Jordan Journal of Educational Sciences Vol. 10, No. 3, pp 383-394

Examining Mathematics and Science Teachers' Perceptions of their Pedagogical Content knowledge

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Received Date:11 /2/2014 **Accepted Date: 26/6/2014**

Abstract: This study aimed at examining mathematics and science teachers' perceptions of their pedagogical content knowledge, and whether their perceptions vary according to: gender, teaching experience, scientific qualification, and workshop attendance. To achieve the aims of the study, the researchers used a questionnaire that consisted of (45) items. Two domains were adopted from Edwards, Higley, Zeruth, & Murphy (2007) and the third domain was constructed by the researchers. The participants of the study were (273) male and female mathematics and science teachers assigned to teach in the Directorate of Education in Irbid. The results showed that mathematics and science teachers' perceptions of their pedagogical knowledge were weak. Furthermore, the study revealed significant differences in teachers' perception due to scientific qualifications and workshop attendance. On the other hand, no significant results were found due to gender nor teaching experience. Discussions and implications are forwarded.

Keywords: Pedagogical Content Knowledge, Mathematics and Science Teachers, Teachers' perceptions).

تصورات معلمي الرياضيات والعلوم للمعرفة البيداغوجية للمحتوى

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ملخص: هدفت هذه الدراسة إلى فحص تصورات معلمي الرياضيات والعلوم للمعرفة البيداغوجية للمحتوى، وما إذا كانت هذه التصورات تختلف باختلاف جنسهم وخبرتهم التدريسية ومؤهلاتهم العلمية وحضورهم ورش تدريبية. لتحقيق أهداف الدراسة، استخدمت الباحثتان استبانة تألفت من (45) فقرة، تم اعتماد مجالين من دراسة (Edwards, Higley, Zeruth, & Murphy, 2007) ، في حين تم بناء المجال الثالث من الباحثتين. تكونت عينة الدراسة من (273) معلماً ومعلمةً من معلمي الرياضيات ومعلمي العلوم التابعين لمديرية التربية والتعليم في اربد. أظهرت نتائج الدراسة أن تصورات معلمي الرياضيات والعلوم للمحتوى المعرفي البيداغوجي ضعيفة، كما أظهرت النتائج وجود فروق ذات دلالة إحصائية في تصورات المعلمين يعزى لمتغيري (المؤهل العلمي، وحضور ورشة تدريبية). من ناحية أخرى، أظهرت النتائج عدم وجود فروق ذات دلالة تعزى لمتغري (الجنس، والخبرة التدريسية).

الكلمات المفتاحية: المعرفة البيداغوجية للمحتوى، معلمو الرياضيات والعلوم، وتصورات المعلمين.

One of the most important objectives of teaching is promoting students' understanding of the subject matter. Teachers use various pedagogical practices to facilitate the growth of scientific knowledge of their students. These practices include teacher efficacy in posing questions, managing the class, handling the curriculum, and utilizing useful and effective representations.

Several studies suggest that teachers consider themselves capable of effectively applying teaching practices (Burke-Spero, 1999). Despite this, there is an increasing need for mathematics and science teachers who acquire high level of professional competences, skill in administering the process of teaching, helping students comprehend mathematical and scientific concepts, and capable of promoting scientific values (Mulhall, Berry & Loughran, 2003; Park & Chen, 2012).

In 1987 Shulman introduced a paradigm in which teacher' knowledge was classified into seven categories. They include: content knowledge, curriculum knowledge, general pedagogical knowledge, pedagogical content knowledge, knowledge of learners and their characteristics, knowledge of educational contexts, and knowledge of educational values. He defined content knowledge as the knowledge, understanding, skill, and disposition that are to be learned by school children.

On the other hand, curriculum knowledge is a teacher's 'tools of the trade' like knowledge of materials, which can be used in class. General pedagogical knowledge refers to strategies and rules around classroom management and organization. The topic of pedagogical practices is aligned with strategic teaching (Cullen & Sinclair, 1996; Zakhartchouk, 2001). Pedagogical content knowledge is a combination of content and pedagogy, which Shulman (1987) saw as unique to this profession. Moreover, "Pedagogical content knowledge is the set or repertoire of private and personal content-specific general event-based as well as story-based pedagogical constructions that the experienced teacher has developed as a result of repeated planning and teaching of, and reflection on teaching of, one of the most regularly taught topics" (p. 277). Shulman elaborated on pedagogical content knowledge (PCK) by saying: "the most regularly taught topics in one's subject area, the most useful forms of representation of those ideas, the most powerful analogies, illustrations, examples, explanations, and demonstrations – in a word, the ways of representing and formulating the subject that make it comprehensible to others" (Shulman, 1986, p. 9).

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Later on, a theory regarding PCK comes from Gess-Newsom (1999) who examines the validity of PCK as a heuristic model for the study of teachers' knowledge and its implications for teacher education and professional development. He views "pedagogical content knowledge" as of special interest because it identifies the distinctive bodies of knowledge for teaching. In his own words PCK "It represents the blending of content and pedagogy into an understanding of how particular topics, problems, or issues are organized, represented, and adapted to the diverse interests and abilities of learners, and presented for instruction" (p. 8).

Since its introduction in 1987, PCK has become a widely useful and used notion (Koehler, 2011; Ceylan, Türk, Yaman & Yurdakul, 2014) . Grossman (1990) suggests that general pedagogical knowledge is responsible for bringing together "a body of general knowledge, beliefs, and skills related to teaching", which includes knowledge about the students and the learning, the curriculum and the instruction, and an additional component known as classroom management" (p. 5-6).

In short, PCK can be viewed as practices inside the classroom related to teacher efficacy and classroom management, beliefs and persuasion, and representations. Teacher efficacy is defined as teachers' efforts inside classrooms that could have positive influences on their students (Goddard, Hoy and Hoy, 2000). A physiological perspective views teacher efficacy as a concept within social behaviour theory of Pandora who views that the capability for one to perform a certain deed influences the teachers' actual performance. Two elements emerge out of this. First, an element related to self-efficacy (one's beliefs about his/her own capability to perform successfully the required deed). The other is related to expectations (one's beliefs about his/her expectation to the extent that their behaviour will lead to specific results).

Persuasion is an interaction process that includes hidden messages sent designed to change ones' view, knowledge or belief. Although this can be seen as effective in the process of teaching and learning, yet there is a great need to understand all properties of the learner, content and tasks to achieve such goals (Murohy & Alexender, 2004). The persuasion pedagogy begins with gathered information of students' beliefs and knowledge of the content. After this, the teacher focuses on metaphors and analogies, arguments reasoning and different models that help the student realize why his/her knowledge or beliefs are valid or invalid. In short, the persuasion pedagogy includes dialog and discussion about what is correct and why (Hennessey, Higley & Chesnut, 2012).

Mathematics and science teachers encounter unlimited instructional obstacles. Many educators have suggested the constructive approach for teaching in order to overcome such obstacles. Despite this, difficulties arise when used as a foundational mathematical pedagogy (Hennessey, Higley, & Chesnut, 2012).

Representations in teaching mathematics and science refer to the variety of ways to express an abstract concept or relationship. It has different forms such as visual illustrations (pictures, graphs, diagrams,...), internally seeing and thinking about ideas, or using concrete models. Representations can help improve the communication skills of students, reasoning ability and student's capability to solve problems. According to the National Council of Teachers of Mathematics (NCTM, 2000) mathematical programs should enable all students to

- Create and use representations to organize records and communicate mathematical ideas.
- Select, apply, and translate among mathematical representations to solve problems.
- Use representations to model and interpret physical, social, and math phenomena.

In this regard, Van Driel & Dejong (2001) focused on the pedagogical knowledge growth utilizing models and simulation activities. The researchers used several instruments to gather data: responses to questionnaire and tests, audio records to workshops, reflective journal writing by teachers. The study revealed that pedagogical content knowledge grew with experience and exposure to workshops.

Sinatra & Kardash (2004) examined 182 primarily pre-service teachers' views of teaching as persuasion Their findings suggested that the teaching as persuasion metaphor would be more successful embedded in an instructional context designed to broaden teachers' epistemological views.

Angel, Ryder & Scott (2005) studied the scientific material, teachers, teaching strategies and its effect on experience. The sample consisted of 41 teacher-trainers, 24 experienced teachers of physics and 17 new teachers. The study revealed that experienced teachers were capable of teaching in ways that promoted higher order thinking.

Drechsler & Van Driel (2007) explored the interests of nine experienced chemistry teachers' pedagogical content knowledge. These teachers have had a course aimed at studying the difficulties encountered as they learn chemistry. The teachers were interviewed after two years of taking the course. The study showed significant differences of misconceptions of students and development of self efficacy. Moreover, the teachers' reflections on their teaching differed. For example, while some had reflected on students' difficulties, others were more concerned about their own teaching performances.

Khasawneh and Al-Baraket (2007) conducted a study that aimed to investigate the mathematical knowledge along with the pedagogical knowledge student-teachers acquired and the relationship between them. The sample consisted of 152 of the student-teachers. The study revealed that the student-teachers did not meet the mastery level of 80% on both tests and that they only achieved the passing score of 50%. Furthermore, the study showed a positive moderate relationship between students performance on both tests. The study showed that the students' grade point average and students' academic discipline predicted the highest students' pedagogical and mathematical knowledge.

On the other hand, Usak (2009) conducted an investigation of science teachers' pedagogical content knowledge regarding the study of "the cell". Several instruments were used to collect data for a group of 6 student-teachers in 2006-2007 academic years in a university in Turkey. The data were related to planning lessons, knowledge of the content of curriculum in science, assessment tools and beliefs regarding science. The results revealed that most teachers' concentrated on the textbook and that their teaching strategies were teacher-centered.

In addition, Wong et al. (2012) explored the levels of pedagogical knowledge and skills as perceived by student-teachers in Singapore starting from the first year to the end of the program. A sample of 812 student-teachers participated in the study. The MANOVA showed there was significant increase in teachers' pedagogical knowledge and skills over all six factors in the study.

A study conducted in Oman by Ambusaidi & Al-Hajeri (2013) aimed at investigating the importance of pedagogical content knowledge perceptions of teachers in light of some variables: gender, specialty, and teaching experience. The sample consisted of 102 female and male science teachers chosen from three different school districts. The study showed a statistical significant difference in teachers' perceptions of the importance of pedagogical content knowledge due to gender in favor of males and due to teaching experience. The study showed that knowledge about the science learners has the highest average mean among the other two domains, namely, knowledge about teaching strategies and knowledge about science curriculum.

On the other hand, Shinas, Yilmaz-Ozden, Mouza, Kardanel-Klien & Glutting (2013) used factor analysis in order to investigate student-teacher technological and pedagogical content knowledge. Another purpose was to question the exploratory factor analysis using a sample of 365 pre-service teachers who were enrolled in an instructional technology course in an American university. The study revealed that the participants did not always make conceptual distinctions between the seven domains associated with technological pedagogical and content knowledge. Furthermore, factors were congruent across only technological knowledge and content knowledge.

Sancar-Tokmak, Konokman, & Yelken (2013) conducted a study that aimed at investigating the early childhood program teacher candidates self-confidence on their (TPACK). 154 teacher candidates completed the Technological, Pedagogical, Content knowledge, self-confidence and their self-confidence on their TPACK was high. Furthermore, their TPACK did not differ with regard to the gender and grade level.

In addition, Batur & Balci (2013) Investigated pre-service teachers´ Pedagogical Content knowledge. Five Turkish pre-service teachers were interviewed in which the teachers´ knowledge about the curriculum and content knowledge were inadequate. Furthermore, traditional teaching behaviour is still the norm.

On the other hand, Tuysuz (2014) conducted a study that aimed at determining pre-service teachers´ self-confidence towards Technological Pedagogical Content knowledge (TPCK). The participants were 368 pre-service teachers in Turkey. The study revealed that pre-service teachers´ self-confidence towards (TPCK) was high.

The Problem

The teachers' role in the process of teaching and learning is considered, by all means, vital. Although, the student is the center of attention in the process of learning, yet the teacher still plays a significant role in this. In particular, the science and mathematics teacher has a specific importance. In recent years, science and mathematics curricula along with teacher preparation programs have witnessed reform movements so that they could meet the needs of the twenty-first century and all the dramatic changes in technology, multimedia and communication. Despite all that change, the role of the teacher remained fundamental and significant.

Many countries acknowledge that in order to develop and compete internationally, they must emphasize science and mathematics education. No doubts, this includes the emphasis on science and mathematics teachers. The teaching practices the teacher utilizes, shapes the knowledge growth of his/her students. In addition, teachers' beliefs and perspectives are passed indirectly to their students. Moreover, the more teachers perceive themselves as capable of performing effective instructional tasks, the more positive outcomes in students' achievement and attitudes are seen. Therefore, it seems that teachers' perception of their teaching practices is an important research topic.

Despite all the educational development and the reinforcement of teachers knowledge and all the programs and workshops Jordan and in particular the Ministry of Education offers in order to promote teachers' skills and competences, still Jordanian students encounter ample difficulties in learning mathematics and science. For example, in the Trends in International for Mathematics and Science Study TIMSS (2011), Jordan scored significantly lower than the centerpoint of the 8th grade scale. The students of Jordan scored 406 in which the average mean value was 500. Additionally, Jordanian 8th graders' performance in science significantly declined from the previous TIMSS study of 2003 (Foy, 2012).

Many researchers such as (Cox & Graham, 2009; McCrory, 2008; Niess, 2000) believe that for teachers to teach effectively and be up to date with contemporary instructional technologies and strategies, they need a lot of enhancement in their pedagogical content knowledge. This study has twofold: First, to investigate mathematics and science teachers' perception of their pedagogical content knowledge. Second, to explore whether these perceptions are statistically different according to their gender, experience, qualifications and workshops attendance.

Purpose of the study:

This study aimed to detect the perceptions of mathematics and science teachers' pedagogical content knowledge, and whether these perceptions vary according to: gender, workshop attendance, academic qualification, and teaching experience.

Questions of the study:

The study addresses the following research questions:

1. What are the mathematics and science teaches' perceptions of their pedagogical content knowledge?
2. Is there any statistical significant difference in mathematics and science teachers' perceptions of pedagogical content knowledge due to gender, workshop attendance, academic qualification, or teaching experience?

Procedural Definitions:

- **Science and Mathematics teachers:** teachers, who were assigned to teach in the Directorate of Education of Irbid Jordan in the scholastic year 2013/2014.
- **Perceptio**n is the organization, identification and interpretation of sensory information in order to represent and understand the environment. The perceptions are measured by the frequencies of teachers' responses to the scale of pedagogical content knowledge in science and mathematics.
- **Pedagogical knowledge (PK):** is deep knowledge about the processes and practices or methods of teaching and learning and how it encompasses (among other things) overall educational purposes, values and aims. This is

a generic form of knowledge that is involved in all issues of student learning, classroom management, lesson plan development and implementation, and student evaluation. It includes knowledge about techniques or methods to be used in the classroom; the nature of the target audience; and strategies for evaluating student understanding

- **Pedagogical Content Knowledge (PCK):** is knowledge about how to combine pedagogy and content effectively. It is knowledge about how to make a subject understandable to learners, knowledge of common misconceptions and likely perceptions students bring with them to the classrooms.

Limitations of Study

- The rating scale used in the study was translated, tuned and then applied to the study sample by the researchers; therefore, the interpretation of the results depends on the validity and reliability of the scale.
- The study was applied to a group of science and mathematics teachers belonging to the Directorate of Education of Irbid in Jordan which limits the generalization of results.

Methodology and Procedures:

The current study uses the descriptive analytical paradigm that describes the phenomena as is and is then followed by explanation trials.

Population and Sample:

The population consisted of all mathematics and science teachers assigned to teach in public schools in the Directorate of Irbid Jordan during the academic year of 2012-2013. A simple random sample that consisted of 273 female and male teachers were chosen to participate in this current study. Among the sample 135 were mathematics teachers, and 138 were science teachers.

Instrument of the Study:

To achieve the goals of the study, the researchers adopted two domains from a scale that was developed by (Edwards, Higley, Zeruth, & Murphy, 2007). Further, the researchers built on this and constructed a third domain. The instrument was first translated to Arabic and then was given to group reviewers (Professors at Yarmouk University) in order to check the validity of the instrument and to check whether the two versions were parallel and convey the same meaning. The original version consisted of 46 items, however; the first item was removed for lack of clarity as was suggested by one of the reviewers. Therefore, the final version consisted of 45 items distributed over three domains (Teacher Efficacy, Beliefs and Persuasion, Representation). Table 1 shows the distribution of the items over the domains.

Table 1: the distribution of the items over the domain

Factor	Items Numbers	Total
Teacher Efficacy	2, 10, 24, 25, 26, 27, 28, 29, 31, 32, 33, 34, 39, 40, 42, 43, 44, 45	18
Beliefs and Persuasion	1, 4, 5, 6, 9, 12, 13, 18, 19, 20, 21, 30	12
Representation	3, 7, 8, 11, 14, 15, 16, 17, 22, 23, 35, 36, 37, 38, 41	15
	Total	45

For the purpose of measuring the extent to which mathematics and science perceptions of (PCK), the respondent rated the 45 items using a 5-point Likert scale ranging from 1 (very little) to 5 (very much). The criterion was as following:

2.49 or less weak, 2.5-3.49 moderate, 3.5 and above strong.

Validity Measures

The instrument was given to a panel of ten university professors of science education, mathematics education, and evaluation and measurement. The purpose of this was to check the clarity of items, its relevance to the domain and the scale as a whole. The reviewers' remarks were primarily related to language and clarity. The construct validity was measured in which a group 40 teachers outside of the study sample participated in the pilot study. The correlation coefficient was calculated among the domains. Table (2) shows the coefficients.

Table 2: Person Correlation Coefficients

Dimension	Teacher Efficacy	Beliefs and Persuasion	Representation
Teacher Efficacy	1	0.673	0.696
Beliefs and Persuasion		1	0.773
Representation			1

The values of Person correlation coefficients ranged from (0.673) to (0.773). All the coefficients were significant at (α= 0.05).

Reliability Measures

Edwards, Higley, Zeruth, & Murphy (2007) performed factor analysis and measured the internal consistency by calculating Cronbach Alpha which was found (0.87). The researchers of this current study calculated Cronbach's Alpha as (0.9395). Table (3) shows the internal consistency measures over the three domains.

Table 3: Cronbach's Alpha

No.	Dimension	No. of Items	Cronbach's Alpha
1	Teacher Efficacy	18	0.9030
2	Beliefs and Persuasion	12	0.8578
3	Representation	15	0.8019
	Total	45	0.9395

Study Procedures:

The study followed this procedure:

- The instrument was translated from English language to Arabic language. Two bilingual professors reviewed both versions and confirmed the accuracy of the translation.
- An official permission was obtained from the Directorate of Irbid in order to collect data.
- A random sample of 40 teacher participated in the pilot study to check the reliability measures.
- The instrument was distributed to teachers who were selected randomly.
- The data was analyzed using SPSS in order to answer the research questions.

Study Variables:

1- Independent variables:

a) Gender, which has two levels: (male, female).

b) Teaching experience, which has three levels: (1-5, 6-10, more than 10).

c) Scientific qualification, which has three levels: (Diploma, Bachelor, Postgraduate).

d) Workshop attendance, which has two levels: (yes, no).

2- Dependent variable:

Mathematics and Science teachers' perceptions of pedagogical content knowledge.

Results and Discussion:

➢ The results related to the first question: **"What perceptions mathematics and science teachers hold for their pedagogical content knowledge?"** To answer the first question, the means and standard deviations were found for each domain and were ranked according to their mean values.

Table 4: Means and standard deviations for the perceptions of mathematics and science teachers

Rank	No.	Dimension	Mean	SD
3	1	Teacher Efficacy	2.1825	0.5524
2	2	Beliefs and Persuasion	2.3370	0.5753
1	3	Representation	2.4591	0.5093
		Total	2.31005	

Table (4) shows that the domain "Representation" has the highest mean of 2.4591 with standard deviation 0.5093 and the least mean was of "Teacher Efficacy". It seems that science and mathematics teachers are aware of representation as a pedagogical content practice and its importance in helping students built their own mathematical and science concept and its role in clearing any misconception that could arise. However, representations mean is still moderate. This result coincides with that of Van Driel & Dejong (2001) who focused on the pedagogical knowledge growth of teachers utilizing models and simulation activities. Contrary to our expectations the domain "Teacher Efficacy" has the lowest mean of 2.1825 with standard deviation 0.5524. This may be due to the teachers' feeling that they need extra support and training in order to be more effective as teachers. Table (5) shows the means and standard deviation of all 45 items of the scale.

Table 5: Means and standard deviations for the perceptions of mathematics and science teachers

Dimensions	Rank	No.	Items	Mean	SD
Teacher Efficacy	1	10	How important is it that information be personally relevant to students?	2.4725	0.9702
	2	43	How much can you assist families in helping their children do well in school?	2.2784	1.0161
	3	26	To what extent can you make your expectations clear about student behavior?	2.2747	0.8540
	4	2	To what extent do you draw on students' emotions to teach content?	2.2711	0.9662
	5	24	How much can you do to control disruptive behavior in the classroom?	2.2271	0.7571
	6	39	How much can you use a variety of assessment strategies?	2.2051	0.9325
	7	25	How much can you do to motivate students who show low interest in school work?	2.1868	0.8564
	8	34	How much can you do to get children to follow classroom rules?	2.1795	0.9475
	9	29	How well can you establish routines to keep activities running smoothly?	2.1722	0.9012
	10	44	How well can you implement alternative strategies in your classroom?	2.1612	0.8200
	11	42	How well can you respond to defiant students?	2.1612	0.9411
	12	27	How much can you do to get students to believe they can do well in school work?	2.1282	0.8922
	13	45	How well can you provide appropriate challenges for very capable students?	2.1282	0.8963
	14	31	How much can you gauge student comprehension of what you have taught?	2.1099	0.8285
	15	40	How well can you keep a few problem students from ruining an entire lesson?	2.1026	0.9016
	16	33	How much can you do to foster student creativity?	2.0952	0.9146
	17	32	To what extent can you craft good questions for your students?	2.0659	0.8376
	18	28	How well can you respond to difficult questions from your students?	2.0659	0.9132
Beliefs and Persuasion	1	12	To what extent do you change students' knowledge about the world?	2.4652	0.9547
	2	20	To what extent should students resist attempts to change their thinking?	2.4542	0.9695
	3	18	How much is learned by students who are dissuaded of their beliefs?	2.4505	0.8861
	4	13	To what extent do you alter students' thinking?	2.4359	0.9836
	5	19	To what extent do you change students' beliefs about the world?	2.3956	0.9457
	6	21	How much does teaching involve persuading students to change their beliefs?	2.3260	0.8445
	7	6	To what degree do you change students' beliefs about academic content?	2.3040	0.9231
	8	9	To what extent is there room for persuasion in your classroom?	2.2637	0.9095
	9	1	To what extent does your teaching about controversial topics involve persuasion?	2.2527	0.9385
	10	4	To what extent does learning involve changing students' beliefs?	2.2527	0.8693
	11	30	How much can you do to help your students value learning?	2.0952	0.8124
	12	5	To what extent is persuasion a valuable tool for you?	2.0842	0.8725
Representation	1	8	To what extent are you capable of using representations to organize and record ideas?	3.1758	1.2998
	2	7	To what extent are you capable of using models, pictures and simulation activities to introduce concepts?	3.0513	1.2356
	3	11	To what extent is representation helpful in interpreting physical phenomena?	2.9634	1.1689
	4	15	To what extent does persuading students to change their beliefs involve representation?	2.7839	1.1019
	5	14	To what extent is representation helpful in solving problems?	2.4286	0.9488
	6	35	How much can you do to improve the understanding of students through representations?	2.3736	0.9073
	7	22	To what extent is changing students' thinking achieved through representations?	2.3590	0.9448
	8	17	How important is it for you to correct the inaccuracies in students' arguments through representations?	2.3004	0.9498
	9	37	How much can you help students adjust their perceptions of concepts through representations?	2.3004	0.9420
	10	23	How much can you do to help your students think critically through critically?	2.2418	0.8226
	11	16	To what extent does your teaching result in changing students' knowledge and beliefs through representations?	2.2308	0.8796
	12	36	How much can you do to help the most confused student in your class understand concepts through representation?	2.2198	0.9370
	13	38	How much can you do to adjust your lessons to the proper level using representation?	2.2051	0.8325
	14	41	To what extent can you provide an alternative explanation or model, or example when students are confused?	2.1392	0.8417
	15	3	To what extent do you provide evidence to support your representations?	2.1136	0.8649

Table (5) shows that for the domain “Teacher Efficacy”, item 10 which states “How important is it that information be personally relevant to students?” has the highest mean of 2.4725 which shows that teachers believe that information given to students is more powerful and lasting when it is related to students daily life and relevant problems. On the other hand, item #28 “How well can you respond to difficult questions for your students?” has the least mean of 2.0659. This could be explained that most Jordanian teachers are not prepared for students’ questions specially those questions asked by curious students, who have ample learning resources and access to technologies. This result of the study coincides with the study results of (Drechsler & Van Driel (2008) that showed significant differences of misconceptions of students and development of self efficacy, and with the study results of (Sinatra & Kardash, 2004) whose findings suggested that the teaching as persuasion metaphor would be more successful embedded in an instructional context designed to broaden teachers’ epistemological views.

For the domain “Beliefs and Persuasion” the highest mean value was item #12 “To what extent do you change students’ knowledge about the world?, It seems that teachers believe that their pedagogical content knowledge they hold could change fundamental ideas students hold of the world around them. Whereas, item #5 “To what extent is persuasion a valuable tool for you?” received the lowest mean of (2.0842). Our belief is that most teachers do not understand what persuasion means as a pedagogical practice. In science and mathematics teaching it means providing evidence and valid logical arguments in order to shape students thinking. This is done through representations, reasoning, communication, connection and experimentation. For that reason our understandings as previous teachers, educators and researchers that many teachers lack those skills and the necessary equipment and materials to do so.

For the domain “representation’ the item “ To what extent are you capable of using representations to organize and record ideas?” has the highest mean value of (3.1758) with standard deviation (1.2998). Again this shows that science and mathematics teachers realize the importance of representations to teach abstract concepts in the case of mathematics, and using inquiry skills of gathering information, recording and testing hypothesis in the case of science. On the other hand, the item “To what extent do you provide evidence to support your representations? received the lowest mean of (2.1136) and with standard deviation of (0.86490. This may be due that providing evidence in supporting ones’ representations requires reasoning and higher order skills that the teachers feel they lack.

- The results related to the second question: “**Is there any statistically significant difference of mathematics and science teachers’ perceptions of pedagogical content knowledge due to gender, workshop attendance, academic qualification, or teaching experience?**” To answer this question the mean and standard deviation was used for the three domains and the overall scale according to gender, workshop attendance, academic qualification, or teaching experience. Table 6 shows this:

Table 6: Means and standard deviations for the perceptions of mathematics and science teachers due to Independent variable

Independent variable	Independent variable levels	No	Beliefs and Persuasion		Representation		Teacher Efficacy	
			Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**
Gender	Male	110	2.277	0.487	2.437	0.373	2.132	0.544
	Female	163	2.378	0.626	2.474	0.584	2.217	0.557
Teaching experience	1-5	77	2.3301	0.5494	2.4788	0.5144	2.1840	0.5805
	6-10	90	2.3824	0.4236	2.4067	0.4152	2.2204	0.5183
	more than 10	106	2.3035	0.6955	2.4893	0.5751	2.1494	0.5627
Academic qualifications	Diploma	27	2.3889	0.3819	2.4790	0.4634	2.2654	0.5338
	Bachelor	188	2.2664	0.5360	2.3840	0.4793	2.1350	0.5388
	Postgraduate	58	2.5417	0.7138	2.6931	0.5583	2.2979	0.5912
Workshop attendance	Yes	61	2.579	0.653	2.687	0.609	2.350	0.566
	No	212	2.267	0.533	2.393	0.458	2.134	0.540

Table 6 shows differences in means of teachers' perception on all three domains due to gender, experience, qualification, and workshop attendance. Table 7 shows the multivariate test for the four independent variables.

Table 7:Multivariate Tests for the variables gender, workshop attendance, academic qualification, and teaching experience

Effect	Multivariate Tests	Value	F	Hypothesis df	Error df	Sig.
Gender	Hotelling's Trace	.018	1.605[a]	3.000	264.000	.189
EXP	Wilks' Lambda	.961	1.788[a]	6.000	528.000	.099
qualifications	Wilks' Lambda	.903	4.586[a]	6.000	528.000	.000
Work	Hotelling's Trace	.101	8.865[a]	3.000	264.000	.000

The result of the multivariate test shows significant difference for the variables qualification and workshop attendance. On the other hand, it shows no significant difference due to gender or teaching experience. In order to investigate the significance of the independent variables over the three dimensions, Multivariate analysis of variance was conducted in Table 8.

Table 8:MANOVA results for the variables gender, workshop attendance, academic qualification, and teaching experience

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Model	Beliefs and Persuasion	1496.941a	7	213.849	725.691	.000
	Representation	1748.799b	7	249.828	1195.764	.000
	Teacher Efficacy	1320.556c	7	188.651	503.353	.000
Gender	Beliefs and Persuasion	.569	1	.569	1.932	.166
	Representation	.011	1	.011	.053	.819
	Teacher Efficacy	1.037	1	1.037	2.768	.097
Teaching experience	Beliefs and Persuasion	.380	2	.190	.644	.526
	Representation	.255	2	.127	.610	.544
	Teacher Efficacy	.733	2	.367	.978	.377
Academic qualifications	Beliefs and Persuasion	2.188	2	1.094	3.713	.026
	Representation	5.041	2	2.520	12.063	.000
	Teacher Efficacy	1.526	2	.763	2.035	.133
Workshop attendance	Beliefs and Persuasion	4.311	1	4.311	14.629	.000
	Representation	5.433	1	5.433	26.007	.000
	Teacher Efficacy	2.559	1	2.559	6.828	.009
Error	Beliefs and Persuasion	78.386	266	.295		
	Representation	55.575	266	.209		
	Teacher Efficacy	99.694	266	.375		
Total	Beliefs and Persuasion	1575.326	273			
	Representation	1804.373	273			
	Teacher Efficacy	1420.250	273			

Table (8) shows that there were no significant differences over the three domains according to gender. This is due to the fact that teachers, regardless of their gender, receive the same academic knowledge and the same in-service training, and hence acquire similar professional competencies and skills. Therefore, their perceptions seem also to be similar according to their pedagogical content knowledge. This result contradicts the study results of (Ambusaidi & Al-Hajeri, 2013) that showed a statistical significant difference in teacher's perceptions of the importance of pedagogical content knowledge due to gender.

Furthermore, Table (8) shows that there is a significant difference in students' teacher efficacy, beliefs, and representation in favor of those who attended workshops. The explanation of this is that teachers who have attended workshops during service may have had more exposure to different teaching strategies and have had promoted their competences' and teaching skills, and hence their perceptions of their abilities of pedagogical content knowledge and ability seem to be higher than those who never attended workshops. This result is consistent with the study of (Van Driel & De jong, 2001) that revealed that pedagogical content knowledge grew with exposure to workshops.

As for the domain of academic qualifications, Table (8) shows no significant differences according to Teacher Efficacy whereas; there were significantly differences according to Representation and Beliefs. Table 8 shows LSD post-hoc test which shows which domains are statistically significantly different according to Representation and Beliefs.

Table 9: LSD post-hoc Test for - Academic qualification

Dependent Variable	Level	Bachelor	Postgraduate
representation	Diploma	0.5	0.024
	Bachelor		0.000
Beliefs and Persuasion	**Diploma**	**0.308**	**0.636**
	Bachelor		0.034

From Table 9, and using the LSD post hoc test for Representation, we can conclude that there is a significant difference in the mean value between teachers who hold a bachelor degree and those with postgraduate degrees, and those who hold diploma and post graduate degree. This is predictable since higher academic degree means exposure to more experience and teaching strategies. Hence, that will enhance teachers capabilities to represent scientific and mathematical abstract concepts. Furthermore, Table 9, reveals that for the Belief domain, there is a significance difference in the mean value between those who hold a bachelor and post graduate in favor to those who hold a post graduate. Similarly, the explanation to this is that higher academic degrees means exposure to experiences and knowledge of how students learn mathematics and science and how one could influence how students think. However, the LSD post hoc test revealed no significant difference is seen between those who hold a bachelor degree versus those who hold a diploma, nor those with diploma and those who hold a post graduate degree. This result is contrary to our belief, and the possible explanation to this is that the experiences that students have in the two year college is quit similar to that with students who hold a bachelor degree. However, more research studies should be conducted before we can conclude such an explanation.

In contrast, Table (8) shows no significant differences over all the three domains according to teaching experience. Contrary to our belief that teachers' perception of pedagogical content knowledge would level up as teachers have more teaching years and experience yet, these differences appear to be not significant. It could be explained that teachers in Jordan carry a heavy duty load of teaching and that this load is not decreased as years pass. Therefore, these teachers do not have the time needed to enhance their teaching strategies, develop rich lesson plans and grow professionally as teachers. This result of this study contradicts with the study results of (Angel, Ryder & Scott, 2005) that showed that experienced teachers were capable of teaching in ways that promoted higher order thinking. This result of this study is also inconsistent with the study results of (Van Driel & De jong, 2001) that showed that pedagogical content knowledge grew with experience.

Conclusion and Recommendations:

This study examined the extent to which teachers perceive they are capable of teaching mathematics and science as persuasion, representation and extent of their overall self-efficacy. The results of this study revealed that their perceptions of their capability of performing pedagogical content knowledge (PCK) are generally weak. Therefore, we recommend the reevaluation of teacher preparation programs in which more emphasis should be placed on pedagogical practices and how to align it with the subject-matter. Furthermore, such programs should abandon traditional training and concentrate on programs that may increase teachers' confidence in making changes in students' thinking and in promoting scientific and mathematical understandings. After all, change is at the heart of the learning process (Edwards et al, 2006). This is consistent with recommendations with the study of (Khasawneh, & Al-Barakat, 2007). Another finding of the study revealed that teachers felt were generally capable of performing representations the most of the other pedagogical practices. We recommend that teachers continue to receive in-service support and training in order to promote their (PCK) and teaching practices in a way that promote genuine understandings. This is consistent with the recommendations of (Ambusaidi & Al-Hajeri, 2013).

The researchers recommend the use of various instruments including field observations to assess the pedagogical content knowledge teachers posses. Furthermore, the researchers recommend the need to reevaluate the effectiveness of pre-service and in-service teacher preparation programs in promoting pedagogical content knowledge.

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