Submitted: 04/01/2017 - Accepted: 04/02/2017 - Published: 28/04/2017

Primary Science Teachers' Perceptions of Technological Pedagogical and Content Knowledge (TPACK) In Malaysia

Mohammed Yousef Mai[1]*

Mahizer Hamzah[1]

[1]Faculty of Education, Universiti Pendidikan Sultan Idris, Tanjong Malim, Perak Darul Ridzuan

*Email: dr.mohd.mai@gmail.com

DOI: 10.26417/ejser.v6i2.p167-179

Abstract

The integration of Information and Communications Technology (ICT) in classrooms has been a challenge for the educational systems that aim to cope with the needs and the demands of the 21st century. The TPACK framework represents the knowledge needed by teachers bringing together content knowledge, technological knowledge and pedagogical knowledge with the aim of integrating ICTs into teaching-learning processes. The aim of this study is to determine the primary science teachers' perceptions of technological pedagogical content knowledge (TPACK) addressing teachers' perceptions of the affordances of technology application in instruction. A total of 133 prımary science teachers in Malaysia were surveyed (Female= 67, Male= 66). Data were collected through "Technological Pedagogical and Content Knowledge" (TPACK) scale. The questionnaire consisted of 47 questions about TPACK and is based on the survey instrument developed by Schmidt et al. (2009). TPACK involving the seven factors of technological knowledge (TK), pedagogical knowledge (PK), content knowledge (CK), technological content knowledge (TCK), technological pedagogical knowledge (TPK), pedagogical content knowledge (PCK), as well as synthesized knowledge of technology, pedagogy, and content (TPC). The findings indicate that primary science teachers perceive higher self-confidence in pedagogical knowledge in general. Further, no differences between science teachers' perceptions according to thier gender, while there are diferences between the teachers perceptions of PK, CK, and PCK accordıng to their age.

Keywords: İCT, TPACK, Science Education, Primary science teacher.

Introduction

The integration of Information and Communications Technology (ICT) in classrooms has been a challenge for the educational systems that aim to cope with the needs and the demands of the 21st century (Kyriakidou, Chrisostomou, & Banks, 1999; Yapici & Hevedanli, 2012). The Malaysian Ministry of Education (MOE) has introduced various initiatives to facilitate the adoption and diffusion of Information and Communication Technology (ICT). In line with the Vision 2020, Ministry of Education has draft ways to integrate ICT into the education system. The Malaysian government has invested millions of Ringgit for the usage of ICT in education (Rashid, 2011). The concept of ICT in education, as seen by the Ministry of Education, includes systems that enable information gathering, management, manipulation, access, and communication in various forms. The Ministry has formulated three main policies for ICT in education (Chan & Foong-Mae, 2002; Mohd Zaki M. et al., 2009):

ICT is for all students, meaning that ICT is used as an enabler to reduce the digital gap between the schools.

Emphasizes the role and function of ICT in education as a teaching and learning tool, as part of a subject as well as a subject by itself.

Emphasizes the use of ICT to increase productivity, efficiency and effectiveness of the management system such as the processing of official forms, timetable generation, management of information systems, lesson planning, financial management and the maintenance of inventories.

Much discussion about technology and education has focused on the question of how technology facilitates teaching and learning. The potential benefits of using ICT in teaching and learning are immense. The use of ICT has greatly transformed the outcomes of teaching and learning experience in classrooms. It does not only supplement and/or complement teacher instructional processes, but also offers unlimited access to knowledge and information that is readily available through the internet, manipulate data, explore relationships, intentionally and actively process information, construct personal and socially shared meaning and reflect on the learning process. It also gives the students opportunities to examine a variety of viewpoints so they can construct their own knowledge of various concepts (Koç, 2005; Tam, 2000). Look (2005) cited that a review of 219 studies on the use of technology in education consistently found that students in technology rich environments experienced positive effects on achievement in all subject areas. The merits of ICT in education have been extolled in the literature. The use of ICT has been found to (Fu, 2013; Kubiatko & Haláková, 2009; Look, 2005; Sim & Theng, 2014):

- Assist students in accessing digital information efficiently and effectively
- Support student-centered and self-directed learning
- Produce a creative learning environment
- Promote collaborative learning in a distance-learning environment
- Offer more opportunities to develop critical (higher-order) thinking skills
- Support teaching by facilitating access to course content
- ICT offers students more time to explore beyond the knowledge allowing them to understand better the scientific concepts.
- ICT enhances the effectiveness of information presentation and stimulates students' interest.
- ICT can improve the quality of education.
- The use of multimedia approach had been successful in generating conceptual understanding.
- The use of interactive multimedia software motivates students and leads to improved performance.
- Using ICT increase the students' attitudes.

Further, research studies showed that ICT motivate student learning, there are a lot of assumptions that students are interested in using ICT; they found it more pleasant, more appealing, and more motivating to study with ICT tools than by traditional means (Kubiatko & Haláková, 2009). Multimedia and technology have proven helpful in engaging students in learning about subjects, in exploring ways to present their learning, and in helping students control their learning (Taylor & Parsons, 2011). In sum, although the use of ICT changes the teaching and learning relationship, but there is a lack of theoretical grounding for developing or understanding this process of integration ICT in the teaching and learning (Mishra & Koehler, 2006).

To integrate educational technologies effectively into education, teachers need to plan their instruction according to curriculum requirements, students' learning needs, available technologies' affordances and constraints, and the realities of school and classroom contexts. The complex knowledge needed for such planning is known as technology, pedagogy, content, and context knowledge (TPACK) (Harris & Hofer, 2011).

Theoretical Background

The way that young people precieve and use digital technologies in and out-of-school settings and the intensity with which technologies are being used has challenged the educational community in general and educational technology researchers in specific. Research has shown that teachers still resist the integration of new technology into the classroom. There are many factors affect the teachers' usage of new technology, Kathryn MacCallum, Lynn Jeffrey, & Kinshuk (2014) proposed those factors as the following:

1. Teachers' beliefs about the perceived value of the new technology "usefulness" and the perceived effort needed to learn to use the new technology "ease of use".
2. Teachers' skills to use and integrate digital technology into their teaching "digital literacy".
3. Teachers' self-efficacy beliefs pertaining to their own level of competence and their attitudes towards technology adoption.
4. ICT anxiety is considered as the tendency of a teacher to experience a level of uneasiness over his/her impending use of ICT.

Those factors are important in motivating and encouraging a teacher to use technology in the classroom (Gilakjani, Leong, & Ismail, 2013). The success of any initiatives to integrate ICT in classroom life depends strongly upon teachers' perceptions of technology use and its affection in their use of technology in instruction; guide the decisions teachers make and actions they take in the classroom. The question of what teachers need to know in order to appropriately incorporate technology into their teaching has received a great deal of attention recently (Mishra & Koehler, 2006), the results of many studies (Fu, 2013; Palak & Walls, 2009) support the evidence that teachers' beliefs have an influence on the way they organized their classrooms, interacted with students, and how they act in the classroom.

For several decades, educational technology as a field has struggled to find its theoretical roots (Graham, 2011), developing theory for educational technology is difficult because it requires a detailed understanding of complex relationships that are contex- tually bound. Moreover, it is difficult to study cause and effect when teachers, classrooms, politics, and curriculum goals vary from case to case (Mishra & Koehler, 2006). Acoording to Khaddage & Knezek (2013), educational technology researchers around the world who are interested in issues related to technology integration, therefore, they are increasing the use of the technological pedagogical content knowledge (TPACK) framework in the recent studies (Graham, 2011).

The most important influence of technological pedagogical content knowledge (TPACK) framework is for thinking about teacher knowledge (what they need to know, and how they might develop it) and the importance of pedagogical approach to teachers' professional development, learning technology by design, leads to the development of TPACK (Mishra & Koehler, 2006).

Teaching is a complex cognitive skill occurring in an ill-structured, dynamic environment. It is important to understand that teaching is a highly complex activity that draws on many kinds of knowledge. Historically, teacher education have focused on the content knowledge of the teacher. More recently, teacher education has shifted its focus to general pedagogical classroom practices independent of subject matter and often at the expense of content knowledge. This lead teacher education to emphasize one or the other domain of knowledge, focusing on knowledge of content (C) or knowledge of pedagogy (P) (Mishra & Koehler, 2006). The TPACK framework builds on Shulman's (1986, 1987) conception of pedagogical content knowledge (PCK) by explicitly integrating the component of technological knowledge into the model (Graham, 2011). The TPACK framework is most commonly represented using a Venn diagram with three overlapping circles, each representing a distinct form of teacher knowledge (see Figure 1).

The TPACK framework highlights three core knowledge components: Content, Pedagogy, and Technology. It refers to the knowledge that emerges from an understanding of an interaction of these three components (Karadeniz & Vatanartıran, 2013). Therefor, TPACK framework includes three core categories of knowledge: pedagogical knowledge (PK), content knowledge (CK), and technological knowledge (TK). The framework proposes that combining these three core types of knowledge results in four additional types of knowledge: pedagogical content knowledge (PCK), technological pedagogical knowledge (TPK), technological content knowledge (TCK), and technological pedagogical content knowledge (TPACK) (Graham, 2011; Koehler, Matthew J. ; Mishra, Punya; Cain, 2013).

The different components of TPACK framework are described as follows: (Mishra & Koehler, 2006; Doukakis, S., Psaltidou, A., Stavraki, A., Adamopoulus, N., Tsiotakis, P. & Stergou, 2010; Graham, 2011; Harris & Hofer, 2011; Karadeniz & Vatanartıran, 2013; KOEHLER, MATTHEW J. ; MISHRA, PUNYA; CAIN, 2013; Roig-Vila, Mengual-Abdres, & Quinto-Medrano, 2015).

1. Technological Knowledge (TK): Technological knowledge is the knowledge about the various technologies, ranging from low-tech technology such as pencil and paper to digital technology such as the internet, digital video, interactive whiteboard etc. It refers to the knowledge about all sorts of technology –not only computers.
2. Content Knowledge (CK): Content knowledge is about the knowledge that a teacher is having on Mathematics or Science subjects which he/she teaches, it covers the knowledge linked to a subject matter.
3. Pedagogical Knowledge (PK): This describes the knowledge of the teacher about the processes and practices of teaching and learning, it includes knowledge about classroom management and organisation; curricular analysis and planning; and student's learning.
4. Technological Pedagogical Knowledge (TPK): It entails understanding how various technologies tools can be used in teaching, along with the conviction that the use of technology can change the way in which teachers improve their pratices and develop their professional activity.

5. Technological Content Knowledge (TCK): This is the knowledge of how technology can create new representations and/or new learning scenarios for specific contents
6. Pedagogical Content Knowledge (PCK): Pedagogical content knowledge integrates both content and pedagogy with the goal of developing better teaching practices in the content area.
7. Technological Pedagogical Content Knowledge (TPACK): This refers to the knowledge required by teachers for integrating technology into their teaching and content area. Teachers have an intuitive knowledge of the complex interrelationships existing between the three basic component of knowledge (CK, PK, TK) which is reflected in their ability to teach using the appropriate pedagogical methods and technologies.

The TPACK framework clarifies the complexity of teaching with ICT (Hasniza Nordin, 2014). Schmidt et al. (2009), describe TPACK as a useful framework for thinking about what knowledge teachers must have to integrate technology into teaching and how they might develop this knowledge. They further argue that, measuring teaching knowledge could potentially have an impact on the type of training and professional development experiences that are designed for both pre-service and in-service teachers.

TPACK is a specialized, highly applied type of knowledge that supports content-based technology integration. It has been characterized as the multiple intersections of teachers' knowledge of curriculum content, general pedagogies, technologies, and contextual influences upon learning (Harris & Hofer, 2011).

Many researchers recognize the broad appeal and potential of the TPACK model (Graham, 2011). Pedagogical content knowledge is of special interest because it identifies the distinctive bodies of knowledge for teaching. 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. TPACK framework can guide further research and curriculum development work in the area of teacher education and teacher professional development around technology (Mishra & Koehler, 2006).

TPACK framework gives flexibility and provides dynamic strategies to teachers to enhance and therefore improve the teaching and learning process (Junnaina & Hazri, 2014). According to Hasniza Nordin (2014) the use of the TPACK framework can create an added value since the structure of this particular model can be used to:

- simplify topics that are not easy for teachers to understand.
- help teachers to increase their competencies by being able to create good educational materials and useful instructional material designs that can utilize both pedagogical knowledge and ICT.

- allow teachers to develop strategies that will be effective for students' learning.
- enable teachers to effectively integrate the use of ICT in designing content.
- increase teachers' skills not only in the use of effective technology when designing course-related content and pedagogy
- help teachers to design and implement useful content-based lectures using a wide-range of ICT (such as design tools in Web 2. 0).
- enabled teachers to shift their focus from the use of social networking tools to re-designing the main uses of the social networking tools

Theories and models on professional knowledge are very broad and had been studied from various perspectives (Junnaina & Hazri, 2014). The studies about TPACK are varied in their aims, a range of research has identified the usefulness of the TPACK framework to inform the provision of teacher education (Hasniza Nordin, 2014) while some other studies aimed at adapting technological pedagogical and content knowledge (TPACK) instrument. For instance, Karadeniz & Vatanartıran (2013) administered a survey to 285 teachers who teach a variety of subject areas at the secondary school level in Edirne, Turky. The CFA results showed that original 5 factor scale fitted with Turkish data and TPACK survey was a valid and reliable instrument for measuring secondary school teachers' TPACK.

Other studies tried to invisitgate the teachers' knowledge with respect to technology, pedagogy, content knowledge and the combination of each of these areas. Doukakis, S., Psaltidou, A., Stavraki, A., Adamopoulus, N., Tsiotakis, P. & Stergou (2010) examined 1032 secondary teachers of computer science, findings indicate that content knowledge and technology knowledge rating are high and it seems that secondary teachers are less confident with their pedagogical content knowledge and their technological content knowledge. Junnaina & Hazri (2014) summarized the results of many studies, they found that the level of knowledge gained varied from one cohort to another. For instance, physics pre-service teachers had moderate level of knowledge while the results of another study shows that student teachers' knowledge to be at high level. Others found that the level of knowledge among school teachers was unsatisfactory and Female teachers were reported to dominate good pedagogical knowledge but have difficulty in gaining technology knowledge as compared to male teachers.

Roig-Vila, Mengual-Abdres, & Quinto-Medrano (2015) study has as its aim to analyze the technological, pedagogical and content knowledge needed for Primary Education teachers to integrate ICTs into teaching. 224 Preschool and Primary Education teachers working in the province of Alicante (Spain) was performed with that aim. The important results showed that teachers are more knowledgeable in the pedagogical and content fields than in technology, which means that their level of technological knowledge does not suffice to integrate ICTs into their teaching tasks. Significant differences were additionally identified between gender and years of experience, together with the relationship between the fun use of technology and the knowledge of its essential aspects. Our findings confirm the need for a digital literacy campaign addressed to teachers, involving not only a technological type of training but also an overall pedagogical and content approach.

In Malaysia, Raman (2014) study measures the level of Technological Pedagogical Content Knowledge (TPACK) seven knowledge dimensions. This study involved 154 pre-service teachers from various programs. The findings showed that the pre-service teachers have a high level of competency, confidence and lastly TPACK. The test results have also shown that there is a significant difference between the male and female pre-service teachers regarding the confidence level in using ICT in teaching and learning.

Purpose of the Study

The advent of digital technology has dramatically changed routines and practices in most arenas of human work (Mishra & Koehler, 2006). The success of student learning with ICT will depend largely on the teachers' abilities, perceptions, and their willingness to embrace the technology (Teo, 2006). Teachers' attitudes and perceptions towards ICT is a very important factor that educators ought to consider in implementing mobile learning in classroom and it is a major predictor for future ICT use in the classroom (Teo, 2008) (Mai, 2014).

In recent years, a new model for teachers' technology integration has been developed. This model requires teachers' competency in technology pedagogy and content to form the technological pedagogical content knowledge (TPACK). Most important, the TPACK framework allows us to identify what is important and what is not in any discussions of teacher knowledge surrounding using technology for teaching subject matter (Mishra & Koehler, 2006).

Recently, research in educational technology suggests the need for "Technological Pedagogical and Content Knowledge" (TPACK). To understand the challenges available in TPACK for science teachers' competent in using technology is teaching science, it is considered important to invisigate science teachers' competency in TPACK. In particular, the following research questions will be addressed:

- how algorithmic and
- What are science teachers' perceptions of their own TPACK levels?
- What is the existing relationship between the different TPACK model components?
- Are there any significant differences in science teachers' perceptions of all seven domains of TPACK according to their gender, qualification and age?

Method

Research Design

This research is a descriptive in nature; its key purpose is a description of the state of affairs, as it exists at present. Surveys are concerned with describing, recording, analyzing and interpreting conditions that exist (Kothari, 2004). In this study, qualitative data were obtained through a survey conducted with science teachers in primary school, the gathered data were analyzed using both descriptive and inferential statistics.

Participants

The research sample consist of 133 science teachers who teaching science in primery schools in Selangor and Perak in Malaysia in the academic year of 2014-2015. The male teachers (n = 66) form 49. 6% of the sample while the female teachers (n = 67) form 50. 4% of the sample. Approximately 22. 6% of the respondents aged (25-30 years old), 44. 4% aged 31-35 years, and 33% aged more than 35 years old. The majority of teachers (74. 4%) have at most an undergraduate degree, while 25. 6% have at most a postgraduate degree.

The Instrument

In this research, data were collected through "Technological, Pedagogical, and Content Knowledge" scale. It consists of 47 items about TPACK on a 5-point Likert scale and is based on the survey instrument developed by Schmidt et al. (2009). TPACK model 47 questions in the questionnaire are divided into questions about TK (15 questions), PK (6questions), CK (6 questions), TPK (4 questions), PCK (7 questions), TCK (4 questions) and TPACK (5 questions). Every item in the questionnaire is 5 Likert scale. Likert scale question comprised five points ranking following: ''strongly agree" (5 points), ''agree" (4 points), ''neutral" (3 points), ''disagree" (2 points), ''strongly disagree" (1 point). For each subscale (CK, TK,PK, PCK, TCK, TPK, TPACK) the participant's responses are averaged. In addition, the questionnaire utilised covers also with the same demographic data (gender; age; and qualification)

Several studies have acknowledged the need to develop a more reliable and valid instrument when measuring teachers' TPACK (Hasniza Nordin, 2014). Cronbach's alpha, the measure of reliability, was calculated for the scales and subscales for items measured on the five-point Likert scale. The overall scale had an alpha of 0. 947 and the alpha for subscales ranged from 0. 814 to 0. 89. The instrument has a good reliability and can be used to measure the science teachers' perceptions towards TPACK.

Research Results

Descriptive statistics

The respondents answered all the questions; basic descriptive statistics (mean and standard deviation) about the data collected for this research are summarized in Table 1. Overall, teachers are more knowledgeable in TPACK model areas, it can be seen that the scince teachers rated themselves around four on a five-point scale for all of the subscales, indicating a high level of confidence for these TPACK areas. According to the results in Table 1, the subscales with the best level of perception are "Technology Knowledge" (TK) (M=4. 07; SD=0. 503) and "Technology Pedagogical Knowledge" (TPK) (M=4. 064; SD=0. 554) and "Technological Content Knowledge" (TCK) (M=3. 975; SD=0. 496) where the percent of the mean 80% or more. In the second level of perception with around 78% of mean are "Content Knowledge" (CK) (M=3. 939; SD=0. 507) and "Pedagogy Knowledge" (PK) (M=3. 911; SD=0. 558). Finally, the factor where teachers obtain the worst result is that of "Technological Pedagogical and Content Knowledge" (TPACK) (M=3. 826; SD=0. 441) and "Pedagogical Content Knowledge" (PCK) (M=3. 793; SD=0. 604) with the lowest percent of mean around 76%.

Relationship between the different variables

In addition to descriptive statistics measuring Science Teachers' TPACK, Pearson's linear correlation r coefficient was analysed in order to study the relationship existing between the different TPACK model components (Table 2).

The correlational results can be found in Table 3 below. With respect to correlations between subscales, although the values of the coefficients varied from. 211 (TCK and PK) to. 783 (PCK and PK) but all of the coefficients are positively correlated. Such results allows us to appreciate the links existing between the different TPACK model components. The components more closely related to one another are the intersections directly linked to the same section, such as TCK, TPK and TPACK as all of them related to the same section "technology".

A strong positive correlation exists between the variables PCK and PK (r=0. 783, n=133, p= 0. 001), between TK and TCK (r=0. 666, n= 133, p=0. 001), between TCK and TPACK (r=0. 652, n= 133, p=0. 001), between TPK and TPACK (r=0. 638, n=133, p=0. 001) and between PCK and TPACK (r=0. 637, n=133, p=0. 001). Nevertheless, technical, pedagogical and content knowledge TPACK presents a positive –though weak– correlation with TPACK (between TCK and these two variables (between TCK and PK; r=0. 211, n=133, p=0. 015; between TCK and PCK r=0. 239, n=133, p=0. 006, and between TK and PK r=0. 334, n=133, p=0. 000). The results reveal that, an increase of technological knowledge was correlated with the increased understanding of: technological content knowledge; technological pedagogical knowledge; and technological, pedagogical and content knowledge.

Differences in perceptions of TPACK according to their gender, age and qualification

An independent-samples t-test was conducted to compare between the means of the different TPACK model components for checking if significant differences existed according to the independent variables (gender and qualification) as the comparison was made between two groups. One way analysis of variance (ANOVA) with the independent variable (age) because the comparison was made between more than two groups.

Gender

Considering any significant differences in science teachers' perceptions of all seven domains of TPACK according to their gender (male and female) science teachers, the researchers used t-test for independent samples, the results included in table 3.

A t-test for independent samples was carried out in order to compare TPACK model components among male and female science teachers. The results show that there are no significant diferences appeared in all of the TPACK model components. Such results reveal that nevertheless of science teachers' gender they are more knowledgeable in TPACK model components and have almost the same level of perceptions.

Qualification

Considering any significant differences in science teachers' perceptions of all seven domains of TPACK according to science teachers' qualification (degree and master), the researchers used t-test for independent samples, the results included in table 4.

The results of t-test for independent samples summemoriezed in table (4), the results show that there are no any differences in science teachers' perceptions of TK, CK, TCK, and TPACK according to their qualification. This means that all the teachers regardless of their qualification have the same level of percepctions about technological knowledge, content knowledge; technological content knowledge; and technological, pedagogical and content knowledge.

On the other hand, from table 4 significant differences appeared in a;most all the pedagogical sectors associated with technology and or content, such as pedagogical knowledge PK for degree (M=3. 985; SD= 0. 483) and master (M=3. 696; SD=0. 7); t(131)= 2. 661, p=0. 009. The same significant differences were found in technological pedagogical knowledge TPK in degree (M=4. 136; SD=0. 54) and master (M=3. 855; SD=0. 549); t(131)=2,598, p=0. 01, as well as in pedagogical content knowledge PCK among degree (M=4. 029; SD=0. 423) and master (M=3. 819; SD= 0. 646); t(131)= 2. 156, p= 0. 033.

The aforesaid results suggest that scince teachers with undergarduate degree are more familiarised with pedagogical knowledge and its didactic application than scince teachers with master degree or, alternatively, that scince teachers with master degree because they know more about the new pedagogy and technology; they think that they need to be more competent in using TPACK model componants.

Age

A one-way between subjects ANOVA was conducted to compare science teachers' perceptions of all seven domains of TPACK according to their age (25-30 years, 31-35 years, and more than 35 years old), the results included in table 5.

An ANOVA one way analysis of variance subsequently helped us to compare the effect caused by years of teachers' age on the perceptions of TPACK model. The 133 sample members were classified into three subgroups formed by 30 teachers (22. 6 % of the sample) whose aged between 25 and 30 years old; 59 teachers (44. 4 %) with 31-to-35 years old; and the remaining 44 (33. 1 %), whose their age exceeded 35 years. According to the results expressed in Table 5, it was found that no significant differences appear between the science teachers' perceptions of all seven domains of TPACK according to their age. On the whole, it can be said that science teachers have the same perceptions of the all seven domains of TPACK regardless of their age.

Discussion

In the study it was found that scince teachers felt quite confident on their TPACK perceptions. The results of the study also showed that the scince teachers' TPACK confidence didn't differ with regard to gender or age. Also, the gender and age were not a signifance factor in TPACK model components. The only significance difference was in their pedagogical knowledge PK, technological pedagogical knowledge TPK, pedagogical content knowledge PCK where scince teachers with undergarduate degree are more familiarised with pedagogical knowledge and its didactic application than scince teachers with master degree.

The study results showed that the scince teachers felt quite confidence about their TPACK. When analyzed similar researchs it was determined that teachers are more knowledgeable in the pedagogical and content fields than in technology, which means that their level of technological knowledge does not suffice to integrate ICTs into their teaching tasks (Roig-Vila et al., 2015). Another results of the study showed that there were no significance difference between gender. This result was parallel to other studies in literature (Raman, 2014; Roig-Vila et al., 2015).

The Science teachers who participated in this survey rated "Technology Knowledge" (TK) (4. 07) higher than the other TPACK subscales. According to Mishra & Koehler (2006) Technological Knowledge is associated with the ability to use technological tools but also the knowledge behind this technology. This enables teachers to effectively apply technological knowledge to improve student learning and to be ready to any forthcoming changes. In align with this, teachers seem to have high (81%) Technological Pedagogical Knowledge (TPK, 4. 06). This shows that science teachers have realized that teaching and learning are reformed when using technological tools in designing pedagogical strategies taking into account that such knowledge includes awareness of tools' limitations and capabilities. The TPK is likely to appear stronger because all available technological tools are designed to fulfil educational aims of the subject (Mishra & Koehler, 2006).

According to the results, science teachers rating highly their perceptions of "Technological Content Knowledge" (TCK) (3. 975) and "Content Knowledge" (CK) (3. 939). this means that they are able to use knowledge of science concepts presented in the content, theories, the general framework of the course in order for students to acquire scientific knowledge. As well as, they can select and utilize effectivelly the technology that will help them in teaching the science content (TCK).

Regarding to the science teachers' perceptions of "Pedagogy Knowledge" (PK), "Technological Pedagogical and Content Knowledge" (TPACK), and "Pedagogical Content Knowledge" (PCK), it seems that teachers rate themselves with a lower level in the understanding of how technology and subject matter both aid, and limit each other. They seem to be less confident in transforming and applying effectively their Content Knowledge in their teaching process.. For the development of PCK, teachers should be perceptive in recognising students' common misconceptions and the methods by which these misconceptions can be deconstructed (Mishra & Koehler, 2006).

References

[1] Chan, By, & Foong-Mae. (2002). ICT in Malaysian Schools: Policy and Strategies. Retrieved 2/6/2014, from http://gauge. u-gakugei. ac. jp/

[2] Doukakis, S., Psaltidou, A., Stavraki, A., Adamopoulus, N., Tsiotakis, P. & Stergou, S. (2010). MEASURING THE TECHNOLOGICAL PEDAGOGICAL CONTENT KNOWLEDGE (TPACK) OF IN-SERVICE TEACHERS OF COMPUTER SCIENCE WHO TEACH ALGORITHMS AND Spyros Doukakis Dept. of Primary Education University of the Aegean Alexandra Psaltidou and Athena Stavraki The Americ. Readings in Technology and Education: Proceedings of ICICTE 201, (2009), 442–452.

[3] Fu, Jo Shan. (2013). ICT in Education: A Critical Literature Review and Its Implications. International Journal of Education and Development using Information and Communication Technology (IJEDICT), 9(1), 112-125.

[4] Gilakjani, Abbas Pourhosein, Leong, Lai-Mei, & Ismail, Hairul Nizam. (2013). Teachers' Use of Technology and Constructivism. I. J. Modern Education and Computer Science, 4, 49-63. doi: 10. 5815/ijmecs. 2013. 04. 07

[5] Graham, C. R. (2011). Theoretical considerations for understanding technological pedagogical content knowledge (TPACK). Computers and Education, 57(3), 1953–1960. doi:10. 1016/j. compedu. 2011. 04. 010

[6] Harris, J. B., & Hofer, M. J. (2011). Technological pedagogical content knowledge in action: A descriptive study of secondary teachers' curriculum-based, technology-related instructional planning. Journal of Research on Technology in Education, 43(4), 211.

[7] Hasniza Nordin. (2014). Pre-Service Teachers' TPACK and Experience of ICT Integration in Schools in Malaysia and New Zealand. University of Canterbury, New Zealand.

[8] Junnaina, H. C., & Hazri, J. (2014). The Effect of Field Specialization Variation on Technological Pedagogical Content Knowledge (TPACK) Among Malaysian TVET Instructors. The Malaysian Online Journal of Educational Technology, 2(1), 36–44.

[9] Karadeniz, Ş., & Vatanartıran, S. (2013). Adaptation of a TPACK survey to Turkish for secondary school teachers. International Journal of Human Sciences, 10(2), 34 – 47. Retrieved from http://www. j-humansciences. com/ojs/index. php/IJHS/article/view/2636

[10] Kathryn MacCallum, Lynn Jeffrey, & Kinshuk. (2014). Factors impacting teachers' adoption of mobile learning. Journal of Information Technology Education, 13.

[11] Khaddage, Ferial, & Knezek, Gerald. (2013). Introducing a Mobile Learning Attitude Scale for Higher Education. Paper presented at the X World Conference on Computers in Education, Toruń, Poland.

[12] Koç, Mustafa. (2005). Implications of Learning Theories for Effective Technology Integration and Pre-service Teacher Training: A Critical Literature Review. Journal of Turkish Science Education, 2(1), 2-18.

[13] Kothari, C. R. (2004). Research Methodology: Methods and Techniques: New Age International Publishers.

[14] Kubiatko, M., & Haláková, Z.. (2009). Slovak High School Students' Attitudes to ICT Using in Biology Lesson. Computers in Human Behavior 25, 743–748.

[15] Kyriakidou, Maria, Chrisostomou, Charalambos, & Banks, Frank. (1999). Primary Teachers' Attitude to the Use of ICT: a comparative study between Cyprus and the UK. Paper presented at the the European Conference on Educational Research, Lahti, Finland

[16] Lim, Tina, Fadzil, Mansor, & Mansor, Norziati. (2011). Mobile Learning via SMS at Open University Malaysia: Equitable, Effective, and Sustainable.. International Review of Research in Open and Distance Learning, 12(2), 122-137.

[17] Look, D. (2005). Discussion Paper: Impact of Technology on Education: PUSD Excellence Committee.

[18] Mai, M. Y. (2014). Pre Servıce Teachers ' Perceptıons Towards The Usage of Mobıle Learnıng in Hıgher Educatıon in Malaysıa, 5(19), 257–264.

[19] Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. Teachers College Record, 108(6), 1017–1054. doi:10. 1111/j. 1467-9620. 2006. 00684. x

[20] Palak, Deniz, & Walls, Richard T. (2009). Teachers' beliefs and technology practices: A mixed-methods approach. Journal of Research on Technology in Education, 41(4), 417–441.

[21] Raman, A. (2014). TPACK Confidence of Pre-Service Teachers in Universiti Utara Malaysia. Mediterranean Journal of Social Sciences, 5(22), 167–175. doi:10. 5901/mjss. 2014. v5n22p167

[22] Rashid, Adnan Abd. (2011). The Utilization of Information and Communication Technology among Islamic Secondary School Teachers in Malaysia. Sosiohumanika, 4(2), 145-158.

[23] Roig-Vila, R., Mengual-Abdres, S., & Quinto-Medrano, P. (2015). Primary Teachers ' Technological, Pedagogical and Content Knowledge. Media Education Research Journal, 23(45), 151–159. doi:10. 3916/C45-2015-16

[24] Sim, Janice CH, & Theng, Lau Bee. (2014). Teachers' perceptions of the use of ICT as an instructional tool in Mathematics and Science. Retrieved 2/6/2014, 2014, from https://www. google. com. my/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0CC0QFjAA&url=http%3A%2F%2Fictl. intimal. edu. my%2Fictl2007%2Fproceeding%2FFull_Paper%2F1A-03-Paper%252069%2520(Malaysia). pdf&ei=R5CMU9aeCZPn8AX2vIDwDQ&usg=AFQjCNFaQnzrsHB8dbqt8fVJpIqtqd9W4w&sig2=FIySeO2caUCIvp80cVwHNg

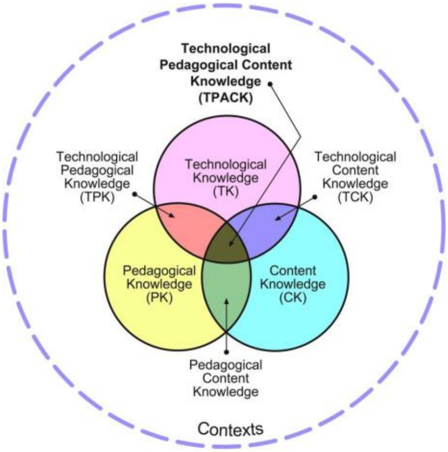
[25] Schmidt, D. a., Baran, E., Thompson, A. D., Koehler, M. J., Shin, T. S., & Mishra, P. (2009). Technological Pedagogical Content Knowledge (TPACK): The Development and Validation of an Assessment Instrument for Preservice Teachers. Journal of Research on Technology in Education, 42(2), 123–149. doi:10. 1007/978-1-60761-303-9

[26] Tam, Maureen. (2000). Constructivism, Instructional Design, and Technology: Implications for Transforming Distance Learning. Educational Technology & Society 3(2).

[27] Taylor, L., & Parsons, J.. (2011). Improving Student Engagement. Current Issues in Education, 14(1), 1-32.

[28] Teo, Timothy. (2008). Pre-service teachers' attitudes towards computer use: A Singapore survey. Australasian Journal of Educational Technology, 24(4), 413-424.

[29] Yapici, İ. Umit, & Hevedanli, Murat. (2012). Pre-Service Biology Teachers' Attitudes towards ICT Using In Biology Teaching. Procedia - Social and Behavioral Sciences 64 633 – 638. doi: 10. 1016/j. sbspro. 2012. 11. 074



TPACK framework (Mishra & Koehler, 2006)

Table 1: Summary of descriptive statistics for subscales of TPACK

Subscale	Mean	% of Mean	Std. Deviation
Technology Knowledge (TK)	4. 072	81. 4%	. 503
Pedagogy Knowledge (PK)	3. 911	78. 2%	. 558
Content Knowledge (CK)	3. 939	78. 8%	. 507
Technology Pedagogical Knowledge (TPK)	4. 064	81. 3%	. 554
Technological Content Knowledge (TCK)	3. 975	79. 5%	. 496
Pedagogical Content Knowledge (PCK)	3. 793	75. 9%	. 604
Technological Pedagogical and Content Knowledge (TPACK)	3. 826	76. 5%	. 441

Table 2: Correlations among TPACK subscales

	TK	PK	CK	TPK	PCK	TCK	TPACK
TK	1	. 334**	. 496**	. 528**	. 300**	. 666**	. 619**
PK	. 334**	1	. 603**	. 533**	. 783**	. 211*	. 477**
CK	. 496**	. 603**	1	. 505**	. 440**	. 357**	. 638**
TPK	. 528**	. 533**	. 505**	1	. 540**	. 420**	. 637**
PCK	. 300**	. 783**	. 440**	. 540**	1	. 239**	. 415**
TCK	. 666**	. 211*	. 357**	. 420**	. 239**	1	. 652**
TPACK	. 619**	. 477**	. 638**	. 637**	. 415**	. 652**	1

*. Correlation is significant at the 0. 05 level (2-tailed).

**. Correlation is significant at the 0. 01 level (2-tailed).

Table 3: Results of independent sample T-Test between Males and Females

	Mean Female	Mean Male	Std. Dev. Female	Std. Dev. Male	t-value	df	p
TK	4. 073	4. 072	0. 503	0. 508	0. 010	131	0. 992
PK	3. 896	3. 927	0. 506	0. 611	-0. 322	131	0. 748
CK	3. 915	3. 962	0. 488	0. 529	-0. 530	131	0. 597
TPK	4. 039	4. 090	0. 570	0. 541	-0. 530	131	0. 597
PCK	3. 974	3. 976	0. 490	0. 505	-0. 021	131	0. 984
TCK	3. 761	3. 826	0. 625	0. 585	-0. 615	131	0. 540
TPACK	3. 782	3. 870	0. 463	0. 416	-1. 148	131	0. 253

Table 4: Results of independent sample T-Test according to teachers' qualification

	Mean	Mean	Std. Dev.	Std. Dev.	t-value	df	p
	Degree	Master	Degree	Master			
TK	4. 073	4. 069	0. 494	0. 536	0. 048	131	0. 962
PK	3. 985	3. 696	0. 483	0. 700	2. 661	131	0. 009
CK	3. 976	3. 828	0. 479	0. 575	1. 475	131	0. 143
TPK	4. 136	3. 855	0. 540	0. 549	2. 598	131	0. 010
PCK	4. 029	3. 819	0. 423	0. 646	2. 156	131	0. 033
TCK	3. 803	3. 765	0. 593	0. 645	0. 318	131	0. 751
TPACK	3. 857	3. 735	0. 437	0. 445	1. 389	131	0. 167

Table 5: Results of ANOVA

	Between Groups			Within Groups				
	SS Effect	df Effect	MS Effect	SS Error	df Error	MS Error	F	p
TK	0. 427	2	0. 214	33. 004	130	0. 254	0. 842	0. 433
PK	1. 701	2	0. 850	39. 441	130	0. 303	2. 803	0. 064
CK	0. 091	2	0. 046	33. 824	130	0. 260	0. 175	0. 839
TPK	0. 697	2	0. 348	39. 843	130	0. 306	1. 137	0. 324
PCK	0. 410	2	0. 205	32. 019	130	0. 246	0. 831	0. 438
TCK	0. 662	2	0. 331	47. 527	130	0. 366	0. 906	0. 407
TPACK	0. 473	2	0. 236	25. 160	130	0. 194	1. 221	0. 298