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Introducing pre-service teachers to game-based learning

James Hernandez[1]
Rica Ramirez[2]

[1,2]*Department of Interdisciplinary Learning and Teaching, University of Texas at San Antonio, San Antonio, Texas, USA.*
[1]*Email: jjhernandez520@gmail.com*
[2]*Email: rica.ramirez@utsa.edu*

Abstract

Game-based learning has increased research and interest in teacher education and teacher pedagogy. However, there is still much to learn about how teachers understand and feel about game-based learning pedagogy in the classroom. This study utilized a quantitative research methodology to better understand the changes in beliefs and attitudes toward game-based learning of teachers before and after experiencing game-based learning opportunities first-hand. The participants in this study were ninety-six pre-service teachers enrolled in a Child Growth and Development course at a public Hispanic Serving Intitution in South Central Texas University. Findings from this study indicate that pre-service teachers are comfortable using game-based learning pedagogy prior to any game-based learning interventions. Specifically, game knowledge, game content knowledge, and game pedagogical content knowledge, had a strong positive relationship with learning opportunities, attitudes towards game-based learning and overall acceptance of digital game-based learning score. Access to game-based learning experiences significantly increased teachers' game pedagogical knowledge, game content knowledge, and experience with games knowledge. Overall, pre-service teachers' personal experiences with gaming and attitude towards gaming is one of the key factors that contributes to their positive attitudes towards game-based learning and their ability to see the learning opportunities games have in their future classrooms.

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(Corresponding Author)

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1. Introduction

Digital games have been shown to support learning both inside formal classroom settings and informal settings, such as home or after-school (Chauhan, 2017; Connolly, Boyle, MacArthur, Hainey, & Boyle, 2012; Whitton, 2014). In addition, studies have shown that children can learn a myriad of content through digital games, including math (Kahila, Valtonen, Tedre, Mäkitalo, & Saarikoski, 2020) science (El Mawas et al., 2020)

and reading (Li & Chu, 2021). Elementary students prefer game-based interactions in the classroom over teacher-led lessons resulting from digital technologies being a novel experience, fun, and motivating in the classroom compared to teacher-based learning (El Mawas et al., 2020). Thai and Ponciano (2016) found that digital games can be a valuable addition for students needing focused content knowledge or skill acquisition. Researchers of educational technologies support the need for teachers to stay current in a world that is becoming more digitized and technologically focused (Mishra & Koehler, 2006). When designed properly, games are able to foster students' engagement in learning and motivation to learn (Mohamad, Salam, & Bakar, 2017).

1.1. Pre-Service Teachers and Digital Games

Much of the literature about game-based learning (GBL) has focused mainly on students as game players rather than future educators. There is much to learn about preservice teachers' use of digital games in the classroom and how these variables can be leveraged for training teachers in game-based learning and teaching (Chauhan, 2017; Hsu, Liang, Chuang, Chai, & Tsai, 2021). There are, however, many variables for why teachers may choose to utilize games in the classroom. Recent studies have shown that teachers' responses are often ambiguous when asked if their students are learning while playing a digital game; therefore, many teachers opt not to utilize a game-based approach to teaching (Hernandez & I Alanís, 2022).

Teachers have expressed a basic understanding of games as a medium for learning but often need formal training on incorporating digital games into their curriculum (Hsu, Liang, Chai, & Tsai, 2013). A recent study with third-grade teachers showed that education level might influence a teacher's confidenze to use game-based learning in the classroom, however, more research on this demographic is needed (Hernandez & Alanís, 2022). One of the most vital indicators of acceptance and confidence in game-based learning in the classroom is a teacher's previous experience as a gamer in their personal and professional lives (Avidov-Ungar & Hayak, 2021; Hsu et al., 2013; Hsu et al., 2021; Hsu, Liang, & Su, 2015; Smith, Closser, Ottmar, & Arroyo, 2020). Teachers had favorable attitudes towards GBL when they were provided opportunities for them to explore various digital games themselves (Hsu, Tsai, Chang, & Liang, 2017). The current study seeks to provide opportunities to pre-service teachers to explore various digital games in order to influence their attitudes and willingness to incorporate games into their own future teaching.

1.2. Theoretical Framework- TPACK-G

The current study uses the TPACK-G framework, which has been utilized to understand the confidence levels of teachers when thinking of utilizing game-based learning pedagogy in the classroom (Hsu et al., 2013; Hsu et al., 2021; Hsu et al., 2015; Hsu et al., 2017). The TPACK-G framework focuses on teachers' perspective of video game use in the classroom and has shed light on many variables that affect a teacher's attitude and confidence in game-based learning pedagogy. TPACK-G comprises of game knowledge (GK), game pedagogical knowledge (GPK), game content knowledge (GCK), and game pedagogical content knowledge (GPCK) (See Instruments section for descriptions of each of the factors).

1.3. Current Study

This quantitative study sought to replicate the methods used by Hsu et al. (2017) with in-service teachers in Taiwan. This study utilized a quasi-experimental design in which a convenience sample of pre-service teachers was exposed to game-based learning experiences. Before and after these experiences, participants completed surveys and blogs about their experiences and confidence levels with game-based learning. The following research questions guided the study: (1) What are pre-service teachers' TPACK-G scores and Acceptance of Digital Game-Based Learning (ADGBL) scores before and after experiencing game based learning? (2) Are there differences in the knowledge, beliefs, and attitudes of pre-service teachers toward game-based learning after they have participated in game-based learning opportunities? (3) What relationship exists between pre-service teachers' confidence in game-based learning and their attitudes and acceptance towards game-based learning pedagogy?

2. Methods

2.1. Participants

The participants in this study were ninety-six pre-service teachers enrolled in a Child Growth and Development course at a public Hispanic Serving Intitution in South Central Texas University. Ninety-one participants identified as female, and five participants identified as male. Fifty-two participants were between the ages of 18-21 years old, 35 participants were between the ages of 22-30 years old, 4 were between the ages of 31-40 years old, 3 were between the ages of 41-50 years old, and 1 participant was above the age of 50. Eighty pre-service teachers reported wanting to teach kindergarten – 3rd grades, 11 want to teach 4th-6th grades, 1 wants to teach 7th-12th grades, and 3 pre-service teachers want to teach in higher education.

2.2. Instruments

The instruments used in this study were the TPACK-G Survey (Hsu et al., 2017) and the Acceptance of Digital Game-Based Learning (ADGBL) survey (Hsu et al., 2013). Both instruments have shown reliable results when used with Taiwan's pre-service and in-service teachers (Hsu et al., 2013; Hsu et al., 2021; Hsu et al., 2015; Hsu et al., 2017). This study directs its use toward pre-service teachers in the United States within a Hispanic Serving Institution. The TPACK-G framework consists of subcategories, all of which make up the total TPACK-G score. Descriptions of the scales are presented below:

1. Game Knowledge (GK): assesses teacher's confidence in their knowledge of how to use games (i.e., I can learn how to use digital games easily).
2. Game Pedagogical Knowledge (GPK): assesses teachers' confidence in their knowledge of how games can support pedagogical approaches (i.e., I know how to use characteristics of digital games to support teaching).
3. Game Pedagogical Content Knowledge (GPCK): measures teachers' confidence in their knowledge of supporting students' learning of content through appropriate pedagogy and games (ie., I can select games to use in my classroom that enhance what I teach, how I teach and what students learn).

The ADGBL survey measures teachers' attitudes toward digital game-based learning. It consists of four sub-categories:

1. Learning opportunities (LO): measures teachers belief that the usage of games in the classroom can offer students' learning opportunities (ie., Games offer opportunities for students to experience things they learn about).
2. Preference for games (PFG): measures teachers' preference for using games in the classroom (i.e., I am enthusiastic about using games in the classroom).
3. Experience with games (EWG): assesses the amount of teachers' experience with games (i.e., I play different types of digital games).
4. Attitudes towards Game-based learning (ATT): measures the extent of the teachers' agreement with using digital games in teaching (i.e., Game-based learning can enhance students' learning motivation).

All of the items adapted from the two surveys were presented as a 7-point Likert Scale, with 1 = Strongly Agree and 7 = Strongly Disagree.

2.3. Procedure

All participants in this study received and signed an informed consent document describing the extent of the research and their contribution to the study. Prior to exposure to the game-based learning experiences, participants completed a pre-survey during class time. During the last 30 minutes of each class meeting, participants were introduced to different examples of game play and encouraged to explore the games. During the 30-minute exploration period, teachers were allowed to play the digital game for 20 minutes, leaving 10 mintues for discussion with the researchers. Altogether, teachers were exposed to 60 minutes of gameplay and 30 minutes of discussion. Each class period a different game play was chosen, such as iCivics (2009) where students had the opportunity to play the game "Cast your Vote." The purpose of this game is to participate in a virtual elections campaign. During the game, the player must choose their top priorities from a list of general topics. Examples include topics on the environment, the judicial system, and education. Throughout the game, the player, attends virtual town halls where politicians participate in debates. The player is then allow to choose whether they agree or disagree on their point of view at the end of each debate. By the end of the game, the player has a list of topics and candidates that they support and is allowed to vote for the candidate that best aligns with their policital views. By engaging in a mock election, students gain a virtual experience of participating in a low stakes electioneering process where they are introduced to language that is particular to the policitcal process, often referred to as "specialist language" (Gee, 2007). Since the game can be replayed as many times as the student wants, this low stakes, virtual experience gives students a safe context to practice political-type engagement through normalizing experimentation and exploration (Whitton, 2014). This game was chosen because the first author had previous experience with the gameplay and content and therefore evaluated it as an excellent example of game-based learning. Other examples were, "Push Pull Puzzles" and "Treehouse Trouble," on Public Broadcasting Service (1999). The researchers selected both games as examples of pre-algebra skills for young children. At the end of the semester, students completed a post-survey, were identical to the ones answered in the pre-survey.

2.4. Data Analysis

Surveys were analyzed using IBM SPSS Statistics version 28.0.0.0 (190). The TPACK-G subcategories were calculated for every individual based on the average of the participants knowledge on each factor. Subsequently, overall TPACK-G score is calculated as an average of the subcategory scores (Lyublinskaya & Kaplon-Schilis, 2022). The ADGBL survey were calculated similarly. Paired samples t-tests were conducted on pre- and post-survey scores of the subcategories, the overall TPACK-G score, and the overall ADGBL score.

3. Findings

Findings will be presented by research question. To answer the first research question regarding what are pre-service teachers' TPACK-G scores and ADGBL scores, descriptive statistics and frequencies were conducted (See Table 1). Participants in this study averaged "slightly agree" on their pre (M = 2.88, SD =.82) and post (M =2.60, SD =.90) surveys. Based on the surveys, the participants in this study feel comfortable using game-based teaching in the before and after exposure to game-based learning. The same pattern was seen in their ADGBL scores, where students averaged slightly agree on their pre (M = 2.47, SD =1.01) and post (M =2.97, SD =.84). This indicates that students have positive attitudes toward digital game-based learning.

Table 1. Descriptive statistics for T1 and T2.

Variable	N	Mean (SD)
Game knowledge T1	63	2.75(0.92)
Game knowledge T2	63	2.47(1.02)
Game content knowledge T1	63	2.70(1.01)
Game content knowledge T2	63	2.41(0.93)
Game pedagogical knowledge T1	63	3.23(1.06)
Game pedagogical knowledge T2	63	2.80(1.14)
Game pedagogical content knowledge T1	63	2.85(1.01)
Game pedagogical content knowledge T2	63	2.72(1.04)
TPACK- G score T1	63	2.88(0.82)
TPACK-G score T2	63	2.60(0.90)
Learning opportunities T1	63	2.05(0.66)
Learning Opportunities T2	63	2.15(0.99)
Experience with games T1	63	4.75(1.66)
Experience with games T1	63	4.40(1.60)
Preference for games T1	63	2.76(1.18)
Preference for games T2	63	2.84(1.32)
Attitudes towards game-based learning T1	63	2.30(.93)
Attitudes towards game-based learning T2	63	2.47(1.01)
ADGBL score T1	63	2.97(0.84)
ADGBL score T2	63	2.97(1.00)

For research question two, there was a significant difference between the Game Knowledge score at time 1 (M = 2.75; SD = .92) and the Game Knowledge score at time 2 (M = 2.47; SD = 1.02), t (62) = 2.31, p < .02 with a medium effect size of .29. The difference indicates that students have more game knowledge after exposure to game-based learning. There was a significant difference between the Game Content Knowledge score at time 1 (M = 2.70; SD = 1.01) and the Game Content Knowledge score at time 2 (M = 2.4; SD = .93, t (62) = 2.08, p <.04 with a medium effect size of .26, suggesting that students had more game-based content knowledge at the time of the post survey. There was a significant difference between the Game Pedagogical Knowledge score at time 1 (M = 3.23; SD = 1.06) and Game Pedagogical Knowledge score at time 2 (M = 2.80; SD = 1.14), t (62) = 2.96, p < .00, with a medium effect size of .37. The difference suggests that students have more pedagogical knowledge in game-based learning after exposure to game-based learning. There was a significant difference between the Experience with Games scores at time 1 (M = 4.75; SD = 1.66) and Experience with Game scores at time 2 (M = 4.40; SD = 1.60), t (61) = -2.09, p < .04 with a medium effect size of .26, suggesting that students have more experience with games after exposure to game-based learning in the current study. In addition, the overall TPACK-G score had a significant difference between time 1 (M = 2.88; SD = .82) and time 2 (M = 2.60; SD = .90), t (62) = 2.63, p < .01 with a medium effect size of .33, which suggests that students are more comfortable in game-based teaching and knowledge at the end of the study. There were no significant differences found between ADGBL scores (See Table 2).

Table 2. Paired samples *t* test.

Variable	Paired *t* test			
	t value	df	Significance	Effect size
Subcategories				
GK T1	2.31	62	0.02*	0.29
GK T2				
GCK T1	2.08	62	0.04*	0.26
GCK T2				
GPCK T1	0.926	62	0.36	
GPCK T2				
GPK T1	2.96	62	0.00***	0.37
GPK T2				
LO T1	-0.78	62	0.44	
LO T2				
EWG T1	2.09	62	0.04*	0.26
EWG T2				
PFG T1	-0.62	62	0.54	
PFG T2				
ATT T1	-1.25	62	0.22	
ATT T2				
Overall score				
TPACK-G T1	2.63	62	0.01**	0.33
TPACK-G T2				
ADGBL score-T1	-0.006	62	0.995	
ADGBL score-T2				

Note: $p < 0.05$*; $p < 0.01$**; $p < 0.001$***.

For the third research question (See Table 3), age had a moderately positive relationship with game pedagogical knowledge ($r(61) = .25$, $p < .05$), game pedagogical content knowledge at time 1 ($r(61) = .26$, $p < .05$), at time 2 ($r(61) = .27$, $p < .05$), and experience with gaming ($r(61) = .27$, $p < .05$). Grade level was found to have a moderately negative relationship with experience with games, ($r(61) = -.31$, $p < .05$).

There were several significant correlations, therefore only the strong relationships will be reported on (i.e., correlations of .50 and above). Game knowledge at time 2 had strong positive relationship with learning opportunities ($r(61) = .54$, $p < .01$), attitudes towards game-based learning at time 2 ($r(61) = .50$, $p < .01$), and the overall acceptance of digital game-based learning score ($r(61) = .56$, $p < .01$). Game content knowledge had strong positive relationships with learning opportunities at time 2 ($r(61) = .79$, $p < .01$), preference for games at time 2 ($r(61) = .61$, $p < .01$), attitudes towards game-based learning ($r(61) = .68$, $p < .01$), and the overall acceptance of digital game-based learning score ($r(61) = .75$, $p < .01$). Game pedagogical knowledge at time 2 had strong positive relationships with learning opportunities at time 2 ($r(61) = .57$, $p < .01$) and the overall acceptance of digital game-based learning score at time 2 ($r(61) = .58$, $p < .01$). Game pedagogical content knowledge was found to have strong positive relationships with learning opportunities at time 2 ($r(61) = .63$, $p < .01$), preferences for gaming at time 2 ($r(61) = .54$, $p < .01$), and attitudes towards game-based learning at time 2 ($r(61) = .62$, $p < .01$), and the overall acceptance of digital game-based learning score at time 2 ($r(61) = .64$, $p < .01$). Learning opportunites at time 2 was found to have a strong positive relationship with the overall TPACK-G score at time 2 ($r(61) = .72$, $p < .01$). Experience with gaming at time 2 was found to have a strong positive relationship with TPACK-G score at time 2 ($r(61) = .50$, $p < .01$). Preferences of games was also found to have a strong positive relationship with TPACK-G score at time 2 ($r(61) = .56$, $p < .01$). Attitudes towards games at time 2 has a strong positive relationship with TPACK-G score at time 2 ($r(61) = .65$, $p < .01$). TPACK- G score at time 2 had a strong positive relationship with the overall acceptance of digital game-based learning score at time 2 ($r(61) = .72$, $p < .01$).

Table 3. Correlations.

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1. Age																						
2. Grade level	-0.09																					
3. GK T1	0.10	0.07																				
4. GK T2	0.12	-0.19	0.52**																			
5. GCK T1	0.04	0.03	0.60**	0.28*																		
6. GCK T2	0.01	-0.20	0.22	0.62**	0.32*																	
7. GPK T1	0.25*	0.13	0.46**	0.37**	0.66**	0.37**																
8. GPK T2	0.25	-0.21	0.28*	0.69**	0.15	0.59**	0.45**															
9. GPCK T1	0.26*	-0.11	0.42**	0.320	0.58**	0.47**	0.67**	0.51**														
10. GPCKT2	0.27*	-0.22	0.33**	0.66**	0.28*	0.70**	0.50**	0.78**	0.48**													
11. LO T1	0.09	0.02	0.29*	0.03	0.18	-0.09	0.13	0.05	0.10	0.02												
12. LO T2	0.05	-0.15	0.12	0.54**	0.17	0.79**	0.22	0.57**	0.29*	0.63**	0.23											
13. EWG T1	0.12	0.08	0.38**	0.29*	0.33**	0.17	0.21	0.12	0.08	0.18	0.23	0.08										
14. EWG T2	0.27*	-0.31*	0.26*	0.47**	0.33**	0.47**	0.41**	0.41**	0.38**	0.39**	0.02	0.32*	0.66**									
15. PFG T1	0.02	-0.21	0.12	0.05	0.20	0.20	0.06	0.08	0.11	0.19	0.63**	0.39**	0.35**	0.23								
16. PFG T2	0.04	-0.19	0.01	0.35**	0.27*	0.61**	0.34**	0.46**	0.34**	0.54**	0.24	0.70**	0.23	0.50**	0.63**							
17. ATT1	0.01	-0.20	-0.00	-0.09	0.12	0.04	-0.03	-0.03	-0.03	0.06	0.67**	0.28*	0.11	-0.02	0.79**	0.43**						
18. ATT T2	0.03	-0.19	0.10	0.50**	0.31*	0.68**	0.31*	0.49**	0.31*	0.62**	0.28*	0.83**	0.10	0.33**	0.46**	0.81**	0.39**					
19. TPACK-G T1	0.20	0.04	0.74**	0.45**	0.87**	0.42**	0.86**	0.42**	0.82**	0.49**	0.20	0.25	0.30*	0.42**	0.14	0.30*	0.02	0.32*				
20. TPACK-G T2	0.19	-0.23	0.39**	0.85**	0.29*	0.82**	0.49**	0.89**	0.51**	0.90**	0.00	0.72**	0.22	0.50**	0.15	0.56**	-0.01	0.65**	0.51**			
21. ADGBL T1	0.09	-0.09	0.28*	0.14	0.30**	0.15	0.14	0.09	0.09	0.18	0.72**	0.30*	0.69**	0.40**	0.87**	0.50**	0.75**	0.37**	0.24	0.16		
22. ADGBL T2	0.14	-0.27	0.17	0.56**	0.34**	0.75**	0.40*	0.58**	0.41**	0.64**	0.21	0.81**	0.38**	0.72**	0.51**	0.90**	0.30*	0.86**	0.41**	0.72**	0.49**	

Note: *Correlation is significant at the 00.05 level ; ** Correlation is significant at the 00.01 level

4. Discussion

Overall, findings suggest that pre-service teachers felt comfortable using game-based teaching before and after exposure to game-based learning as indicated by their TPACK-G scores. The same pattern was seen in their ADGBL scores, where students have positive attitudes toward digital game-based learning. Furthermore, findings from this study suggest that even brief exposure to game-based learning pedagogy increased a pre-service teacher's inclination to both use game-based learning in the classroom and be more open to learning about it in the future. Specifically, pre-service teachers gained more knowledge of ways to implement game-based learning in their teaching based on their increase of the game knowledge, game content knowledge, and game pedgagocial knowledge scores after exposure to game-based learning. In addition, students were found to be more comfortable in game-based teaching and knowledge at the end of the study, according to their overall TPACK-G scores. Not surprising was an increase in the Experience with Games scores suggesting that students have more experience with games after exposure to game-based learning since they had time to play games and observed the researchers utilizing games to teach a lesson. This is important for teachers in wanting to implement game-based learning in the classroom, since experience with digital games contributes to their ability and confidence with using GBL (Hsu et al., 2017; Smith et al., 2020). There were no significant differences found between the overall ADGBL scores possibly due to the fact that students already had a positive attitude towards game-based learning.

Results suggested that older students are unlikely to have much knowledge or experience with gaming in the classroom. Grade level was found to have a moderately negative relationship with experience with games, suggesting that those who want to teach older grade levels have more experience with gaming.

Game knowledge, game content knowledge, and game pedagogical content knowledge, had a strong positive relationship with learning opportunities, attitudes towards game-based learning and overall acceptance of digital game-based learning score. This is not surprising finding because when someone knows a lot about gaming they are more than likely able to appreciate the capabilities and the learning opportunities game based learning has in a classroom, have positivie attitudes towards game based learning, and be more accepting of digital game based learning. Teachers' personal experiences with gaming and attitude towards new teaching methods is one of the key factors that contribute to their implementation and influence their attitudes and willingness to incorporate gamining into the classroom (Martín Del Pozo, Basilotta Gómez-Pablos, & García-Valcárcel Muñoz-Repiso, 2017; Mertala, 2019). Preservice teachers who acknowledge the learning opportunities that game-based learning has to offer are more confident when thinking of utilizing game-based learning pedagogy in the classroom. Those with more experience with games, a preference for and positive attitudes towards gaming tend to have more confidence in using game-based learning in the classroom (Martín Del Pozo et al., 2017). Similarily, those who have more confidence in utilizing game-based learning in the classroom are more likely accepting of digital game-based learning in the classroom.

5. Limitations and Future Research

This study's findings are limited to preservice teachers, specifically within a pre-service teaching program, therefore, results from different schools of thought may produce different outcomes and responses. Time limitations were also an important consideration for the results of the study. Future research should look into longer interventions of GBL pedagogy, possibly even over a teachers' educational career in pre-service programs. GBL may also be introduced and integrated into the overall teacher education program as a viable pedagogical tool in all educational courses, leading to a better understanding and pedagogical fidelity. Experiential learning using GBL with teachers may be more valuable and impactful than simply learning about it from a theoretical perspective. In addition, the current study's sample were part of a teacher preparation program where there is not one specific course dedicated to technology, it is instead left up to the instructor on whether to incorporate it into the course content. It may not be enough to have technology integrated into each course. Therefore, it may be prudent to incoroporate a technology course into teacher preparation programs.

Overall, our findings suggest that pre-service teachers felt comfortable using game-based teaching before and after exposure to game-based learning and have positive attitudes toward digital game-based learning. A finding that is particularly promising is that even brief exposure to game-based learning pedagogy increased a pre-service teacher's inclination to both use game-based learning in the classroom and be more open to learning about it in the future.

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