The analysis of the relationship between epistemological beliefs and TPACK education competence among pre-service teachers

Erkan Efilti[1]
Ahmet Naci Çoklar[2]

Abstract

The purpose of the present research is defining TPACK education competence and epistemological beliefs of pre-service teachers, and presenting the relationship between TPACK education competence and epistemological belief. In accordance with this purpose, TPACK education competence scale and Epistemological Beliefs Questionnaire were conducted on 342 (222 female-65%, 120 male-35%) pre-service teachers studying senior year at Necmettin Erbakan University, Faculty of Education in 2012-2013 academic-year. According to the findings obtained from the present designed in quantitative method, pre-service teachers' epistemological belief scores are ranked as learning process-casting doubt on authority/expert knowledge, learning effort, innate/fixed ability, and certainty of knowledge. As for TPACK education competencies, pre-service teachers perceive themselves as advanced level. Another finding is that, gender is not an effective variable in terms of epistemological beliefs and TPACK education competencies among pre-service teachers. For the correlations between TPACK education competencies and epistemological beliefs among pre-service teachers, only learning process and doubt on expert knowledge factors are positively correlated with TPACK competencies at medium level. From this perspective, it can be claimed that TPACK education competencies are higher among pre-service teachers who tend to believe that acquiring knowledge process is important in learning.

Keywords: Epistemological Belief, TPACK, Pre-service Teachers.

Introduction

As the essential of life, technology has taken effect in education as in many other areas, and now technology is no longer a luxury. Technology use has become must especially with the policies on the Ministry of National Education (e-school, FATIH project, etc.). With the arrival of technology at schools, the expectations have increased from the teachers, who had to take part in this activity. The most important factor technology brought to this increase was the integration of technology. The integration of technology is defined as a process covering some variables, such as teaching program, teacher competencies and pedagogy (Tinio, 2003). For example, Kabadayi (2006) stated that the teachers tend to use mostly traditional teaching devices rather than high-techs.

As the integration of technology to education has become more important in recent years, there has been a change from technology oriented ICT education approaches towards pedagogy-

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[1] Assist. Prof. Dr., Necmettin Erbakan University, Ahmet Keleşoglu Education Faculty, Department of Special Education, eefilti@konya.edu.tr

[2] Assoc. Prof. Dr., Necmettin Erbakan University, Ahmet Keleşoglu Education Faculty, Department of Computer Education and Instructional Technologies, acoklar@konya.edu.tr

oriented approaches (Kabakçı-Yurdakul, et al., 2012). Technological Pedagogical Content Knowledge (TPACK) is one of these approaches.

TPACK model, coined by Koehler and Mishra (2005), refers to the combination of three disciplines; technology, pedagogy and content knowledge, and emphasizes the inter-disciplinary interaction (Koehler & Mishra, 2008; Koehler & Mishra, 2005). In general terms, TPACK is defined as unified knowledge that requires the association of pedagogy and technology knowledge in the process of teaching a content field (Schmidt, Baran, Thompson, Mishra, Koehler & Shin, 2009; Koehler & Mishra, 2008). In other words, this knowledge refers to a knowledge that is related to effective and efficient use of technology in order to increase the efficiency and quality of teaching of certain content, in the whole teaching process from planning to assessment.

TPACK model; consists of three main knowledge components as; "technological knowledge-TK" "content knowledge - CK" and "pedagogical knowledge -PK". Besides, structures, related to knowing what this knowledge is, and how learning occurs, are defined as epistemological beliefs in the literature. Epistemological beliefs reflect perspectives such as, what is knowledge?, how is it acquired?, is knowledge something occurring out of students and given by authorities?, what is the certainty level of knowledge?, and what are the limitations for knowledge? (Ravindran, Grene and Debacker, 2000; Hofer and Pintrich, 1997).

Epistemology, as known as the theory of knowledge, has been the subject of interest for philosophers as of the first ages. Epistemology is derived from the Greek words episteme (knowledge) and logos (science, explanation, theory), and is defined as the area of philosophy studying the nature, structure, source, origin, value, measures, and limits of knowledge (Pears, 2004; Denkel, 2003). It can be claimed that, the reasons for all decisions and behaviours of the individuals during their life times are their reasons (Hofer and Pintrich, 1997; Pajares, 1992). Both beliefs and knowledge are mental structures. The fundamental differences between them are the size of the area they cover and the way they are acquired. Both knowledge and beliefs consist of both cognitive and affective elements. However, the main element of knowledge is cognitive content organized in a systematic, consistent and logical way, while affective element is the main element of beliefs (Pajares, 1992). Perry (1981) defines epistemological beliefs as "an individual's opinions about what knowledge is, how it is acquired, the extent, limits and criteria of its certainty (Brownlee et al., 2001). William Perry (1968) tried to explain the intellectual development of individuals as the process of transition from dualistic thinking, which is a cognitive dimension, to contextual logic. Intellectual development, that is the process of interpretation of phenomena, is a cognitive filtering process from simple to complex. Therefore, individuals' establishing and interpreting their worlds are not directly related to their personality.

King and Kitchener, developed a staged development model called reflective judgement model, and claimed that epistemological belief development is a single-dimensional process occurring in seven different stages (King, 1977; King and Kitchener, 1994; Baxter Magolda, 1992). According to this model, each stage in the development process of epistemological beliefs comprises the development of logical theory patterns and suitable beliefs used to justify the beliefs.

Schommer (1989) argued that epistemological beliefs were so complex that they could not be degraded to one single dimension, and epistemological beliefs should be reconceptualised as a system of independent beliefs. Schommer (1989) tried to explain epistemological beliefs as five epistemological belief dimensions with values that should be considered partially independent from each other. These five dimensions are;

1. Structure (organization) of knowledge: It covers the area from where knowledge can be seen as clichés, to where knowledge is complex and integrated.
2. Certainty of knowledge: knowledge is certain and absolute.
3. Source of knowledge: Knowledge is handed down by authorities and knowledge is obtained from one authority.

4. Speed of learning: Covers a range from learning is quick or not-at-all to where learning is a gradual process.
5. Control of knowledge: The ability to learn is predetermined genetically, and cannot be acquired later.

Schommer developed a questionnaire in order to test the validity of these dimensions. The questionnaire consists of 63 5-point likert type items aimed at defining student beliefs about the nature of knowledge and learning. Factor analysis was conducted on the items of the questionnaire, and consequently four independent epistemological dimensions were obtained (Schommer, 1990). These are:

1. Fixed Ability: The individuals in this dimension perceive learning as a fixed and stable process, and believe that learning depends on innate abilities.
2. Quick Learning: According to the individuals in this dimension, learning occurs quickly, not gradually.
3. Simple Knowledge: The individuals in this dimension have open-minds about knowledge and they believe knowledge consists of interrelated concepts.
4. Certain Knowledge: Knowledge is absolute and unchanging for the individuals in this dimension.

The organization and certainty of knowledge define beliefs about the nature of belief, while speed and control define the nature of learning. Through her studies, Schommer (1994) changed epistemological beliefs from a single-dimension phenomenon to a multi-dimensional structure. Epistemological beliefs of teachers affect the way they conceptualize their teaching (Chan and Elliott, 2004).

Dirkx, Kielbaso and Smith (2004), who stated that computer technologies can be used in a way that enables constructivist practices that can stimulate high order thinking skills and problem-solving skills, transform students from knowledge consumers to knowledge processors and producers, reported in their study that teachers use technology to present content to students in a more effective way. Researchers found that teachers see computer technologies as a tool to make knowledge transfer more effective, faster and interesting. They concluded that although teachers tried or thought of trying different techniques and approaches for teaching and learning, all these trials were significantly affected from teachers' perceptions of knowledge, and they mostly designed knowledge with a perception that saw knowledge as something out of students and teachers as the transmitter of knowledge.

According to the findings of the researches, some of which are mentioned above, schools are now one of the indispensable fields of the use of technology, which is now a must rather than an option. These findings indicate that, one of the factors affecting the use of technology by teachers at schools, is teachers' epistemological beliefs.

Purpose of the Study

In this context, the purpose of the present research is analysing the epistemological beliefs and TPACK education competencies of pre-service teachers, and defining the relations between epistemological beliefs and TPACK education competencies. Accordingly, the answers to the following questions are sought;

1-What are the epistemological beliefs and TPACK education competencies of pre-service teachers?

2-Do epistemological beliefs and TPACK education competencies of pre-service teachers vary by gender?

3-Is there a significant correlation between epistemological beliefs and TPACK education competencies of pre-service teachers?

Methods

Research Design

The present research on the relationship between TPACK education competencies and epistemological beliefs of pre-service teachers is designed in survey model. Survey model is a research approach that aims at describing a case that existed in the past or still exists today, as it was/is (Frankel & Wallen, 2006).

Participants

The participants of the present research are 342 pre-service teachers, who studied their senior years at Necmettin Erbakan University Faculty of Education in 2012-2015 academic year. Of the participants, 222 (65%) were female, and 120 (35%) were male. Those senior year students took many courses from three different areas (professional teaching knowledge, field knowledge, and general knowledge), and also had teaching experience within the scope of teaching practice course.

Data Collection Tools

As data collection tools, Epistemological Beliefs Questionnaire and TPACK-Deep (Techno-pedagogical Education Competencies) Scale were utilized in the present research.

Epistemological beliefs of pre-service teachers were measured with "Epistemological Beliefs Questionnaire" which was developed by Schommer (1990) including 63 items, and later re-developed by Chan and Elliott (2002) including 30 items. The responses to the questionnaire are scaled on a 5-point likert type scale as, "1-totally disagree" to "5-totally agree". Epistemological Beliefs Questionnaire was adapted to Turkish by Aypay (2011). Epistemological Beliefs Questionnaire consists of four dimensions as; learning process-casting doubt on expert knowledge, innate/fixed ability, learning effort and certainty of knowledge. Aypay (2011) calculated the internal consistency coefficient of the questionnaire as .78.

The other data collection tool utilized in the present research was "Techno-pedagogical Education Competence Scale", developed by Kabakçı-Yurdakul et al., (2012). Like the Epistemological Beliefs Questionnaire, this scale is also scored on a 5-point likert type scale as "5-Can do easily" to "1-Can't do at all", and consists of 33 items. The scale has a four-factor structure; as design, exertion, ethics and proficiency. Kabakçı-Yurdakul et al., (2012) calculated the internal consistency coefficient of scale as .95, and test-retest coefficient as .80 (Kabakçı Yurdakul, Odabaşı, Kılıçer, Çoklar, Birinci & Kurt, 2012). On the other hand, the average score from the scale in 1-2.33 range is assessed as "low level", 2.34-3.67 range is assessed as "medium level", and 3.68-5.00 range is evaluated as "advanced level" (Kabakçı Yurdakul, 2011).

Data Analysis

First, collected data were tested for suitability for analysis, and the unsuitable data were excluded from the analysis. Collected data were transferred to computer and analysed on SPSS 17 (Statistical Package for the Social Sciences 17) program. For data analysis, besides descriptive statistics, independent samples t-test was conducted in order to define the variation by gender, Pearson Product-Moment Correlation was conducted to define the correlations between TPACK competencies and epistemological beliefs, and multiple regression analyses were conducted in order to find out the teaching styles predicting TPACK competencies.

Findings

Findings related to the Epistemological Beliefs of Pre-service Teachers
Participants' scores for each epistemological belief dimension are analyzed on descriptive statistics values. Obtained findings are presented in Table 1.

Table 1. Pre-service teachers' epistemological beliefs

	n	$\overline{X}$	Sd
Learning Process/Doubt on Expert Knowledge	342	3.83	.42
Learning Effort	342	3.61	.56
Innate/Fixed Ability	342	2.77	.73
Certainty of Knowledge	342	2.75	.71

As presented in Table 1, the dimension, which pre-service teachers have epistemological beliefs in most is learning process and doubt on expert knowledge ($\overline{X}$=3.83). This indicates that pre-service teachers see knowledge acquisition process and understanding the essence of the course more important than acquiring the knowledge, and need to ask for opinions of the experts of the field. The second dimension of highest rate is learning effort ($\overline{X}$=3.61), which includes the items referring that learning takes time and effort, little work means little learning. These two dimensions are followed by innate/fixed ability ($\overline{X}$=2.77) dimension, which includes the items referring that some abilities are innate, and certainty of knowledge ($\overline{X}$=2.75) dimension, which includes that items referring that scientific knowledge is absolute and unchanging. In other words, the epistemological belief that "learning process and doubt on expert knowledge" was the most adopted epistemological belief by pre-service teachers, while "certainty of knowledge" was the least.

The present research tested whether pre-service teachers' epistemological beliefs varied by gender. Independent samples t-test was conducted for that purpose, and the findings are presented in Table 2.

Table 2. Comparison of epistemological beliefs of pre-service teachers by gender

	Group	n	$\overline{X}$	sd	t	df	p
Learning Process/Doubt on Expert Knowledge	Female	222	3.84	.40	.450	340	.653
	Male	120	3.82	.45			
Innate/Fixed Ability	Female	222	2.75	.71	.438	340	.698
	Male	120	2.79	.74			
Learning Effort	Female	222	3.60	.55	.393	340	.695
	Male	120	3.63	.58			
Certainty of Knowledge	Female	222	2.70	.67	1.866	340	.063
	Male	120	2.85	.75			

p<.05

According to the findings presented in Table 2, the epistemological beliefs of pre-service teachers don't vary by gender at a significant level.

Findings related to the TPACK Education Competencies of Pre-service Teachers
The results of the analyses on the TPACK education competencies of pre-service teachers are presented in Table 3.

Table 3. Average scores for TPACK education competencies of pre-service teachers

	n	$\overline{X}$	sd
Design	342	3.84	.510
Exertion	342	3.78	.503
Ethics	342	3.76	.584
Proficiency	342	3.95	.545
TPACK competence	342	3.83	.490

As can be seen in Table 3, pre-service teachers' TPACK education competencies are "advanced level" ($\overline{X}$=3.83) in general. As for the factors of TPACK-Deep scale, pre-service teachers' average scores for all factors are in advanced level ($\overline{X}$>3.68) range (Table 3). Pre-service teachers got the highest average score in "Proficiency" factor ($\overline{X}$=3.95); and the lowest in "Ethics" factor ($\overline{X}$=3.76). The factors are ranked according to average scores as "Proficiency", "Design", "Exertion" and "Ethics".

The present research tested whether pre-service teachers' TPACK education competencies varied by gender and the findings are presented in Table 4.

Table 4. Comparison of TPACK competencies of pre-service teachers by gender

	Group	N	$\overline{X}$	sd	t	df	p
Design	Female	222	3.84	.483	.168	340	.867
	Male	120	3.83	.559			
Exertion	Female	222	3.79	.478	.255	340	.799
	Male	120	3.77	.547			
Ethics	Female	222	3.78	.559	.494	340	.622
	Male	120	3.74	.631			
Proficiency	Female	222	3.96	.507	.369	340	.713
	Male	120	3.93	.613			
TPACK competency	Female	222	3.83	.457	.312	340	.755
	Male	120	3.82	.548			

p<.05

Obtained findings show that pre-service teachers' TPACK education competencies and dimension don't vary by gender (Table 4).

Findings related to the Correlation between TPACK Education Competencies and Epistemological Beliefs of Pre-service Teachers
The present research tested whether there are significant correlations between 342 pre-service teachers' epistemological beliefs and TPACK education competencies. Related findings are presented in Table 5.

Table 5. Correlations between epistemological beliefs and TPACK education competencies

	Learning Process/Doubt on Expert Knowledge	Innate/Fixed Ability	Learning Effort	Certainty of Knowledge
TPACK competency	.329**	-.028	.057	-.076

**p<0.01.

There is a positive and medium level correlation (r=.329; p<.01) only between pre-service teachers' TPACK education competency and learning process and doubt on expert knowledge factor of epistemological beliefs (Table 5). On the other hand, TPACK education competency is almost not correlated with other epistemological belief factors, and these correlations are as; Innate/Fixed Ability (r=-.028; p>.01), Learning Effort (r=.057; p>.01), Certainty of Knowledge (r=-.076; p>.01). In other words, pre-service teachers' TPACK education competency has a medium correlation with learning process and doubt on expert knowledge factor, and very weak correlations with other factors.

The present research tested whether epistemological beliefs predict TPACK education competency with multiple regression analysis and the findings are presented in Table 6.

Table 6. Regression analysis for epistemological beliefs' predicting of TPACK education competency

Predictor Variables	B	Standard Error	β	t
Constant	2.424	.278		8.711
Learning Process/Doubt on Expert Knowledge	.398	.064	.345	6.204*
Innate/Fixed Ability	.044	.040	.066	1.091
Learning Effort	-.033	.050	-.038	-.666
Certainty of Knowledge	-.045	.043	-.064	-1.028
R=.338		R2=.114		F=10.859*

n=342; *p<0.01.

According to the results of multiple regression analysis, only learning process and doubt on expert knowledge dimension of epistemological beliefs predict TPACK education competencies of pre-service teachers [R=.338, R^2=.114, F=27.368, p<.01]. In other words, pre-service teachers' scores from learning process and doubt on expert knowledge dimension of epistemological beliefs questionnaire, adapted to Turkish by Aypay (2011), is a variable predicting TPACK education competency, and predicts the 11.4% of the variance of TPACK education competency.

Discussion and Conclusions
TPACK education, which approaches teachers' technology use from a different perspective, is a technology integration model, and emphasized the unity three different teacher competencies; content knowledge (CK), technology knowledge (TK), and pedagogical knowledge (PK) (Mishra and Koehler, 2006). Pre-service teachers, who get the education for these three fields at university, can have a multi-dimensional perspective of technology use. In this context, investigating the TPACK education competencies of pre-service teachers is the foundation of the present research. On the other hand, Kabadayi (2010) said that teacher qualifications significantly affect the quality of teaching beliefs and education. In line with this view, it was considered that epistemological beliefs, which represent the belief of how teaching occurs, might affect pre-service teachers' education competencies, and the correlations between TPACK education competencies and epistemological beliefs, and epistemological beliefs' predicting TPACK education competencies were also analysed. Previous studies on the epistemological beliefs show that epistemological beliefs affect education process, and performance, permanence and success (Qian and Alvermann, 2000; Schommer, Mau, Brookhart and Hutter, 2000).

Within the scope of the present research, pre-service teachers were asked how teaching occurred according to their epistemological beliefs, and according to their responses learning process and doubt on expert knowledge dimension was prominent. Accordingly, pre-service teachers tend to believe that knowledge acquisition process is important in learning, expert knowledge should be sought, and effort is important in learning. These findings are in agreement with the findings of similar researches in literature (Karataş and Erden, 2012; Topcu, 2011; Deryakulu, 2004). According to the findings, pre-service teachers are less prone to believing that students' abilities are innate and fixed, and knowledge is certain and unchanging. Accordingly, it can be claimed that pre-service teachers, who participated in the present research, have developed awareness on the role of process and effort in learning.

On the other hand, it was found that pre-service teachers consider their TPACK education competencies as advanced level with the sub-dimensions of design, exertion, ethics and proficiency. This finding indicates that pre-service teachers perceive themselves as competent in efficiently integration different technologies into the teaching-learning processes. Kabakci-Yurdakul (2011) also obtained similar results. Because the present research was conducted on senior year students, and these students took all the courses in the education program about the field knowledge, professional knowledge and technology use (Computer-I, Computer-II and Educational Technologies and Material Development) (Odabaşı and Gündüz, 2004), this finding is expected, and presents the importance of education given at faculties of education.

Some previous studies report that female teachers consider themselves competent more than male teachers in teaching competency (Kuh, Nelson Laird, & Umbach, 2004; Starbuck, 2003). Considering that, this might be a result of epistemological beliefs, the effect of gender on epistemological beliefs was analysed. However, the findings show that pre-service teachers' epistemological beliefs don't vary by gender. Tumkaya (2012) also reported similar findings, while Karataş and Erden (2012) stated that gender was an important factor for epistemological beliefs, this variable was affective only on the epistemological belief dimension that learning depends on effort, and not affective on other dimension. Cano (2005) also reports that gender is an important factor, besides experiences. In the present research, participants are distributed homogenously in terms of gender and departments, which might have prevented the variation by gender. Previous researches conducted on students from different levels of education report that there aren't significant differences between female and male students in terms of their beliefs about knowledge, while female students' beliefs about learning in other dimension are more developed than male students. Those findings were explained with gender roles in societies, and were interpreted as that female students might associate their achievement with effort, while male students might associate their achievement with their abilities (Neber and Schommer-Aikins, 2002; Schommer, 1993; Enman and Lupart, 2000).

The present research also investigated the effect of gender on TPACK education competencies, and found that gender was also not an important variable for TPACK competencies. Teo (2008) reported that male students considered themselves competent in TK-Technological Knowledge of TPACK competencies more than female students did. However, most of the researches on TPACK also found that gender was not an important factor in terms of TPACK competency (Koh, Chail and Tsai, 2014; Çuhadar, Bulbul & Ilgaz, 2013; Jang & Tsai, 2012; Koh & Sing, 2011). The participants of the present research were students studying at the same faculty, who got the same education on all areas of field knowledge, formation knowledge, and content knowledge, which form TPACK, which might have prevented the variation in TPACK education by gender. Another reason may be the similar access opportunities to information and communication technologies.

According to the findings obtained in the present research, there is a positive correlation between pre-service teachers' epistemological belief scores and TPACK education competencies, and learning process and doubt on expert knowledge factor of epistemological belief is a predictor of TPACK education competencies, and predict the 11% of the variance in TPACK competencies. Tsai (2002) and Chain and Elliot (2004) emphasized the importance of environment or upbringing culture in their studies on learning processes, and reported that some epistemological beliefs became prominent in learning theories based on traditional and constructivist theories. Pre-service teachers' upbringing culture and the education they got might have put forward the learning process and doubt on expert knowledge in TPACK competencies. On the other hand, the reviewed literature didn't present any studies directly on the relationship between TPACK and epistemological beliefs. However, some researches studied the relations between epistemological beliefs and TK, PK, and CK areas forming TPACK. Tsai, Tsai and Hwang (2011) report that teachers' Internet use and searching strategies on the Internet are related with epistemological beliefs. Kim et al. (2013) found that epistemological belief was an important parameter of technology integration. Accordingly, teachers' epistemological beliefs affect their technology use educational processes. Shifflet and Weilbacher (2015) report that, belief is among the factors that are important for technology use. On the other hand, there is also a relationship between pedagogical knowledge (PK) and epistemological beliefs (Chai, Khine and Teo, 2006; Gregoire-Gill, Ashton and Algina, 2004). In the literature, there are also some researches conducted to find out whether epistemological beliefs were related with content knowledge (CK), which analysed epistemological beliefs in terms the departments, students study at. These researches report that content knowledge is related with epistemological beliefs (Kazu and Erten, 2015; Er, 2013; Aypay, 2011). Review of the related studies in literature shows that epistemological beliefs are related with TK, PK, and CK dimensions of TPACK. Accordingly, the medium level correlation between epistemological beliefs and TPACK found in the present research is expected.

The present research found that pre-service teachers' TPACK education competencies are correlated with only learning process and doubt on expert knowledge dimension of epistemological beliefs. This finding may have resulted from the fact that TPACK education philosophy is learning process oriented. On the other hand, some limitations of the present research are that participants were per-service teachers, and they developed self-efficacy beliefs. It is suggested that a similar research is conducted on teachers and with different research methods to observe the situation in practice.

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