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Pre-service Science Teachers' Motivational Factors associated Technology Integration Competency: An Exploration of TPACK Confidence and Beliefs about Technology in Education

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Abstract

Background: Technological pedagogical and content knowledge (TPACK) is critical for effective teaching with technology, and TPACK has been considered in recent years as a theoretical framework for pre-service teacher preparation improvement. *Purpose:* The purpose of this study was to explore current status of pre-service science teachers' TPACK confidence and their beliefs about technology in education, and examine the relationship between those factors. *Methods:* The participants were 74 pre-service science teachers, who were in their final year before school internship, studying in science teacher education program at a public university located in Northeastern region of Thailand. They were explored TPACK confidence and beliefs about technology in education by using 5-points rating scale questionnaires. *Results:* The highest mean scores were 4.01 and 3.96 on TPK and TPACK, respectively, and the lowest mean scores were 3.54 and 3.66 on CK and TCK, respectively. These results indicated that pre-service science teachers had highly confidence to use technology in their instruction, but they showed lowly confidence in their knowledge related to science content. In term of their beliefs about technology in education, the highest scores were 3.88, 3.46, and 3.37 on measured dimensions of technology as educational process, technology as integrating tool in education, and technology as teaching and learning tools, respectively. The result indicated that pre-service science teacher sensed that technology plays a critical role in educational reform more than just acting as supporting tools in instructional process. In addition, there were some degrees of relationship among their TPACK confidence, particularly by PK, and belief about technology in education. The highest correlations were between TPACK and technology as educational process (r=.489) and TPK and

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technology as educational process (r=.440). *Implication:* Several implications and recommendations are derived and discussed in this study regarding their' TPACK confidence and their belief about technology in education.

Keywords: Digital technology, Technology integration, Pre-service teachers, Teaching confidence, Teaching beliefs,

Introduction

For today's world, technology is a ubiquitous part of children's lives. In order to facilitate new-generation learners' development of 21st century skills for today's living, there is a critical call for technology integration into school curriculum and their learning experience in classes. To better prepare leaners for the science and technology of the 21st century, the current reforms of science education worldwide ask science teachers to be able to integrate digital technologies and inquiry-based pedagogies into their instruction (American Association for the Advancement of Science [AAAS], 1993; National Research Council [NRC], 2000). To promote the better quality of learning experience in school science, many new instructional technology tools are prevalently available for science teachers that can help students actively engage in the acquisition of scientific knowledge and development of the nature of science and inquiry. When technological tools are used pedagogically, moreover, in science classrooms, students actively engage in their knowledge construction and improve their scientific thinking and abilities to solve problems (Trowbridge, Bybee, & Powell, 2008). As such, technology integration is most commonly associated with professional development opportunities.

The rapid advancement of technology has created new expectations for today's science teachers. The numerous studies indicated that technologies were applied to support their teaching and supporting to transform content easier. Therefore, technological and pedagogical skills are crucial factors for high-quality science teacher in twenty-first century (Srisawasdi, 2014; Srisawasdi, Pondee, & Bunterm, 2016.). In context of teacher education, pre-service teachers' professional learning is a significant component of the process of becoming a qualified teacher and considered an important indicator of the professional teacher in future. To achieve high-quality pre-service science teacher, high confidence in teaching practice and belief in education are important factors related to pre-service teacher development. However, only a limited investigation of the motivational basis for pre-service science teacher learning has been done, Thus, the motivational factors, such as confidence and belief, should be investigated from the pre-service science teachers' perspectives, in order to design better preparation process for the future science teachers. In this study, the researchers explore pre-service science teachers' technological pedagogical and content knowledge (TPACK) confidence and beliefs about information and communication technology (ICT) in education. Seventy-four third-year pre-service science teachers has been included into the survey. A 46-items five-point Likert-scale questionnaire was used to explore their confidence and belief. The results of

this study will be used as a basis for the next study in order to prepare pre-service science teachers' TPACK comprehension, TPACK confidence, and belief about ICT in education.

Research Questions

The current study aims to examine pre-service science teachers' TPACK confidence and their beliefs about ICT or digital technology in education from a public university in Thailand. Accordingly, it assesses also how well the teacher education program has prepared future science teacher for their future professional career in terms of technological integration readiness and potential as future teachers in digital era. Therefore, the guiding research questions in this study are follows.

1) How are current pre-service science teachers' confidence to teach science content with technology integration regarding TPACK?
2) How are current pre-service science teachers' beliefs about roles of technology in education?
3) Is there any relationship between their TPACK confidence and beliefs about technology in education?

Significance and Purposes of the Study

In response to the reforms for achieving better quality of education, Thailand like other countries underscores the critical need for teacher preparation programs to reflect the current teacher education development and emergency need educate youths with instructional perspectives of today's classrooms. The current teacher education reform requires a high quality agenda for Thai teachers to acquires and possess essential knowledge and competences in technological integration to transform students' learning and development.

To the current situation in Thailand, many teacher education programs in universities were designed based on Shulman's (1986) pedagogical content knowledge (PCK) framework. Therefore, the focus of these programs is mainly based on the appropriate pedagogies associated with specific content. The introduction of ICT or digital technology, however, is usually through one or two educational courses that are considered to be theoretical and general in educational technology field. Moreover, the courses emphasized the learning of technical knowledge about the software and hardware or features of digital technologies in a surface level. The previous researches mentioned that many pre-service teachers are not adequately prepared to integrate ICT or digital technology in their classrooms (Bakir 2015; Saltan, Arslan, & Wang, 2017). In addition, Martin (2015) reported that most of teacher preparation programs are skill-focused technology courses, rather than technology-infused pedagogy curriculum. In an alignment with current technology-enhanced learning views, teacher preparation programs are expected to prepare pre-service teacher to integrate digital technology with instruction in meaningful ways to enhance better learning for students (Srisawasdi, 2014; Srisawasdi, Pondee, & Bunterm, 2016). To gain better process for preparing new-coming

teacher, Estes and Dailey-Hebert (2018) suggested that pre-service teachers' preparation coursework must include modeling by faculty, opportunities to practice integration through course assignments, and observing technology integration being implemented in actual classrooms.

According to the mentioned reason, it is important to examine what are pre-service teachers' beliefs about ICT or digital technology in education, and how teacher education programs influence pre-service teachers' confidence for using ICT or digital technology in their future classrooms. Moreover, it is important to move beyond PCK and draw upon the more contemporary conceptualization of TPACK, and a better way is to examine current existing of pre-service teachers' TPACK resulting by teacher preparation programs. A growing body of literature supports usage of the TPACK framework for designing teacher education programs and preparing future teachers for integrating technological tools in facilitating student learning (Finger, Jamieson-Proctor, & Grimbeek, 2013; Thomas et al. 2013; Lee, Smith, & Bos, 2014; Martin, 2015; Srisawasdi, 2014; Srisawasdi, Pondee, & Bunterm, 2016). Particularly, in light of the current initiatives of the Ministry of Education in Thailand to reform all teacher education preparation programs, as well as the necessity to reform these programs to match the competencies required for teachers of the current century by using TPACK as a crucial teacher education framework.

The current study aims to examine pre-service science teachers' TPACK confidence and their beliefs about technology in education from a public university in Thailand. Accordingly, it assesses also how well the teacher education program has prepared future science teacher for their future professional career in terms of technological integration readiness and potential as future teachers in digital era. According to the guiding research questions as abovementioned, the research purposes of this study are follows.

1) To explore current status of pre-service science teachers' TPACK confidence.
2) To explore current status of pre-service science teachers' beliefs about technology in education.
3) To examine the relationship between TPACK confidence and their beliefs about technology in education for pre-service science teachers.

The results of study provide insights for teacher educators, educational researchers, and decision-makers on the level of the TPACK confidence and readiness of pre-service science teachers, which is an essential quality for their professional teaching and learning in the twenty-first century. Drawing on these results, this study highlights future perspectives and recommendations for higher education policy-makers in Thailand.

General Context of Science Teacher Education in Thailand

Srisawasdi and Panjaburee (2014) described a general context of science teacher education in Thailand that there are two main pre-service science teacher education programs. First, the 5-year undergraduate degree program\, known as the Bachelor's degree of Education (B.Ed.) program, is the program which offer candidates the choice of teaching at either the primary or secondary levels of science

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education. In addition, the 5-year preservice science teachers have to enroll in all compulsory coursework for four years and then complete one-year school internship. Another pre-service program is 2-year postgraduate Master of Education (M.Ed.) for teaching at the upper secondary education level for those who already possess at least a Bachelor's degree of Science (B.Sc.), called The Promotion of Science and Mathematics Talented Teachers (PMST) program. For this program, the preservice teacher have to enroll in all compulsory coursework in two or three semesters for one year and then complete one year of school internship and also conduct their Master's degree theses at the same time. For a conclusion, both kinds of science teacher preparation programs are not only a developmental progression of science teacher education development in context of Thailand, but also essential parts to respond the call for better quality of science teachers in the country. Particularly, a call for advancing the practice of science teacher education development should be addressed to equip future science teacher in 21st century to be able to pedagogically and meaningfully integrate digital technologies into the teaching of specific and proper science contents. To response that point, there is a requirement for TPACK development in pre-service science teacher to promote their comprehensive uses of technologies in order to develop students' proficiency in 21st century skills and also support innovative teaching and learning in science (Srisawasdi, 2014).

Literature Reviews

Pre-service Teacher Education

The current worldwide teacher preparation and teacher professional development researches mentioned that teacher quality is a critical factor for achieving quality learning outcomes for students. In term of development of teacher preparation, today's teacher education programs should provide pre-service teachers with ample preparation in shifting instructional approaches enriched with innovative educational technologies (Martin, 2015). To promote the better development, Martin (2015) also suggested that teacher preparation programs need to embrace the shift from skill-focused technology courses to technology-infused pedagogy curriculum. However, educational researchers reported problematic issues that teacher education programs in tertiary institutions have not prepared pre-service teacher with this view of utilizing digital technologies for teaching and learning (Niess, 2012). Moreover, policy makers and governments invest considerably in digital technologies in education, however, both pre-service and in-service teachers do not have sufficient competencies to integrate these technologies in teaching and learning process (Saltan, Arslan, & Wang, 2017). In term of teacher preparation research, several studies have explored early-career teachers or pre-service teachers in relation to technology integration capabilities. Agyei and Voogt (2012), and Martin (2015) reported that pre-service teachers generally have sufficient basic technological skills, but they are less confident and lack of technological pedagogical knowledge on how to incorporate digital technologies for teaching and learning in meaningful way. Martin (2015) mentioned that pre-service teachers were needed to be focused on developing technology integration competency

on how to apply technologies to enhance learning rather than how students can learn from technologies. To promote their competent to apply technologies, the more of their interest, motivation, and confidence are the key to improve pedagogical application of technologies (Hersh, 2013; Jamieson-Proctor, Finger, & Albion, 2010; Niess, 2012). For this purpose, the TPACK framework (Mishra & Koehler, 2006) has been argued in the literature to enhance technology integration capabilities of pre-service science teachers in order to enhance students' learning outcomes, and TPACK is discussed in the following section.

Technological Pedagogical and Content Knowledge (TPACK)

Shulman's viewpoint about teacher education that shifted the requirements of qualified teachers was not only responsible content and pedagogical knowledge but also being an expert crossing of both such as pedagogical content knowledge (PCK). In 2006, Mishra and Koehler advised to add technology into Shulman's framework. They mentioned that technology cannot be divided from PCK, so they proposed TPACK framework. This framework is designed for defining teachers' competence to harmonize technology into the curriculum (Bostancıoğlu & Handley, 2018). Their framework based on evidence which teaching deeply complicated activities that depend on numerous types of knowledge (Mishra and Koehler, 2006)

Shulman established PCK framework that presented fruitful teachers combining content knowledge with pedagogical knowledge in their instructing as shows in Figure 1. The content and pedagogical knowledge are independently considered and a crossing area of pedagogical content knowledge illustrated in Figure 1.

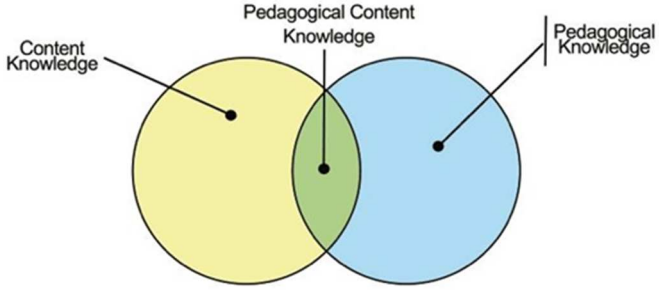

Figure 1. Pedagogical Content Knowledge (PCK) framework

Mishra and Koehler (2006) expanded the aspect of technological knowledge into Shulman's (1986) framework. There were seven components such as content knowledge (CK), pedagogical knowledge (PK), and technological knowledge (TK), pedagogical content knowledge (PCK), technological content knowledge (TCK), technological pedagogical knowledge (TPK), and technological pedagogical and content knowledge (TPACK), as displays in Figure 2. The detail of seven components of TPACK is as follows.

1. Content Knowledge (CK) as knowledge of subject matter
2. Pedagogical Knowledge (PK) as knowledge of teaching methods

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3. Technological Knowledge (TK) as knowledge of adapt technological tool
4. Pedagogical Content Knowledge (PCK) as knowledge of using agreeable teaching method to subject matter
5. Technological Content Knowledge (TCK) as knowledge of transforming subject matter with technology
6. Technological Pedagogical Knowledge (TPK) as knowledge of using appropriate technology to apply in teaching method
7. Technological Pedagogical and Content Knowledge (TPACK) as knowledge of promoting students' learning about specific content via convenient pedagogy and technology

Figure 2 illustrated there three main knowledge which are essential knowledge for teaching. Mishra and Koehler focused on usefulness of exploit on spread technological abilities. TPACK can foster students' learning, affect to more interesting and students can receive equal opportunities. Moreover, teachers may be commit professional development (Malik, Rohendi, & Widiaty, 2019).

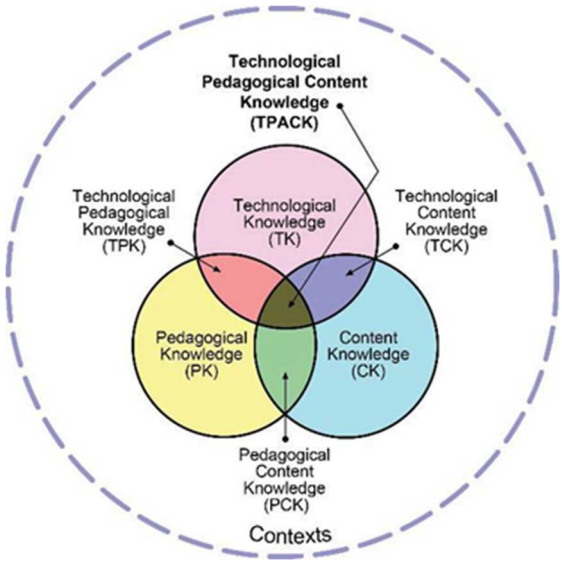

Figure 2. Technological Pedagogical and Content Knowledge (TPACK) Framework

TPACK and Pre-service Science Teacher Education

The application of information and communication technology or digital technology in instruction is highly emphasized in the contemporary education of science teachers (Lin et al., 2013), and the idea of Technological Pedagogical and Content Knowledge (TPACK) has emerged as a theoretical framework that has attracted much attention in recent years for science teacher educators. TPACK is currently an important fundamental framework in community of research and practice for educational research, especially in teacher education (Chai, Koh, & Tsai, 2010; Jimoyiannis, 2010; Srisawasdi, 2014). To promote competency in using technologies to the teaching of specific science content, the epistemology of TPACK is used as a

basis for designing a particular arrangement of courses for science teacher preparation programs (Srisawasdi, 2014). In context of current science teacher education, science teacher educators have broadly reached the consensus that emerging technologies have a great impact on learning and teaching of science (Lee et al., 2011). successful science teachers are likely those teachers who can develop proper teaching strategies and representations of science knowledge to accomplish fruitful teaching with supports of technologies (Lin et al., 2013). In this light for science teacher education, both pre-service and in-service science teachers are targeted to improve teaching proficiency based on the implementation of TPACK in many kinds of instructional intervention, i.e. coursework (e.g. Niess, 2005; Jimoyiannis, 2010; Jang & Chen, 2010; Srisawasdi, 2014; Srisawasdi, Pondee, & Bunterm, 2016), training (e.g. Guzey & Roehring, 2009; Alayyar, Fisser, & Voogt, 2012), and workshop (e.g. Annetta et al., 2013). As such, it is clearly that the development of science teacher education program regarding TPACK framework is an important in order to prepare and cultivate pre-service science teacher for gaining high-quality teaching competencies by integrating technologies into their school science teaching practice.

Methods

Participants

The participants were 74 pre-service science teachers, who were in their final year before school internship, enrolled in a 3-credit pedagogical course studying in science teacher education program at a public university located in Northeastern region of Thailand. There were 59 females (79.7%), and 15 males (20.3%), and they were aged between 21 to 23 years old. The participants have satisfied basic technology skills, but all of them have never had any experience of adopting digital technologies in science instruction before. In addition, they have also never had science instruction experiences in schools.

Instruments and Data Collection

To acquire information of from the pre-service science teachers, a 25 items of Likert-type rating scale questionnaire of TPACK confidence adapted from Schmidt et al. (2009), and a 21 items of Likert-type rating scale questionnaire of beliefs about technology in education obtained from Jimoyiannis and Komis (2007) were administered to the participants in 25-30 minutes. Both instrument were 5-points rating scales that ranked from “strongly disagree” to “strongly agree”. Based on Schmidt et al. (2009), the Cronbach’s alpha internal consistencies of TPACK confidence questionnaire were as follows: CK (0.82), PK (0.84), TK (0.82), PCK (0.85), TCK (0.80), TPK (0.86), and TPACK (0.92), and this survey instrument was designed with a specific purpose for examining preservice teachers' development of TPACK. For the Jimoyiannis and Komis (2007)’s questionnaire, the survey questionnaire was used to measure in three dimensions consisting (i) beliefs and perceptions about ICT as a teaching and learning tool, (ii) beliefs about ICT integration in educational

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practice, and (iii) perceptions and beliefs about the impact of ICT on the role of the school, the teacher and educational media.

Analysis of Data

The statistical techniques for analyzing were descriptive statistics to investigate pre-service science teachers' TPACK confidence, and their beliefs about technology in education and Pearson correlation to investigate the relation between their TPACK confidence and beliefs about technology in education.

Results and Discussion

Results

1) Pre-service science teachers' TPACK confidence

The mean scores for pre-service teachers' TPACK confidence on four sub-scales are given in Table 1. Mean scores for TPK followed by TPACK, and PCK were mean scores of 4.01, 3.96 and 3.82. A graphical representation of Table 1 is provided in Figure 3, which allows us to see confidence change of pre-service science teachers.

Table 1.

Mean scores and standard deviations of TPACK confidence

Component of TPACK	Mean	S.D.
Content Knowledge (CK)	3.54	0.60
Pedagogical Knowledge (PK)	3.79	0.58
Technological Knowledge (TK)	3.81	0.66
Pedagogical Content Knowledge (PCK)	3.82	0.48
Technological Content Knowledge (TCK)	3.66	0.58
Technological Pedagogical Knowledge (TPK)	4.01	0.52
Technological Pedagogical Content Knowledge (TPCK)	3.96	0.57

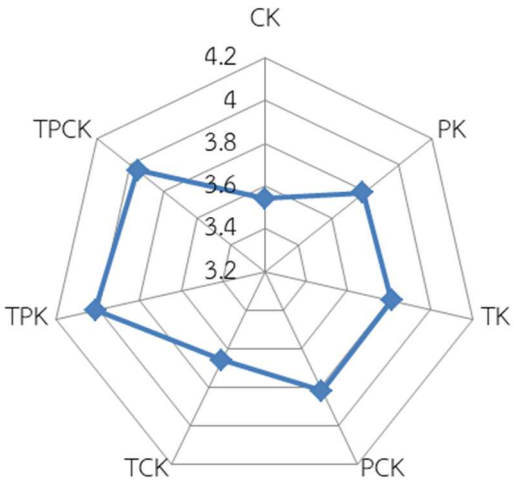

Figure 3. Graphical representation of mean scores of TPACK Confidence

2) Pre-service Science Teachers' Beliefs about Technology in Education

Table 2 illustrated the majority of the pre-service science teachers who believed that technology as educational process (Mean = 3.88). The second investigation of the pre-service science teachers' beliefs about technology in education as technology integration in education (Mean = 3.46). Lastly, they believed that technology was a teaching tool (Mean = 3.37). These findings indicated that they believed that technology was used to integrate in education. A graphical representation of Table 2 presented in Figure 5, which allows us to see change of beliefs in technology in education change of pre-service science teachers.

Table 2.

Mean scores and standard deviations of beliefs about ICT in education

Component of Belief about Technology in education	Mean	S.D.
Technology as teaching and learning tool	3.37	0.86
Technology integration in education	3.46	0.86
Technology as educational process	3.88	0.70

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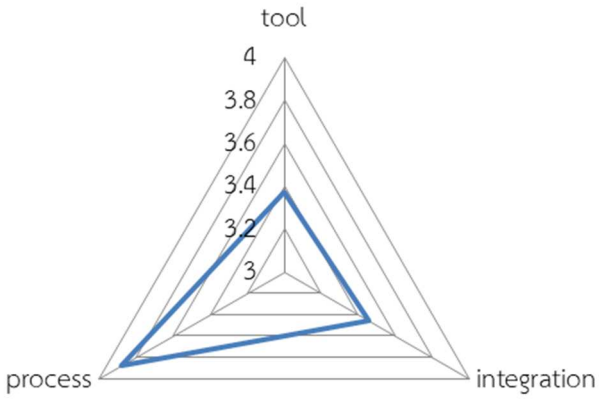

Figure 4. Graphical representation of mean scores of beliefs about ICT in education

3) Correlation between TPACK confidence and belief about technology in education

This study used Pearson correlation analysis to explore how the component of TPACK confidence and scales of beliefs about technology in education are related to each component. In order to find the association between TPACK confidence and beliefs in technology in education, Pearson correlation test was applied. The results showed that CK was positively correlated with Technology – process (r = 0.364, p = 0.01), while PK was positively correlated with Technology – tool (r = 0.254, p = 0.05), Technology – integration (r = 0.260, p = 0.05), and Technology – process (r = 0.349, p = 0.01). TCK was positively correlated with Technology – tool (r = 0.237, p = 0.05), and Technology – process (r = 0.266, p = 0.05). TPK was positively correlated with Technology – process (r = 0.440, p = 0.01). TPACK was positively correlated with Technology – integration (r= 0.308, p= 0.01), and Technology – process (r = 0.489, p = 0.01) (see Table 3). These results can be a guideline for the development and implementation of programs to prepare pre-service science teachers in which technology crucially impacts on their teaching. Thereby, the learning module might be emphasizes the following issues; PK, TCK, and TPACK.

Table 3.

Pearson Correlation Coefficients between TPACK confidence and Beliefs about ICT in Education

	CK	PK	TK	PCK	TCK	TPK	TPACK
Technology - tool	.213	.254*	.109	.031	.237*	.197	.189
Technology - integration	.226	.260*	.047	-.043	.222	.197	.308**
Technology - process	.364	.349**	.186	.071	.226*	.440**	.489**

Discussion

1) Pre-service science teachers' TPACK confidence

This finding is similar to the findings of Graham et al. (2009) who measured in-service teachers' confidence. The results indicated that the participants began and ended with the greatest level of confidence in their TK, followed by TPK, then TPACK, and finally TCK. This finding reinforces the idea that confidence in TK is foundational to developing confidence in the other forms. This makes sense if one believes that some basic technical awareness and skills are a perquisite to being able to meaningfully integrate technology into teaching. It also was not surprising that TPK scores were second highest since this kind of knowledge has often been taught both preservice and in-service trainings. In addition, these study consistent with Raman (2014) who measured the level of TPACK confidence of pre-service teachers from various program. The findings showed that the pre-service teachers have a high level of confidence. The findings showed that the pre-service teachers have a high level of competency, confidence and lastly TPACK. Lehiste (2015) examined the perceived development of in-service teachers' TPACK. The results from the end of the course showed that in-service teachers had the greatest level of confidence in their PK, following by TPK, and TPACK, but the lowest level of confidence in their TCK and CK. Karakaya and Avgin (2017) determined the TPACK self confidence level of physics, chemistry, biology and science teachers. Their study showed that teachers were self-confident greatly on dimension TPACK and TCK, they are self-confident pretty much on dimensions TPK and TK; however, these results showed difference from the research of Saltan and Arslan (2017) investigated and compared in-service and pre-service teachers' self-confidence on TPACK. Their results showed that both pre-service and in-service participants exhibited the highest self-confidence level in the TCK domain. While pre-service teachers had lowest scores in TPACK, in-service teachers had the lowest score in the TK domain. While pre-service mathematics teachers had significantly lowers TPACK than pre-service teachers and The Results of this study revealed that the pre-service science teachers had TPACK confidence as for how teaching and learning could be changed when particular technologies are used in particular ways. The results may suggest that the pre-service science teachers were confident regarding the use of technology for teaching. In order to increase the confidence of pre-service science teachers, different types of instructional activities might be presented to them by using technological tools in instruction and in teaching methods. Therefore, designing of learning module might be creating activities included technological tools to apply to their teaching.

2) Pre-service science teachers' beliefs about technology in education

These findings indicated that they believed that technology was used to integrate in education. A graphical representation of Table 2 presented in Figure 5, which allows us to see change of beliefs in technology in education change of pre-service science teachers. This finding is similar to the findings of Jimoyiannis and Komis (2007) who examined current teachers' beliefs and attitude toward technology in

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education. The results showed the great majority of the teachers perceive technology as a necessity in our modern society. The personal factors are strongly associated with the beliefs and perceptions teachers hold about technology in education. Likewise, these findings are similar to the findings of Mai (2015) which determined the science teachers' attitudes towards technology and using mobile learning in education. The results indicated that science teachers had a high level of knowledge about using mobile learning and technology in the learning process. These results indicated that science teacher believed in the importance of using technology and mobile in education and they asserted its usefulness of application in teaching and learning process. Moreover, the results of this study resembled with the research findings of Sulisworo et al. (2017). They found a realistic picture of the teaching-learning constraints for the use of technology especially those with certain beliefs in its use. The result showed that most physics teachers in Indonesia and Philippines believed that technology has many benefits to enhance learning. The supporting regulation from school management is needed to encourage teachers to use technology in their learning activities. Teachers believed and had awareness of the effect of technology on students' learning performance on certain subject.

3) Correlation between TPACK confidence and belief about technology in education

These results can be a guideline for the development and implementation of programs to prepare pre-service science teachers in which technology crucially impacts on their teaching. Thereby, the learning module might be emphasizes the following issues; PK, TCK, and TPACK. There are close similarities to Jimoyiannis and Komis (2006) who reported that the professional development pointed out pedagogical development about technology for teaching, technology application in education must be adequately justified to the teachers, in order to adopt them as effective tools for supporting teaching and learning processes. In addition, they suggested that teachers' training must be focused on life-durable technology skills combined with continuing technical and pedagogical support.

Conclusion

The finding of this study showed that the majority of pre-service science teachers had TPACK confidence on TPK and believed technology was educational process. In addition, the relationship among TPACK confidence, and beliefs about technology in education illustrated that PK related to all scales of beliefs about technology in education.

Limitations and Recommendations

Limitations

This study still has several limitations. Although the findings were framed in the literature on TPACK in pre-service teacher preparation, this study was, firstly, based on a survey study form a specific pre-service science teacher group. Therefore, the researchers should make it clear that the findings of this study should not be generalized to other pre-service science teacher groups, particularly in different pre-service science teacher preparation contexts. Secondly, another limitation of this study was about the sample population utilized. The research study only recruited pre-service science teachers from a specific science teacher education program at a small university that only offers one major of science education program. Other majors of science teacher education programs, such as physics education, chemistry education, biology education, should also be studied. Thirdly, the pre-service science teachers were investigated their TPACK confidence and beliefs about technology in education using quantitative method only. There should be emphasized in a balance between quantitative and qualitative methods in order to gain fully understand on their TPACK confidence and beliefs about technology in education.

Recommendations

Based on the results of this study it is evident that further research needs to be conducted in some areas. The results of this study have a practical implication for science teacher educators since the findings increase our understanding of pre-service science teachers' TPACK confidence and their beliefs about technology in education and these could provide fundamental information to reflect as a result of current science teacher preparation program regrading TPACK. Regarding pre-science science teachers' development of TPACK, it is clear that there needs to improve pedagogic technology integration comprehension for pre-service science teachers. In addition, the findings could be used as guideline on how to design technology-infused professional learning module or activity that assist to prepare and promote pre-service science teachers' improvement of TPACK and beliefs about technology in education. In the end, further research is needed to find the effects of participating in the technology-infused professional learning program in pre-service science teachers' development of TPACK and their beliefs.

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