,* 1/1, 94-102.

Chiappetta, E. L. (1976). A review of Piagetian studies relevant to science instruction at the secondary and college level. Science Education, 60/2, 253- 261.

Cohen, L., Manion, L., & Morrison, K. (2007). *Research methods in education*. New York:

Cordingly, P., Bell, M., Rundell, B., and Evans, D. (2003). *The impact of collaborative CPD on classroom teaching and learning. In: Research Evidence in Education Library*. London: EPPI-Centre, Social Science Research Unit, Institute of Education, University of London. url: h ttp://eppi.ioe.ac.uk/cms/Default.aspx?tabid=132 (Accessed: Nov. 27, 2013).

Cox, M.D. (1995). *Emerging Trends in College Teaching for the 21st Century*. In Essays on Teaching Excellence Toward the Best in the Academy 6(6), 1994- 1995. A publication of The Professional and Organizational Development Network in Higher Education. (www.podnetwork.org). Retrieved from Google Nov. 2013.

Creswell, J. (2008). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research*. New Jersey: Pearson: Merrill Prentice Hall.

Darling-Hammond, L., Chung Wei, R., Andree, A., & Richardson, N. (2009). *Professional learning in the learning profession: A status report on teacher development in the United Countries and abroad.* Oxford, OH: National Staff Development Council.

Edwards, J. L., & Newton, R. R. (1995, April). *The effect of cognitive coaching on teacher efficacy and empowerment.* Paper presented at the annual meeting of the American Educational Research Association, San Francisco.

Falkenheim, J. C. (2010). *Interdisciplinary Dissertation Research*. InfoBrief NSF 10-316. Arlington, VA: Division of Science Resources Statistics, National Science Foundation. Available at http://www.nsf.gov/statistics/infbrief/nsf10316/

Fullan, M. G. (1993). *The complexity of the change process*. In Change forces: Probing the depth of educational reform, pp. 19-41. Falme Press.

Gay, L., Mills, G., & Airasian, P. (2006). *Educational research: Competencies for analysis and applications*. New Jersey: Pearson Education, Inc.

Gudmundsdottir S.(1990b). Nancy: pedagogical content knowledge of an expert teacher. Paper presented at the Annual Meeting of the American Educational Research Association, Boston.

Gudmundsdottir, S. (1998). *La naturaleza narrativa del saber pedagógico sobre los contenidos*. En H. McEwan y K. Egan (compls.), La narrativa en la enseñanza, el aprendizaje y la investigación. Buenos Aires: Amorrortu, 52-71.

Gudmundsdottir, S.(1990a). *Curriculum stories: four case studies of social studies teaching*. En C. Day, M. Pope y P. Denicolo (eds.), Insights into Teachers' Thinking and Practice. Londres: Falmer Press, 105-118.

Guskey, T. R. (1986) Staff development and the process of teacher change, *Educational Researcher*, 15/5, 5-12.

Guskey, T.R, (2000). *Evaluating Professional Development*. Thousand Oaks, CA: Corwin Press

Guttentag, M., & Struening, E. (1975). *Handbook of evaluation research.* Beverly Hills, CA: Sage.

Hancock, B. (1998). *An Introduction to Qualitative Research. Nottingham*, UK: Trent Focus Group, Division of General Practice, University of Nottingham.

Henson, R. K. (2001). *Teacher self-efficacy: Substantive implications and measurement dilemmas*. Paper presented at the Annual Meeting of the Educational Research Exchange, College Station, TX.

Jacobs, J. A., Frickel, S. (2009). Interdisciplinary: a critical assessment. *Annual Review of Sociology 35*:43–65.

Joubert, M., and Sutherland, R. (2008). *A perspective on the literature: CPD for teachers of mathematics.* Sheffield: NCETM.

Karimi M. N. (2011). The effects of professional development initiatives on EFL teachers' degree of self-efficacy. *Australian Journal of Teacher Education* 36/6, pp. 50–62.

Kennedy, A. (2005). Models of continuing professional development: A framework for analysis. *Journal of In-Service Education*, 31/2, 235-250.

Lee, M. H., Wu, Y. T., & Tsai, C. C. (2009). Research trends in science education from 2003 to 2007: A content analysis of publications in selected journals. *International Journal of Science Education, 31*/15, 1999-2020.

Marks, R. (1990). Pedagogical content knowledge: From a mathematical case to a modified conception. *Journal of Teacher Education*, 41/3, 3-11.

Martin-Dorta, N., Saorin, J. L., Contero, M. (2011). Web-based spatial training using handheld touch screen devices. *Educational Technology & Society, 14*: 163–177. Retrieved from http://www.ifets.info/journals/14_3/14.pdf

McNamara, O., Jaworski , B., Rowland, T., Hodgen, J. and Prestage, S. (2002). *Developing mathematics teaching and teachers*. (See http://mathsteachdev.mathsed.org.uk.)

Menand, L. (2010). *The Marketplace of Ideas: Reform and Resistance in the American University*. New York: Norton.

Millar, M. M, Dillman, D. A. (2010). *Defining and identifying interdisciplinary research among doctoral candidates.* Technical Report #10-063b. Pullman, WA: Social and Economic Sciences Research Center, Washington State University.

Millar, M. M. (2011*). Interdisciplinary research among U.S. doctoral graduates: an examination of definitions, measurement, early career outcomes, and sex differences.* Ph.D. Dissertation. Pullman, WA: Department of Sociology, Washington State University.

Millett A., Askew M. and Simon S. (2002). *Responses of teachers to a course of intensive training*. King's College London: The Leverhulme Numeracy Research Project. Roberts, G. (2002) SET for success. The supply of people with science, technology, engineering and mathematics skills. The Report of Sir Gareth Roberts's Review. London: HM Treasury.

Mullins, D., Lepicki, T., & Glandon, A. (2010). *A Professional Development Evaluation Framework for the Ohio ABLE System*. Columbus, OH: Centre Education and Training for Employment, the Ohio State University.

Potari, D. (2011). Response to part II: *Emerging issues from lesson study approaches in prospective mathematics teacher education in Hart, L.C., Alston, A.S. & Murata, A. (Eds.) Lesson study research and practice in mathematics education: Learning together New York*: Springer, 127-132.

Purrazzella, K., & Mechling, L. C., (2013) Evaluation of manual spelling, observational and incidental learning using computer-based instruction with a Tablet PC, large screen projection, and a forward chaining procedure. Education and Training in Autism and Developmental Disabilities, 48: 218–235.

Retrievedfrom http://daddcec.org/Portals/0/CEC/Autism_Disabilities/Research/Publications/Education_Training_Development_Disabilities/Full_Journals/ETADD_48_2_218-235.pdf

Roth, W-M., & Radford, L. (2011). *A cultural-historical perspective on mathematics teaching and learning*. Rotterdam: Sense publishers.

Sailors, M., & Price, L. (2015). Support for the Improvement of Practices through Intensive Coaching (SIPIC): A model of coaching for improving reading instruction and reading achievement. *Teaching and Teacher Education, 45*: 115-127.

Sánchez, M. (2011). A review of research trends in mathematics teacher education. *PNA*, 5/4, 129-145.

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher*, 15: 4-14.

Shulman, L. S. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review*, 57: 1-22.

Simon, M. (2006). Key developmental understandings in mathematics: A direction for investigating and establishing learning goals. *Mathematical Thinking and Learning*, 8/4, 359–371.

Stern, T. (2007). *The limits of curricular reform and the chances of Teachers" professional development: making top-down and bottom up strategies meet in the Austrian IMST3-Project*. Retrieved 6-6-2017 from http://www.hbcse.tifr.res.in/episteme/episteme-2/e-proceedinGC/stern

Suchman, E. A. *(*1967). *Evaluative research*. New York: Russell Sage Foundation.

Sugrue, C. (2009). Back to the Future: Perspectives on current realities and future quality of educational research through the prism of Irish educational studies, *Irish Educational Studies*, 28/1, 7-25.

Wagner, C., Roessner, JD., Bobb, K. (2009). *SRS Task Order 45: Indicators of Interdisciplinary S&E Research. Final Report*. Unpublished report to National Science Foundation.

Watkins, C., & Mortimore, P. (1999). *Pedagogy: What do we know*. In P. Mortimore (Ed.), Understanding pedagogy and its impact on learning. London: Paul Chapman.

Weiss, C. H. (1998). *Evaluation: Methods for studying programs and policies* (2nd ed.). Upper Saddle River, NJ: Prentice Hall.