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The Effect of Different Metacognitive Skill Levels on Preservice Chemistry Teachers' Confidence in Technological Pedagogical Content Knowledge

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Abstract
The aim of the study was to determine the metacognitive skill levels of preservice chemistry teachers and to investigate the effect of different metacognitive skill levels on their confidence in technological pedagogical content knowledge. In the study, survey method which is one of the quantitative research methods was used to determine the effect of different metacognitive skill levels on confidence in technological pedagogical content knowledge. The study was conducted during 2015-2016 fall semester. A total of 75 preservice chemistry teachers participated in the study. The participants of the study were comprised of preservice chemistry teachers attending the Faculty of Education in a public university. As a data collection tool, The Metacognitive Activities Inventory (MCA-I) which was developed by Cooper and Sandi-Urena (2009) and adapted into Turkish by Temel, Dinçol and Yılmaz (2011) was applied to determine preservice chemistry teachers' metacognitive skill levels. Also, the Technological Pedagogical Content Knowledge Confidence Survey (TPACKCS) developed by Graham, Burgoyne, Cantrell, Smith, and Harris (2009) and adapted into Turkish by Timur and Taşar (2011) was used to determine preservice chemistry teachers' confidence in technological pedagogical content knowledge. Firstly, the data obtained from MCA-I was analyzed. Three groups were formed by using the grouping method developed by Cooper, Sandi-Urena and Stevens (2008). Then, one-way MANOVA test was employed in determining the effects of preservice chemistry teachers' metacognitive skill levels on their technological pedagogical content knowledge, technological pedagogical knowledge, technological content knowledge, and technological knowledge. At the end of the study, the obtained one-way MANOVA test results were presented and interpreted.

Key words: confidence, metacognitive skill levels, preservice chemistry teachers, technological pedagogical content knowledge

Introduction

One of the issues researchers have been questioning recently with advances in technology is how teachers can insert technological knowledge into the implementation of effective teaching (Doering, Veletsianos, Scharber, & Miller, 2009). According to Shulman

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(1987), effective teachers are those individuals who employ both content knowledge and pedagogical knowledge and who understand the correlations between the two. Yet, only technological knowledge is not sufficient for teachers to use technology effectively because technology- which guides effective teaching - is an intersection of pedagogical knowledge and content knowledge (Koehler & Mishra, 2008; Mishra & Koehler, 2006). Mishra and Koehler (2006) combines these three types of knowledge, and defines the combination as technological pedagogical content knowledge (TPACK). TPACK forms the basis of effective teaching. TPACK necessitates explaining concepts by using technology and understanding the knowledge about pedagogical techniques which include techniques used in teaching constructively, knowledge making learning concepts easy or difficult, how technology helps to solve the problems students encounter, how technology can be built on the basis of existing knowledge and can develop new epistemologies or how it can strengthen the previous epistemologies (Koehler & Mishra, 2008). Here, the importance of metacognitive skills is apparent. Metacognitive skills are generally such skills as being aware of the learning process, planning, selecting strategies, monitoring the process of learning, being able to correct mistakes, being able to check whether or not the strategies used work, and being able to change learning methods and strategies when necessary (Özsoy, 2006). Metacognitive teachers tend to use technological integration in their teaching and in students' learning. Also, they will be supposed by their content knowledge to evaluate and analyse websites and applications for appropriateness for teaching the content and assure that instruction facilitates student content knowledge. Also, metacognitive teacher is defined as teacher disposition. Because it is influenced by teachers' self-efficacy, beliefs about teaching as well as teachers' ability to reflect on an ongoing basis, monitor and evaluate instruction and students' learning. It seems more probable that teachers who believe that they have technological and content efficacy reflect, adjust and adapt their teaching according to need while trying to understand their students' needs and various pedagogical approaches which will help students to achieve their targets (Keengwe & Maxfield, 2015).

In the light of above mentioned issues, this study makes an attempt at investigating whether or not different metacognitive skills have any effects on technological pedagogical content knowledge by setting out from the importance of technological pedagogical content knowledge and of metacognitive skills in teachers' adapting the knowledge into their teaching. Since there are no studies researching these correlations in the literature, this study is thought to contribute considerably to the literature.

The aim of the study

The aim of the study was to determine the metacognitive skill levels of preservice chemistry teachers and to investigate the effect of different metacognitive skill levels on their confidence in technological pedagogical content knowledge.

Answers to the following questions were sought for the aim of the study:

(1) What is the level of preservice chemistry teachers' metacognitive skill?
(2) Are there any statistically significant differences between preservice chemistry teachers' confidence in technological pedagogical content knowledge according to different metacognitive skill levels?

Method

Research Model

In the study, survey method which is one of the quantitative research methods was used to determine the effect of different metacognitive skill levels on confidence in technological pedagogical content knowledge. (Fraenkel & Wallen, 2006).

Study Group

The study was conducted during 2015-2016 fall semester. A total of 75 preservice chemistry teachers participated in the study. The participants of the study were comprised of preservice chemistry teachers attending the Faculty of Education in a public university. Purposeful sampling method which is one of the non-random sampling approach was employed in collecting the participants.

Data Collection Tools

Metacognitive Activities Inventory (MCA-I)

MCAI is a 5-point Likert type instrument developed by Cooper and Sandi-Urena (2009) and adapted into Turkish by Temel, Dinçol and Yılmaz (2011), was used to assess preservice chemistry teachers' metacognitive skill levels. The inventory included 23 items. After the factor analysis, the calculated Cronbach's alpha coefficient for the whole questionnaire was .92.

Technological Pedagogical Content Knowledge Confidence Survey (TPACKCS)

The scale, which was developed by Graham et al. (2009) was adapted into Turkish by Timur and Taşar (2011). The findings concerning the construct validity of the scale were obtained through confirmatory factor analysis. The scale contained 31 items and four sub-dimensions. The Cronbach’s Alpha internal consistency coefficient for the sub-factors of the scale ranged between 0.86 and 0.89. The Cronbach’s Alpha internal consistency coefficient for the whole scale was calculated as 0.92. The sub-dimensions included in the scale were as in the following: Technological Pedagogical Content Knowledge (TPACK), Technological Pedagogical Knowledge (TPK), Technological Content Knowledge (TCK) and Technological Knowledge (TK).

Data Analysis

Descriptive statistics and one-way MANOVA were used in data analysis.

Findings

Firstly, it was tried to determine the metacognitive skill levels of preservice chemistry teachers. The data obtained from MCA-I were analysed. Three groups were formed by using the grouping method developed by Cooper, Sandi-Urena and Stevens (2008). Descriptive statistics for each group are shown in Table 1. As seen in the Table 1, there are 18 preservice chemistry teachers in the low group, 33 preservice chemistry teachers in the intermediate group, and 24 preservice chemistry teachers in the high group.

Table 1. Possible Metacognitive Skill Groups of Preservice Chemistry Teachers.

	Possible metacognitive skill groups	**N**
High group (H-Group)	Participants with scores above the mean score (3.72) plus one standard deviation (0,484)	24
Intermediate group (I-Group)	Intermediate group (I-Group) composed by those whose score is between these extremes	33
Low group (L-Group)	Participants below the mean value (3,72) minus one standard deviation (0,484)	18

Secondly, one-way MANOVA test was employed in determining the effect of different metacognitive skill levels on their technological pedagogical content knowledge, technological pedagogical knowledge, technological content knowledge, and technological knowledge. The one-way MANOVA analysis results demonstrated that preservice chemistry teachers' their technological pedagogical content knowledge, technological pedagogical knowledge, technological content knowledge, and technological knowledge differed significantly according to their levels of metacognitive skills $F(10, 136)=4,446$, $p=0,00$; Wilks Lambda (Λ)=0,568; Partial Eta Squared=0.2246. One-way MANOVA test results are shown in Table 2.

Table 2. MANOVA Follow-Up Pairwise Comparisons for Dependent Variables

Dependent Variable	Group	Mean	SD	df	F	Sig.	Partial Eta Squared
TPACK	H-Group	4,46	0,50	2	15,706	0,00	0,304
	I-Group	4,20	0,52				
	L-Group	3,57	0,53				
TPK	H-Group	4,59	0,42	2	13,045	0,00	0,266
	I-Group	4,13	0,47				
	L-Group	3,72	0,79				
TCK	H-Group	4,10	0,82	2	1,471	0,23	0,039
	I-Group	3,80	1,30				
	L-Group	3,50	1,18				
TK	H-Group	4,46	0,48	2	15,568	0,00	0,302
	I-Group	4,13	0,47				
	L-Group	3,56	0,64				

According to the dependent variable in Table 2, preservice chemistry teachers' technological pedagogical content knowledge scores (F(2,72)=15,706, p<,05, partial eta squared=,0304), Technological content knowledge scores (F(2,72)=13,045, p<,05, partial eta squared=,0266) and Technological knowledge (F(2,72)=15,568 p<,05, partial eta squared=,0302) differ significantly according to their levels of metacognitive skills. However, their technological pedagogical knowledge (F(2,72)=1,471, p>,05, partial eta squared=0,039) do not differ significantly according to their levels of metacognitive skills.

Table 3. Multiple Comparisons

Dependent Variable	Group	Group	Std. Error	Sig.
TPACK	H-Group	I-Group	0,13	0,20
		L-Group	0,16	0,00
	I-Group	H-Group	0,13	0,20
		L-Group	0,15	0,00
	L-Group	H-Group	0,16	0,00
		I-Group	0,15	0,00
TPK	H-Group	I-Group	0.14	0.007
		L-Group	0.17	0,00
	I-Group	H-Group	0.14	0,007
		L-Group	0.16	0,43
	L-Group	H-Group	0.17	0,00
		I-Group	0.16	0,43
TK	H-Group	I-Group	0,14	0.058
		L-Group	0,16	0.000
	I-Group	H-Group	0,14	0,058
		L-Group	0,15	0,001
	L-Group	H-Group	0,16	0.000
		I-Group	0,15	0,001

The Tukey HSD test results for the dependent variables of technological pedagogical content knowledge, technological pedagogical knowledge and technological knowledge are shown in Table 3. Post-hoc comparisons using the Tukey HSD test indicated that the mean score of technological pedagogical content knowledge for high group (M=4,46, SD=0,504) was significantly different from low group (M = 3,57, SD = 0,53). Also the mean score of technological pedagogical content knowledge for intermediate group (M=4,20, SD=0,52) was significantly different from low group (M = 3,57, SD = 0,53). The mean score of technological pedagogical knowledge for high group (M=4,59, SD=0,42) was significantly different from intermediate (M = 4,13, SD = 0,47) and low group (M=3,72, SD=0,79). The mean score of technological knowledge for low group (M=3,56, SD=0,64) was significantly different from intermediate (M = 4,13, SD = 0,47) and high group (M=4,46, SD=0,48).

Conclusions and Discussion

Firstly, it was tried to determine the metacognitive skill levels of preservice chemistry teachers. The data obtained from MCA-I were analysed. Three groups were formed by using the grouping method developed by Cooper, Sandi-Urena and Stevens (2008). As seen in the Table 1, there are 18 preservice chemistry teachers in the low group, 33 preservice chemistry teachers in the intermediate group, and 24 preservice chemistry teachers in the high group.

Secondly, one-way MANOVA test was employed in determining the effect of different metacognitive skill levels on their technological pedagogical content knowledge, technological pedagogical knowledge, technological content knowledge, and technological knowledge. The one-way MANOVA analysis results demonstrated that preservice chemistry teachers' technological pedagogical content knowledge, technological pedagogical knowledge, technological content knowledge, and technological knowledge differed significantly according to their levels of metacognitive skills $F(10, 136)=4,446$, $p=0,00$; Wilks Lambda $(\Lambda)=0,568$; Partial Eta Squared=0.2246. According to the dependent variable in Table 2, preservice chemistry teachers' technological pedagogical content knowledge scores ($F(2,72)=15,706$, $p<,05$, partial eta squared=,0304), Technological content knowledge scores ($F(2,72)=13,045$, $p<,05$, partial eta squared=,0266) and Technological knowledge ($F(2,72)=15,568$ $p<,05$, partial eta squared=,0302) differ significantly according to their levels of metacognitive skills. However, their technological pedagogical knowledge ($F(2,72)=1,471$, $p>,05$, partial eta squared=0,039) do not differ significantly according to their levels of metacognitive skills. According to post-hoc comparisons using the Tukey HSD test indicated that the mean score of technological pedagogical content knowledge for high group (M=4,46, SD=0,504) was significantly different from low group (M = 3,57, SD = 0,53). Also the mean score of technological pedagogical content knowledge for intermediate group (M=4,20, SD=0,52) was significantly different from low group (M = 3,57, SD = 0,53). The mean score of technological pedagogical knowledge for high group (M=4,59, SD=0,42) was significantly different from intermediate (M = 4,13, SD = 0,47) and low group (M=3,72, SD=0,79). The mean score of technological knowledge for low group (M=3,56, SD=0,64) was significantly different from intermediate (M = 4,13, SD = 0,47) and high group (M=4,46, SD=0,48).

An analysis of the results of the study shows that the technological pedagogical content knowledge sub-scale scores received by pre-service teachers in the group of high metacognition are significantly different from those in the group of low metacognition. This result seems to be in parallel to the idea put forward in Keenge & Maxfield (2015) that metacognitive teachers tend to integrate technology into their teaching and into students' learning. This study exhibits the importance of having metacognitive skills in integrating technological pedagogical content knowledge- one of the issues that researchers have been emphasizing lately- into teaching practice, and it is believed that the study will contribute to the literature substantially.

References

Cooper, M. M., & Sandi-Urena S. (2009). Design and validation of an instrument to assess metacognitive skilfulness in chemistry problem solving. *Journal of Chemical Education, 86*(2), 240-245.

Cooper, M. M., & Sandi-Urena S., Stevens, R. (2008). Reliable multi method assessment of metacognition use in chemistry problem solving, *Chemistry Education Research and Practice*, 9, 18–24.

Doering, A., Veletsianos, G., Scharber, C., & Miller, C. (2009). Using the technological, pedagogical, and content knowledge framework to design online learning environments and professional development. *Journal of Educational Computing Research, 41*(3), 319-346.

Fraenkel, J.R., & Wallen, N.E. (2006). *How to design and evaluate research in education*. New York: McGraw-Hill.

Graham, C. R., Burgoyne, N., Cantrell, P., Smith, L., St. Clair, L., & Harris, R. (2009). TPACK development in science teaching: Measuring the TPACK confidence of in-service science teachers, *TechTrends, Special Issue on TPACK, 53*(5), 70-79.

Keengwe, J., & Maxfield, M. (Eds.). (2015). *Advancing Higher Education with Mobile Learning Technologies: Cases, Trends, and Inquiry-Based Methods*. Hershey, PA: IGI Global.

Koehler, M.J., &Mishra, P. (2008). Introducing TPCK. AACTE Committee on Innovation and Technology (Ed.), *the handbook of technological pedagogical content knowledge (TPCK) for educators* (pp. 3-29). Mahwah, NJ: Lawrence Erlbaum Associates.

Mishra, P., & Koehler, M.J. (2006). Technological pedagogical content knowledge: A framework for integrating technology in teacher knowledge. *Teachers College Record, 108*(6), 1017-1054.

Özsoy, G. (2006). Problem çözme ve üstbilis [Problem solving and metacognitive]. *Ulusal Sınıf Ögretmenligi Kongresi Bildirileri [National Congress of Elementary Teaching]* (Ankara, Gazi University, May-2006). Ankara: Kök Publishing.

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

Temel, S., Dinçol, S., & Yılmaz, A. (2011). Metacognition und problemlösen [Metacognitive and problem solving]. *GDCh Wissenschaftsforum Chemie 2011*, Bremen.

Timur, B., & Taşar, M. F. (2011). The adaptation of the technological pedagogical content knowledge confidence survey into Turkish. *Gaziantep University Journal of Social Sciences*, *10*(2), 839 -856.