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ORIGINAL PAPER

The Effects of Game Design Experience on Teachers' Attitudes and Perceptions regarding the Use of Digital Games in the Classroom

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Abstract Researchers have investigated how gameplay and other related activities influence teachers' attitudes toward and perceptions of games or game-based learning. Taking one step further, this study was conducted to investigate how game design experience influences teachers' attitudes toward and perceptions of the use of digital games in the classroom and teacher involvement in educational game design. Fifty teachers participated in the study. Both quantitative and qualitative data were collected from pre- and post-surveys. The results revealed that the game design experience had a positive influence on the participants' attitudes, self-efficacy, and perceptions regarding the use of digital games in the classroom. They realized that digital games could help students develop higher-order thinking skills and 21st century skills beyond making learning fun and engaging. After the game design experience, all participants believed that teachers should be involved in the process of educational game design.

Keywords Educational game design · Digital learning games · Digital game-based learning · Teacher perceptions · Teacher professional development

Well-designed digital games or digital game-based learning environments have the potential to make learning more meaningful by providing situated learning experiences and just-in-time support (An and Bonk 2009; Gee 2005; Shaffer et al. 2005). Players use information and resources to solve problems rather than simply memorizing facts. They take risks and learn through their failures in safe environments (An and Bonk 2009; Gee 2005; Squire 2005). While traditional education focuses on knowing rather than on doing, digital games enable players to learn through doing and help them develop transferable knowledge and real world skills (An and Bonk 2009; Shaffer et al. 2005).

Despite the increasing number of teachers using digital games in the classroom, many teachers still do not seem to fully understand the educational potential of digital games. The reason may be because they are unaware or unfamiliar with those games that provide situated learning experiences and foster 21st century skills. Schraderet al. (2006) found that the majority of the pre-service teachers in their study had no or limited experiences with massively multi-player online games and were not fully aware of their pedagogical value. Similarly, Gaudelli and Talyor (2011) reported that teachers were generally skeptical about the pedagogical value of video games, partially due to their lack of familiarity with games, and they remained skeptical about using games in teaching even after playing various games. The national survey conducted by the Joan Ganz Cooney Center (Takeuchi and Vaala 2014) revealed that most game-using teachers use shorter-form genres such as drill-and-practice games. While drill-and-practice games can help students memorize facts and develop basic skills, they are not effective for teaching complex content and higher-level skills.

While contemporary game researchers have designed and developed innovative digital games or digital game-based learning environments that hold potential to foster 21st century skills (e.g., *River City*), teachers still find it difficult to select appropriate games to use. In the study conducted by Sancar Tokmak and Ozgelen (2013), for example, all participants reported that the selection of educational computer games

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was a very difficult process since most of the computer games were not suitable for young children and not aligned with the Early Childhood Education (ECE) curriculum. One way to address this challenge is to involve teachers in the game design process. Collaboration among teachers, researchers, instructional designers, and game developers would lead to the creation of effective digital learning games that can be used by teachers in schools. It is important to understand teachers' perspectives in order to create such games. However, little research has investigated teachers' game design experiences and their perceptions of teacher involvement in educational game design. This study addressed this gap by investigating the effects of game design experience on teachers' attitudes toward and perceptions of the use of digital games in the classroom.

Teachers' Attitudes toward and Perceptions of Games

Literature suggests that many teachers are unaware or skeptical of the pedagogical value of digital games partially due to a lack of experience with games (Gaudelli and Talyor 2011; Schrader et al. 2006). Several researchers have investigated how gameplay and other related activities influence pre-service teachers' attitudes toward and perceptions of games or game-based learning. For example, Ray and Coulter (2010) examined how playing digital mini-games change pre-service teachers' perceptions of the value of digital mini-games. They found that the majority of the participants had a positive change in their perceptions after having played selected mini-games. They believed that digital mini-games could support meaningful learning. Kenny and McDaniel (2011) also found that pre-service teachers developed more positive attitudes toward games after playing the Tiger Woods PGA Tour 07 golf game. These findings indicate that positive gameplay experience could help pre-service teachers see the educational value of games.

Similarly, Kennedy-Clark et al. (2011) examined the effects of a two-hour workshop on the integration of game-based learning into inquiry learning on pre-service teachers' attitudes towards game-based learning. The results of the study showed that there was a significant change in the participants' attitudes towards game-based learning as a result of the two-hour workshop. The pre-service teachers in the study conducted by Sardone and Devlin-Scherer (2010) not only explored digital learning games but also taught their selected game to middle or high school students. After the field experience, they were asked to make a 20-minute presentation to the class. The results indicated that the field experience and peer presentations had a positive influence on their attitudes. The pre-service teachers felt positive and confident about integrating digital games into teaching.

While studies on pre-service teachers report consistently positive results, studies involving in-service teachers reveal teachers' practical concerns about the use of games in the classroom, as well as the positive changes of their attitudes and perceptions. For example, Becker (2007) had in-service teachers play, examine, and discuss a wide variety of games in a graduate-level course on digital game-based learning. The results showed that while all participants were enthusiastic about the potential of digital games to enhance learning as a result of analyses and discussions of various games, they continued to feel that integrating games in the curriculum was still a long way off.

Gerber and Price (2013) examined in-service teachers' perceptions focusing on the use of commercial off-the-shelf (COTS) video games in English Language Arts classrooms. Ten literacy teachers in their study explored several multi-user virtual environments and played a COTS game while researching literacy activities directly related to the game they had selected to play. The study found that while the participants saw the value of game-based learning pedagogy and would like to use game-based learning, they were concerned that their schools and colleagues would not be open to game-based pedagogy.

In a similar vein, Gaudelli and Talyor (2011) investigated social studies teachers' perspectives of the use of serious video games in the context of global education. Seven teachers participated in a series of activities, including a focus group meeting, gameplay, blogging, and focus-group reflection. The results from the initial focus group meeting showed that the participants were generally skeptical about the pedagogical value of video games, due in part to their lack of familiarity with this type of media. Even during and after the gameplay and other activities, the participants remained skeptical about teaching global content through video games. Their findings should be carefully interpreted since teachers might have different views with different social studies topics.

In sum, the above studies examined the changes in teachers' attitudes and perceptions after being exposed to or playing games. Examining the changes in teachers' attitudes and perceptions after game design taps into a relatively unexplored area.

Teachers' Game Design Experience

Almost two decades ago, Kafai et al. (1998) examined how students and pre-service teachers conceptualize the task of creating games for others. Study 1 focused on fifth grade students designing games to teach fractions to younger children, and Study II focused on teams of pre-service teachers engaged in the same task. The participants created games on paper but did not implement them on the computer. The results of their study showed that both students and teachers

shifted from extrinsic game design, where fraction content and game idea were unrelated (e.g., shooting rockets and solving fraction problems when missing rockets), to intrinsic game designs, where game idea and fraction content were integrated (e.g., assembling fractions of a map to progress through the game). Despite these interesting findings and its undoubted importance, teachers' experience of game design has not been actively explored until more recently.

Li et al. (2013) examined pre-service teachers' digital game design experience in a secondary mathematics methods course at a Canadian university. Twenty-one pre-service teachers in the study were first introduced to various online games, and then they were engaged in game design and development. Scratch was introduced in a face-to-face class, but they had the freedom to use any game design software. The results showed that many participants experienced difficulty in translating their design ideas to a game. Some participants had to completely change their game designs to fit the program they used. After developing their own games, about 40 % of the participants mentioned problem solving as a benefit of learning through game design, while only two teachers mentioned problem solving in the pre-survey. The interview results indicated that the game design process enabled the participants to use all the 21st century skills.

Instead of asking pre-service teachers to design their own games, Sancar Tokmak and Ozgelen (2013) had pre-service teachers redesign existing computer games. In the first condition, early childhood education pre-service teachers who participated in the study were asked to select a computer game and prepare a game-based lesson plan. In the second condition, the participants were asked to redesign the selected computer game and prepare a game-based lesson plan. The comparisons of selected and redesigned computer games revealed that most participants made considerable changes to the computer games selected. Interestingly, 62 % of the participants applied a constructivist learning theory when they redesigned computer games, while the majority of the participants planned to apply a behaviorist philosophy in the first condition. The participants reported that they could not integrate the selected computer games into teaching based on a constructivist philosophy, because they required children to have pre-knowledge to play. The interview results indicated that the characteristics of computer games and the opportunities to see classmates' lesson plans were the major factors affecting their game integration decisions.

While previous studies focused on pre-service teachers' game design experiences, Li (2012) explored the affordances and constraints of in-service teachers' experiences in designing and developing digital games for instructional purposes. Fourteen teachers enrolled in a 14-week graduate course at a Canadian university participated in the study. The participants were exposed to current literature related to digital game-based learning as well as existing games for the first 9 weeks, and then they focused on the design and development of their own instructional games starting in Week 10. Scratch was chosen as the primary development software, but those teachers with programming skills chose to use more advanced software such as Adobe Flash. The results of the study showed that the game design and development process improved the participants understanding about game-based learning and afforded them opportunities to re-conceptualize pedagogy. Specifically, they adopted a more holistic approach by integrating different subjects, skills, and knowledge. Some teachers involved their students in the design process and co-designed digital games. The design experience transformed classroom teaching from passive content consumption to active knowledge generation. Regarding constraints, the researcher identified four major challenges faced by teachers during their game building process, including technical challenges, limited time and resources, pedagogical challenges, and the conflict between educational context and game genre.

Although previous research provides insight into the benefits and challenges teachers experience in the process of game design, no study to date has provided empirical evidence of the impact of game design experience on teachers' attitudes toward and perceptions of digital games and teacher involvement in educational game design. This study, therefore, aimed to address the following research questions:

1. What impact does the game design experience have on teachers' attitudes, self-efficacy, and perceptions regarding the use of digital games in the classroom?
2. To what extent does the game design experience influence teachers' perceptions of teacher involvement in educational game design?

Methods

Participants

Participants in this study were 50 teachers enrolled in two sections of an online graduate course in the College of Education at a public university in the southeastern United States. They ranged in age from 22 to 54 years old. Of the participants, over 50 % were in their 20s, 76 % ($n = 38$) were female, and 58 % ($n = 29$) self-identified as Caucasian. Participants' teaching experience varied from less than 1 year to 20 years, with 80 % of participants ($n = 40$) reporting 0–5 years of teaching experience. Table 1 summarizes the demographic information of the participants.

Table 1 Summary of participant demographic information ($n = 50$)

Characteristic	*n*	%	Characteristic	*n*	%
Age			Gender		
20–29 years	26	52 %	Female	38	76 %
30–39 years	11	22 %	Male	12	24 %
40–49 years	11	22 %			
50–59 years	2	4 %			
Ethnicity			Teaching Experience		
Caucasian	29	58 %	0–5 years	40	80 %
African-American	17	34 %	6–10 years	4	8 %
Multiracial	3	6 %	11–15 years	3	6 %
Hispanic American	1	2 %	16–20 years	3	6 %

Procedure

This study focused on a game design assignment, in which students were asked to design a digital learning game for their students. The game design assignment consisted of five parts: (1) pre-survey, (2) reading, (3) game design, (4) peer feedback, and (5) post-survey. Students who chose to participate in this study were asked to read and sign the informed consent form and submit their signed consent form electronically. After receiving the signed consent forms, the instructor, the second author of this study, sent a link to the pre-survey to the participants via email. After they completed the pre-survey, the instructor provided them with articles related to well designed games and game-based learning environments and detailed instructions for the game design assignment, including a game design document template. The participants were encouraged to read the given articles before designing their own game. The participants were given 4 weeks for reading and game design. They did not use game design software for the game design assignment. Findings from previous research on teachers' game design showed that teachers' limited programming skills or the constraints of game design software often prevented them from implementing their original ideas (Li 2012; Li et al. 2013). Therefore, this study engaged the participants in conceptual design. They were asked to design their own educational game by completing a game design document. After submitting their game design documents, the participants were asked to review others' game design documents and provide feedback to at least three classmates on their game designs. After the peer feedback activity, the instructor sent a link to the post-survey to the participants via email.

Data Collection and Analysis

Both quantitative and qualitative data were collected from the pre- and post-surveys. The pre-survey consisted of demographic questions, five open-ended items, and 25 Likert-scale items. The post-survey included the same Likert-scale items and seven open-ended items. The paired-samples t-tests were used to compare pre- and post-survey scores in the following three categories: (1) attitudes and self-efficacy, (2) educational benefits of digital games, and (3) concerns. Further, the Wilcoxon Matched Pairs Signed Rank test, a nonparametric test for comparing two paired groups, was used to compare pre- and post-scores for individual items. All qualitative data were carefully examined, coded, and constantly compared for thematic analysis. For the educational benefits category, qualitative data from the pre-survey and those from the post-survey were compared to examine the participants' perception changes.

Results

Attitudes

Participants' attitudes toward the use of digital games in the classroom were measured using four Likert-scale items. Overall, the post-survey scores ($M = 3.54$, $SD = .44$) were significantly higher than the pre-survey scores ($M = 3.34$, $SD = .62$) ($t(49) = -2.333$, $p = .024$) in the attitudes category. A Wilcoxon Matched Pairs Signed Rank test also revealed a statistically significant difference between pre-survey and post-survey scores for all four items (See Table 2). This finding suggests that the game design experience had a positive influence on the participants' attitudes toward the use of digital games in teaching.

Qualitative data supported the finding. A number of participants commented that the game design assignment helped them see the educational potential of digital games and made them become more interested in the use of digital games in the classroom.

> "I think it made me more interested in the use of games in the classroom."
> "I have played digital games in the past, but I did not think it could be used as a resource in the classroom until now."
> "I've never been a big gamer and even less of an educational gamer. The exercise did however open my eyes to the possibilities of what could be and how they may help me in my class."

Self-Efficacy

Participants' self-efficacy regarding the use of digital games in the classroom was measured using three Likert-scale items. A significant difference in self-

Table 2 Attitudes before and after game design experience ($n = 50$)

	Pre-Survey	Post-Survey	Z	p
I am interested in using digital games in my classroom.	3.86 *(SD = 0.99)*	4.30 *(SD = 0.74)*	−3.013	.003**
I am excited about using digital games in my classroom.	3.94 *(SD = 1.04)*	4.30 *(SD = 0.76)*	−2.278	.023*
I feel comfortable using digital games in my classroom.	3.76 *(SD = 0.87)*	4.14 *(SD = 0.81)*	−2.739	.006**
I am against the use of digital games in the classroom.	1.78 *(SD = 0.65)*	1.40 *(SD = 0.61)*	−3.409	.001**

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

efficacy was found between the pre-survey ($M = 3.39$, $SD = .86$) and post-survey ($M = 3.96$, $SD = .60$) scores, ($t(49) = -5.384$, $p = .000$). A Wilcoxon Matched Pairs Signed Rank test also revealed a statistically significant difference between pre-survey and post-survey scores for all three items (See Table 3).

Educational Benefits of Digital Games

Participants' perceptions of educational benefits of digital games were measured using ten Likert-scale items and one open-ended item. The majority of the participants already possessed positive perceptions of the educational benefits of digital games before the game design assignment ($M = 4.22$, $SD = .45$). However, the post-survey scores ($M = 4.43$, $SD = .41$) were significantly higher than the pre-survey scores ($t(49) = -3.653$, $p = 0.001$). This result suggests that the game design experience positively improved their perceptions of the educational value of digital games. The result of a Wilcoxon test showed a significant increase from pre- to post-survey scores for seven out of ten items (See Table 4). However, the result showed that the game design assignment did not have a significant impact on the participants' perceptions related to the following three items:

- Digital games can foster collaboration among students.
- Digital games can be used to assess student learning.
- Digital games can help students develop problem-solving skills.

Participants were asked to describe the educational benefits of digital games before and after the game design assignment. Participants' responses to the open-ended items in the pre-survey and the post-survey were compared. Initially, the participants mostly discussed the entertaining and motivational value of digital games. The most frequently used words were "fun" and "engaging" (See Table 5). Over 60 % of the participants reported that digital games make learning fun and keep students engaged in the learning process. Eight participants (16 %) reported that digital games "appeal to students" since most of them play games at home. Four participants (8 %) commented that digital games help students "retain" and "recall" information (Table 5).

After completing the game design task, the participants discussed many other benefits of digital games. While no one mentioned "21st century skills" or "real world skills" in the pre-survey, fifteen participants (30 %) reported that digital games would promote the development of "real world skills" or "21st century skills" in the post-survey.

Table 3 Self-efficacy before and after game design experience ($n = 50$)

	Pre-Survey	Post-Survey	Z	p
I am confident using digital games in my classroom.	3.50 *(SD = 1.11)*	4.00 *(SD = 0.76)*	−3.154	.002**
I have knowledge and skills required for using digital games in the classroom.	3.20 *(SD = 0.95)*	3.96 *(SD = 0.67)*	−4.342	.000***
It is easy to integrate digital games into my teaching.	3.46 *(SD = 1.03)*	3.92 *(SD = 0.80)*	−3.384	.001**

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Table 4 Perceptions of educational benefits of digital games before and after game design experience ($n = 50$)

	Pre-Survey	Post-Survey	Z	p
Digital games can enhance students' motivation to learn.	4.52 *(SD = 0.54)*	4.72 *(SD = 0.49)*	−2.132	.033*
Digital games can help students develop higher-order thinking skills.	4.22 *(SD = 0.68)*	4.50 *(SD = 0.61)*	−2.858	.004**
Digital games can be helpful for my students' learning.	4.26 *(SD = 0.80)*	4.52 *(SD = 0.54)*	−2.355	.019*
Digital games can foster collaboration among students.	4.24 *(SD = 0.66)*	4.24 *(SD = 0.79)*	-.484	.629
Digital games help students develop 21st century skills.	4.34 *(SD = 0.59)*	4.58 *(SD = 0.58)*	−2.449	.014*
Digital games have the potential to support meaningful learning.	4.22 *(SD = 0.51)*	4.52 *(SD = 0.54)*	−2.884	.004**
Digital games can help me provide personalized instruction.	3.82 *(SD = 0.80)*	4.12 *(SD = 0.75)*	−2.499	.012*
Digital games can support the needs of diverse learners.	4.22 *(SD = 0.65)*	4.46 *(SD = 0.58)*	−2.353	.019*
Digital games can be used to assess student learning.	4.06 *(SD = 0.51)*	4.22 *(SD = 0.58)*	−1.633	.102
Digital games can help students develop problem-solving skills.	4.28 *(SD = 0.61)*	4.42 *(SD = 0.68)*	−1.528	.127

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

"Prior to designing my own game, I did not realize the types of 21st century skills students can learn from playing digital games outside of the obvious curricular knowledge they cover, such as problem-solving skills, collaboration skills, life-long learning skills etc. I also had not realized how games can promote student management of their learning and help students actively pursue new content knowledge obtainment on their own."

Nine participants (18 %) reported that digital games could be used for individualized or differentiated instruction.

"Probably the biggest impact I can see for digital games is the ability to individualize instruction, and allow each student to both proceed at an individual pace, and have ample chance for remediation."

Concerns

In the pre-survey, participants were asked what concerns they had about the use of digital games in the classroom. The analysis of qualitative data related to concerns revealed that the major concerns participants had about the use of digital games in the classroom included distractions caused by games (18 %), dependency on games (16 %), effectiveness of games (16 %), students focusing on gameplay rather than on learning (14 %), and others views (6 %). Table 6 provides sample quotes for each concern.

Table 5 Words used to describe the educational benefits of digital games (frequency)

Benefits (Pre-survey)	#	Benefits (Post-survey)	#
Fun/engaging/interesting	31	Fun/engaging	17
Appealing	8	21st century/real world/higher order thinking skills	15
Retain/recall	4	Individualization/differentiation	9
Problem solving	3	Learn through play	5
Learning through play	2	Reinforcement	2
Total	58		48

Table 6 Major concerns regarding the use of digital games in the classroom

Concern	#	Quotes
Distraction	9	• My main concern with the use of digital games in the classroom is the distraction it may cause. It takes one click for students to be on a social media site instead of doing their work.
		• Students becoming distracted in class and not using their time wisely while on the game.
Dependency on games	8	• My main concern is if the students would get too dependent on playing the game, as opposed to other forms of curriculum.
		• I think sometimes kids can get dependent on games to the point where they don't want to listen when you are teaching without the use of games.
Effectiveness of games	8	• I would be concerned about the actual effectiveness of learning via a video game.
		• Students may not get what they need out of the game because they are just clicking through or going through the trial and error process, not using their knowledge.
Students focusing on gameplay	7	• My only concern is that the learners will focus more on the entertainment aspect of the games and less on the actual content of the curriculum.
		• I would be concerned that some students would focus more on their performance on the game (i.e. achieving high score or answering quickly based on time restrictions) than mastering the concepts being evaluated.
Others' views	3	• Basically, students viewing my class as one in which we only play games and there is no teaching or learning at all.
		• I do not want parents, administrators, or the students to think we are just "playing games" for fun.

Participants' concerns were measured using five Likert-scale items as well as the open-ended item in the pre-survey. Overall, a significant decrease was found from pre-survey ($M = 2.27$, $SD = .52$) to post-survey ($M = 1.90$, $SD = .51$) scores in the Concerns category; $t(49) = 4.893$, $p = .000$. Further, a Wilcoxon test revealed a significant difference between pre- and post-survey scores for all five items (See Table 7).

Teacher Involvement in Educational Game Design

Initially, only 26 out of 50 participants (52 %) indicated that they were interested in designing their own games for their students. Fourteen participants (28 %) were neutral, and ten participants (20 %) were not interested in designing their own games. After completing the game design assignment, however, 76 % indicated that they were interested in designing their own games. A significant difference was found between the pre- and post-survey scores ($Z = -2.773$, $p = .006$) (See Table 8).

After the game design experience, all participants agreed or strongly agreed that teachers should be involved in the process of educational game design ($M = 4.56$, $SD = .61$). A Wilcoxon test showed that the difference between the pre-survey scores and post-survey scores on the teacher involvement item was

Table 7 Concerns before and after game design experience ($n = 50$)

	Pre-Survey	Post-Survey	Z	p
Digital games may draw students' attention but do not help them learn.	2.08 *(SD = 0.67)*	1.70 *(SD = 0.86)*	−2.549	.011*
Digital games are not effective for teaching complex content and high-level skills.	2.12 *(SD = 0.69)*	1.82 *(SD = 0.77)*	−2.321	.020*
Digital games can be distracting even though they are educational.	3.38 *(SD = 0.86)*	2.98 *(SD = 1.02)*	−2.236	.025*
Digital games are not compatible with my teaching style.	2.16 *(SD = 0.99)*	1.64 *(SD = 0.66)*	−3.401	.001**
Using digital games in the classroom is a waste of time.	1.62 *(SD = 0.69)*	1.36 *(SD = 0.59)*	−3.153	.002**

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Table 8 Perceptions of teachers' involvement in educational game design before and after game design experience ($n = 50$)

	Pre-Survey	Post-Survey	Z	p
I am interested in designing my own games for my students.	3.40 *(SD = 1.14)*	3.92 *(SD = 1.03)*	−2.773	.006**
Teachers should be involved in the process of educational game design.	4.18 *(SD = 0.77)*	4.56 *(SD = 0.61)*	−2.860	.004**

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

statistically significant ($Z = -2.86$, $p = .004$). Several participants commented in the post survey, that teachers should be involved in game design:

> "I learned it is ESSENTIAL for experienced teachers to be involved in game design."
> "More teachers need to be exposed to the work necessary for digital game design."

Discussion and Conclusion

This study was limited by a relatively small sample size and a short intervention period. However, the findings of the study have important implications for teacher professional development and educational game design. The game design experience had a positive influence on the participants' attitudes, self-efficacy, and perceptions regarding the use of digital games in the classroom. The participants became more interested in, more confident with, and less concerned about using digital games in teaching after designing their own educational game. They also developed more positive perceptions of the educational value of digital games. The results showed a significant increase from pre- to post-survey scores for seven out of ten items regarding educational benefits of digital games. Although a significant increase was not found for the three items related to collaboration, assessment, and problem-solving skills, the mean scores showed that participants had positive perceptions about them.

Initially, the participants seemed to view digital games as entertaining or motivational tools. After the game design experience, on the other hand, they realized that digital games could help students develop higher-order thinking skills and 21st century skills beyond making learning fun and engaging. They also realized that they could provide individualized or differentiated instruction using games. The findings suggest that engaging teachers in conceptual design of a digital learning game is an effective way to help them better understand the educational potential of digital games and alleviate their concerns or skepticism from unfamiliarity and lack of experience with good games.

Teacher education and teacher professional development programs should consider providing teachers with opportunities to design their own digital games for their students. Engaging teachers in actual development of digital learning games using game design software could help them better understand game-based learning (Li 2012), but frustration with technical problems in the game design process may negatively influence their perceptions of game design and game-based learning. Previous research on teachers' game design experiences shows that teachers' limited programming skills or the constraints of game design software often prevent them from implementing their original design ideas (Li 2012; Li et al. 2013). It is therefore suggested that teacher education and teacher professional development programs engage teachers in conceptual design of digital learning games before having them actually develop games using game design software.

Surprisingly, all participants believed that teachers should be involved in the process of educational game design. While teachers are end-users of digital learning games, teacher perspectives are often not fully considered in the game design process. Educational game developers should involve teachers in the design process in order to create games that can be successfully integrated in the classroom. Takeuchi and Vaala (2014) reported that most game-using teachers were using shorter-form genres such as drill-and-practice, trivia, and puzzle games. Sancar Tokmak and Ozgelen (2013) found that while the majority of pre-service teachers planned to apply a behaviorist philosophy when preparing a lesson using existing computer games, over 60 % of the participants applied a constructivist learning theory when redesigning computer games. As the participants in their study indicated, most games available to teachers today may prevent them from developing game-based lessons based on a constructivist philosophy because they require students to have pre-knowledge to play. While drill-and-practice games can be useful for practice and reinforcement, the need for developing more constructivist game-based learning environments is apparent. It is necessary to involve teachers in the design process in order to create digital game-based learning environments that engage students in meaningful learning and help them develop 21st century skills.

Future research should further examine how game design experience affects teachers' perceptions of game-based learning and pedagogical approach. Second, further research is needed to examine the differences in perceptions, design strategies, concerns, and support needs between middle school and high school

teachers. Finally, future research could explore teachers' perceptions of game-based learning focusing on a specific game genre, such as immersive 3D games. Exploring how the design of 3D game-based learning environments changes teachers' perceptions of the use of digital games in the classroom would be interesting.

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