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Examining the effects of integrating technological pedagogical content knowledge into preschool teachers' professional development regarding science teaching: using digital game-based learning as an example

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Abstract: A common question emerges while applying the Technological Pedagogical Content Knowledge framework for teachers' preparation to integrate ICT into classroom teaching and learning: which type of knowledge (e.g., TK, CK, or PK) should be instructed first during the course? This study examined the effects of the technology- and pedagogy-oriented course design on improving the in-service preschool teachers' Technological Pedagogical Content Knowledge-Games (TPACK-G) as well as their acceptance of digital game-based learning. The participants were 49 in-service preschool teachers. They were assigned into a technology- and a pedagogy-oriented group. The results show that when integrating the TPACK-G framework into the preschool context, instructing game knowledge before pedagogy knowledge tended to raise the in-service teachers' competencies of game knowledge and game-pedagogical-content knowledge.

Keywords: TPACK, games, preschool, game-based learning

1. Introduction

With the greater accessibility of information technology in education, there is a growing emphasis on utilizing digital games (hereafter named games) to support teaching and learning. Games have the potential of engaging students in active and meaningful learning (Dickey, in press). However, harnessing this potential requires a framework to help teachers integrate games into their teaching. Hsu and Chai (2012) proposed a framework of Technological Pedagogical Content Knowledge-Games (TPACK-G). Developed from the ideas of TPACK (Mishra & Koehler, 2006), the TPACK-G framework consists of game knowledge (GK), game pedagogical knowledge (GPK), and game pedagogical content knowledge (GPCK). GK is defined as the knowledge about the general usage of computer games. GPK refers to the knowledge of using games with various pedagogical characteristics for teaching without specific reference to content knowledge. Last, GPCK is knowledge of using games to implement teaching methods for any targeted content. Much TPACK research has investigated the inter-relations among the various types of TPACK knowledge by using path analysis (Chai, Koh, Tsai, & Tan, 2011; Hsu & Chai, 2012). For instance, in Chai et al.'s (2011) study on exploring pre-service teachers' TPACK development after completing the ICT curriculum, the results showed that the participants' TK, CK and TPK could predict their TPACK. Meanwhile, Hsu and Chai (2012) also found that the participants' GK was able to predict their GPK, and then their GPK could further predict their GPCK. Although the relations among the different types of TPACK knowledge can be identified by using path analysis, which type of knowledge (i.e., TK, CK, or PK) should be instructed first during the course in order to improve students' TPACK is still unknown. Thus, the purpose of this study was to investigate the impacts of course design on the preschool teachers' confidence in their TPACK-G and their acceptance of game-based learning. Specifically, this study was guided by the following questions:

1. What were the effects of the technology- and pedagogy-oriented course design on improving the in-service preschool teachers' TPACK-G?
2. Is there any significant difference in the participants' acceptance of digital game-based learning?

2. Methodology

Participants

The participants were 49 college students recruited from two intact classes in northern Taiwan. They were all in-service preschool teachers who were taking advantage of the weekends to get a college degree in child care and education. Being a preschool teacher in Taiwan does not require a bachelor's degree. Anyone who graduates from a junior college or a vocational school and has a major in a related field is eligible to become a preschool teacher. Thus, the participants of this study had diverse academic backgrounds. Except for one missing value, 35 had a vocational school diploma, 12 had a college degree in a non-child care major, and one had a master's degree. They were all female, the average age was 37.5 (SD =7.42) and the average teaching experience was 11.21 years (SD = 5.19).

Instruments

This study employed two questionnaires, the Technological Pedagogical Content Knowledge-Games (TPACK-G) and the Acceptance of Digital Game-Based Learning (ADGBL) survey, to assess the preschool teachers' confidence in TPACK-G and their acceptance of digital game-based learning. The TPACK-G instrument was developed by Hsu and Chai (2012) according to the previous work of Chai, Koh, and Tsai (in press) and Lee and Tsai (2010). Consisting of 14 items, the survey measures the participants' confidence in game knowledge, game pedagogical knowledge, and game pedagogical content knowledge. Descriptions of the three scales are presented below. In the study of Hsu and Chai (2012), the original reliability (Cronbach's alpha) coefficients for these factors ranged from 0.90 to 0.94 and the overall alpha was 0.95. In this study, the reliability coefficients were 0.92, 0.93, 0.93, and 0.94, respectively for GK, GPK, GPCK, and the overall alpha. This suggests satisfactory reliability of assessing the participants' confidence in TPACK-G.

1. *Game Knowledge (GK)*: the teacher knows how to use digital games; for instance, 'I can learn how to use digital games easily.'
2. *Game-Pedagogical Knowledge (GPK)*: the teacher knows how to use digital games to enhance students' learning, such as 'I am able to facilitate my students to use digital games to observe some phenomena.'
3. *Game-Pedagogical-Content Knowledge (GPCK)*:the teacher knows how to use appropriate pedagogy and digital games to support students' learning of specific content through, for example, teaching lessons that appropriately combine the teaching subject, digital games and teaching approaches.

The ADGBL survey contains factors of learning opportunities, preference for games, experience with games, and attitudes toward game-based learning. Descriptions of these factors with sample items are presented below. Similarly, this instrument was proposed in Hsu and Chai's (2012) study underlying the research of Bourgonjon, Valcke, Soetaert, and Schellens (2010) as well as that of Lee and Tsai (2010). There were 20 items in total. The original reliability coefficients reported in Hsu and Chai's (2012) study ranged from 0.91 to 0.95 with an overall alpha of 0.96. In this study, the reliability coefficients were 0.91, 0.80, 0.92, 0.95, and 0.92, respectively for LO, PFG, EWG, ATT, and the overall alpha. All of the items of the two instruments described above were presented with a 7 point Likert scale, namely: 1) Strongly disagree; 2) Disagree; 3) Slightly disagree; 4) Neither agree nor disagree; 5) Slightly agree; 6) Agree; 7) Strongly agree.

1. *Learning opportunities (LO)*: the teacher believes in affording learning opportunities when using

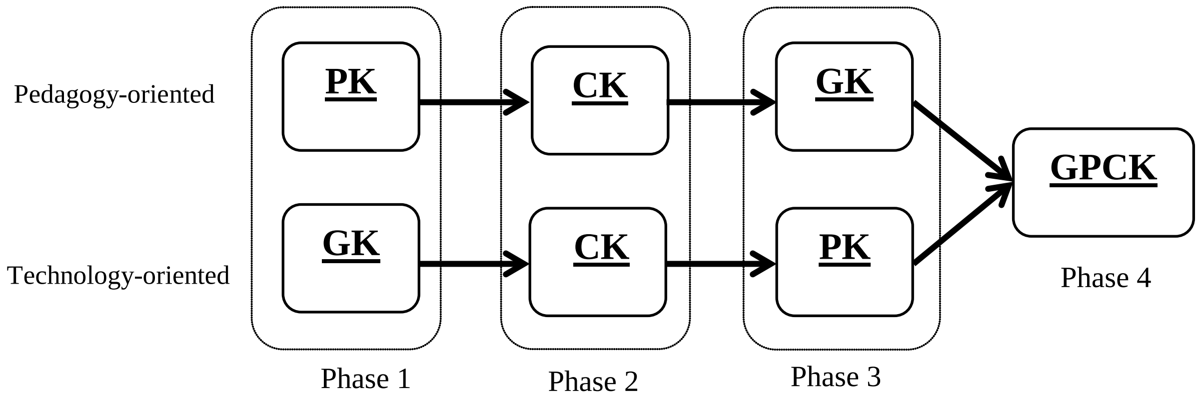
games in the classroom; for instance, 'Games offer opportunities to experiment with knowledge.'

2. *Preference for games (PFG)*: the teacher prefers the usage of games in the classroom; for example, 'If I had to vote, I would vote in favor of using digital games in the classroom.'
3. *Experience with games (EWG)*: the teacher likes playing games; for example, 'Compared to people of my age, I play a lot of digital games.'
4. *Attitudes toward Game-based learning (ATT)*: the teacher agrees with using digital games in teaching; for instance, 'Digital game resources can enrich course content.'

Research treatments

The participants of the two classes were enrolled in a course on Children's Health Care that was developed according to the framework of TPACK-G. Its course objective was to enable the students to design games and integrate them into the course activities. In order to examine how different orientations of the course design influenced the students' TPACK-G as well as their acceptance of digital game-based learning, the curriculum was designed as either pedagogy- or technology-oriented. These two courses consisted of four phases (see Figure 1). As shown, the pedagogy-oriented course started with teaching pedagogy knowledge (PK) in Phase 1, followed by content knowledge (CK), and technology knowledge (GK). An inter-relationship of pedagogy, content, and technology knowledge (GPCK) was instructed in the end. The technology-oriented course, however, began with teaching GK first, followed by CK, PK, and TPCK. The course activities of each phase were inter-related. Take teaching the GK phase for instance; the course initially focused on game-related knowledge such as introducing digital games, game development, related software, gameplaying methods, and evaluation. Following GK was a description of its inter-relation with CK and PK. That is, the activities introduced how to use games to represent the subject content and how to facilitate students to use games to enhance their own learning.

The content of the pedagogy- and technology-oriented courses was exactly the same; only the teaching sequences differed. The time spent on each phase was six hours. During each treatment, the time was evenly divided for the teachers' instruction and the students' group discussion or practice, which allowed more time to construct their understanding. This study used a quasi-experimental design by assigning a class of 24 students to be the technology-oriented group and the other class of 25 students to be the pedagogy-oriented group. They all received instruction from the same instructors.



Data analysis

The descriptive statistics report on the demographic data, such as age, teaching experience, and the participants' TPACK-G and acceptance of digital game-based learning before and after the treatment. Analyses of covariance (ANCOVA) were conducted with group as the independent variable to examine whether any significant difference existed in the two groups of the participants' TPACK-G and acceptance of digital game-based learning.

3. Results

What were the effects of the technology- and pedagogy-oriented course design on improving the in-service preschool teachers' TPACK-G?

Table 1 shows the mean and standard deviation (SD) of the participants' TPACK-G scores before and after the treatment. An ANCOVA was conducted by using the TPACK-G scores before the treatment as the covariate and using the TPACK-G scores after the treatment as the dependent variables. The results revealed that statistically significant differences were identified in GK (F = 9.46, p <.01, eta2 =0.17) and GPCK (F = 11.20, p <.01, eta2 =0.20), suggesting a large effect size based on Cohen's criteria (1988). Students in the TK group outperformed those in the PK group in terms of their GK and GPCK. This finding implies that the participants who took the technology-oriented course first tended to have better performance on their GK and GPCK.

Table 1. Summary of the descriptive statistics of students' pre- and posttest scores on the TPACK-G and ANCOVA.

Factor	Group	Before treatment		After treatment		Univariate ANCOVA			
		Mean	SD	Mean	SD	Mean (adjusted)	Standard error	F	eta2
GK	TK	4.66	1.20	4.81	.83	4.81	.19	9.46*	.17
	PK	4.64	1.22	3.98	1.03	3.98	.19		
GPK	TK	4.94	1.13	5.43	.97	5.35	.20	3.60	.08
	PK	4.70	1.23	4.83	.97	4.80	.20		
GPCK	TK	4.42	1.14	5.47	1.06	5.48	.21	11.20*	.20
	PK	4.10	1.34	4.50	.98	4.49	.21		

* $p < .01$

Is there any significant difference in the participants' acceptance of digital game-based learning?

Similarly, an ANCOVA was conducted by using the ADGBL scores before the treatment as the covariate, and using the ADGBL scores after the treatment as the dependent variables. The results merely identified a statistically significant difference, EWG (F = 5.13, p <.05, eta2 =0.10), suggesting a medium effect size based on Cohen's criteria (1988). Students who took the technology-oriented course first were inclined to describe themselves as being more experienced with games.

Table 2. Summary of the descriptive statistics of students' pre- and posttest scores on the ADGBL and ANCOVA.

		Before treatment		After treatment		Univariate ANCOVA			
		Mean	SD	Mean	SD	Mean (adjusted)	Standard error	F	eta2
LO	TK	5.64	.93	5.77	.96	5.77	.20	.57	.01
	PK	5.52	.78	5.57	.91	5.52	.20		
PFG	TK	4.67	1.35	4.99	1.29	4.96	.27	.14	.00
	PK	4.26	1.22	4.68	1.44	4.82	.27		
EWG	TK	4.12	1.36	4.33	1.31	4.31	.27	5.13*	.10
	PK	3.46	1.36	3.41	1.27	3.43	.27		
ATT	TK	5.43	1.11	5.58	1.05	5.58	.20	.32	.01
	PK	5.39	.94	5.74	.88	5.74	.20		

4. Discussion and conclusion

The present study investigated the effects of a technology- and pedagogy-oriented course on the in-service preschool teachers' TPACK-G and acceptance of digital game-based learning. The results show that the technology-oriented group outperformed those in the pedagogy-oriented group in terms of their GK and GPCK. This finding suggests that when integrating the TPACK-G framework into the preschool context, instructing game knowledge before pedagogy knowledge tended to raise the in-service teachers' competencies in GK and GPCK. It was likely that teaching game knowledge first allowed the participants to get an idea of what games were and how games worked, which helped them articulate their tacit knowledge in the following phases of instruction (e.g., CK, PK, GPCK) and later enhanced their GPCK. Moreover, students who learned game knowledge first were inclined to perceive themselves as being more experienced with games. For future research, it is suggested that a qualitative approach be utilized to probe how students' TPACK-G develops over time. In addition, measurement of learning outcomes is also an important indicator to examine the impacts of the technology- and pedagogy-oriented groups.

References

Bourgonjon, J., Valcke, M., Soetaert, R., & Schellens, T. (2010). Students' perceptions about the use of video games in the classroom. *Computers & Education*, *54*(4), 1145-1156. doi: 10.1016/j.compedu.2009.10.022

Chai, C. S., Koh, J. H. L., & Tsai, C.-C. (in-press). A review of Technological Pedagogical Content Knowledge. *Education Technology and Society*.

Chai, C. S., Koh, J. H. L., Tsai, C.-C., & Tan, L. L. W. (2011). Modeling primary school pre-service teachers' Technological Pedagogical Content Knowledge (TPACK) for meaningful learning with information and communication technology (ICT). *Computers & Education, 57*, 1184-1193. Doi: 10.1016/j.compedu.2011.01.007

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Lawrence Erlbaum.

Dickey, M. D. (in press). K-12 teachers encounter digital games: a qualitative investigation of teachers' perceptions of the potential of digital games for K-12 education. *Interactive Learning Environments*. doi: 10.1080/10494820.2013.788036

Hsu, C.-Y. & Chai, C.-S. (2012, November). Exploring preschool teachers' technological pedagogical content knowledge with educational games. The 20th International Conference on Computers in Education (ICCE 2012), Singapore.

Lee, M. H., & Tsai, C.-C. (2010). Exploring teachers' perceived self-efficacy and technological pedagogical content knowledge with respect to educational use of the World Wide Web. *Instructional Science*, *38*, 1-21. doi: 10.1007/s11251-008-9075-4