Student, parent, and teacher perceptions towards digital educational games: How they differ and influence each other

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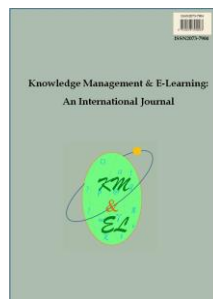
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Abstract: Digital game-based learning has received increased attention in education. As the key stakeholders in education, students, parents, and teachers may have different perceptions and attitudes towards game-based learning, which have a great impact on its adoption and dissemination. However, there is a lack of research examining how the perceptions of different stakeholders towards digital educational games may differ and influence each other. This study aimed to address the gap by investigating the perceptions of students, parents and teachers towards digital educational games, the differences and relationships between their perceptions, and possible sources of their perceptions. The study was conducted with 415 participants in China, a country that has tension between play and learning in its traditional values. The results reveal that most students, parents and teachers have certain experience playing mobile games, but with limited knowledge about educational digital games. Students have more positive perceptions towards digital educational games than teachers and parents, and the perceptions of teachers and parents are correlated with each other. After an introduction to an educational digital game, students' and parents' intention to recommend game-based learning increased, which, however, was not the case for teachers. Implications of the findings were discussed.

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1. Introduction

Game-based learning has been increasingly considered a promising strategy to promote student learning and engagement (Cheng et al., 2015; Connolly et al., 2012; Drigas et al., 2014; Lunn et al., 2016; Steinkuehler, Squire, & Barab, 2012; Zou et al., 2021), mainly by fostering authentic and engaging learning in a secured environment (Buckley, Doyle, & Doyle, 2017; Dede, 2005). Research in this field has explored the incorporation of game-based learning in traditional education, comparisons between games and other learning methods, and comparisons among different game mechanisms (Cheng et al., 2015; Dicheva et al., 2015; El Mawas et al., 2020).

The literature has reported promising effects and benefits of game-based learning in various disciplines (De la Hera et al., 2017; Hamari, Koivisto, & Sarsa, 2014; Huizenga et al., 2017). In particular, game-based learning has been increasingly promoted in science education (Li & Tsai, 2013) with applications in biology (Cheng et al., 2011), chemistry (Winter, Wentzel, & Ahluwalia, 2016), and physics (Carr & Bossomaier, 2011). These studies demonstrate that digital games with high degree of flexibility and responsiveness can facilitate scientific processes such as hypothesis testing and argumentation formation (Spires et al., 2011; Squire & Jan, 2007); digital games and simulations with advantages in visualization and animation can contribute to student motivation, knowledge construction, and learning performance (Hsu, Tsai, & Liang, 2011; Wu & Wang, 2012).

While game-based learning has received increased attention, people's attitudes and perceptions towards digital games have a great impact on its adoption and dissemination in education. For example, teachers' perceptions of game-based learning are found to be crucial to the selection, implementation and evaluation of learning games for their students (Hanghøj & Engel Brund, 2011). Meanwhile, the perceptions of digital learning games may differ among students, educators, and parents, the key stakeholders in education (Demirbilek, 2010; Lee et al., 2011). Further, different perceptions among different stakeholders may influence each other (Bourgonjon et al., 2011).

1.1. Perceptions of different stakeholders towards digital educational games

Perceptions play an important role in the adoption of new technologies like digital games. Existing studies on people's perceptions and attitudes towards digital games have focused on digital games in general, without differentiating educational games and pure entertainment games. For example, children and parents were found to hold different opinions about the 'appropriate' game content and gaming behavior, which may lead to

different perceptions of digital games (Nikken & Jansz, 2006). Teenagers and adolescents are more likely to own gaming devices and gaming applications than adults (Lenhart et al., 2010). However, children's use of screen media (for game-playing and others) is strongly influenced by parents' attitudes towards screen media (Cingel & Krcmar, 2013). Parents tend to have strict attitudes on game-playing when they fear negative effects of playing games (Nikken & Jansz, 2006).

Regarding educational digital games, parents often have negative perceptions, which is enlisted as a barrier toward the adoption of games in classroom settings (Bourgonjon et al., 2011). In addition, parents' perceptions about the educational values of digital games are strongly influenced by the advice from school teachers and experts, and the negative portrait of digital games in the mass media (Bourgonjon et al., 2011). With the mobile gaming industry is becoming a multibillion-dollar business, discussions on the negative effects of gaming have prevailed. For example, the media regularly features stories on the connection between game-playing and Internet addiction (Wallis, 2011). Such negative information may influence people's attitudes towards game-based learning, especially when they have a lack of basic knowledge of educational games.

Teachers' attitudes and perceptions towards digital games in education are found to be mixed in terms of the effectiveness and barriers of using learning games in classrooms (Allsop, Yildirim, & Screpanti, 2013; Dickey, 2015; Watson & Yang, 2016). They can be influenced by the gender, teaching level, and experience with games (Huizenga et al., 2017), as well as the parents' thoughts about digital games (Bourgonjon et al., 2011). Many teachers have limited experience of using digital games as learning or teaching tools, and therefore have limited awareness of the instructional merit of digital games (Schrader, Zheng, & Young, 2006). Teachers' limited use of digital game-based learning can be the result of multiple factors such as the constraints of current educational system, and challenges with using technology, obtaining appropriate games, and implementing game-based learning (Demirbilek, 2010; Ertzberger, 2009; Huizenga et al., 2017).

1.2. Factors influencing the perceptions of digital educational games

Individual perceptions of digital educational games can be influenced by multiple factors such as the game's usefulness, ease of use, learning opportunities, subject norm, negative effects of gaming, and personal experience with digital games (Bourgonjon et al., 2010; Bourgonjon et al., 2011; Li et al., 2016). Research shows that the quality of digital games plays an important role in affecting people's perceptions of digital games (Pinelle, Wong, & Stach, 2008; Sherry et al., 2006). The quality concerns include the usability of digital games for various school subjects (Beavis, Muspratt, & Thompson, 2015), relevance of the content in relation to the competencies aimed to develop (Martí-Parreno, Galbis-Cordova, & Miquel-Romero, 2018), graphic and audio quality (Pinelle, Wong, & Stach, 2008), and response time (Sherry et al., 2006) among others. Moreover, it is important to adapt educational game content to individual needs for personalized learning (Hooshyar, Yousefi, Wang, & Lim, 2018; Hooshyar et al., 2021) and support the transfer of learning beyond the game (Hamari, Koivisto, & Sarsa, 2014).

Mayer and Johnson (2010) proposed the following characteristics of the quality of digital educational games: a set of rules and constraints, dynamic responses to the learners' actions, appropriate challenges, and gradual and learning outcome oriented. However, there is inadequate research investigating the impact of the quality of digital educational games on individual perceptions and attitudes towards game-based learning.

Further, social-cultural contexts may affect individual perceptions of digital learning games (Bai, 2005; Statista, 2018; Wallis, 2011; Li & Tsai, 2013; Lukosch et al., 2017). For example, China is a country that has unique traditional conceptions on play and learning along with tension between the two (Bai, 2005). In China, Confucianism proposed the phrase 'wan wu sang zhi', namely frivoling things would result in the loss of goals, indicating a hostile perception towards play (Bai, 2005). Instead of showing the appreciation of 'the ordinary child' who enjoys playing, the Confucian writings attempt to advocate the image of 'the ideal child' who is a self-disciplined learner. Influenced by Confucian culture valuing academic achievement and authority, many Chinese parents have high expectations on child education and regard gaming and learning as distinct and even contradictory. Many Confucian educators assume that education should be sober rather than fun. A multinational study by McMullen et al. (2005) revealed that while teachers in China believed in student-centered practices and emphasized it in the educational reform, there was low correlation between their beliefs and practices. Although there is progress in terms of increased class discussion and student stress reduction, many teachers use technology primarily for teacher-centered purposes, such as teaching preparation and instructional delivery (Li & Ni, 2011), which is not fully aligned with the rationale of engaging students in active learning through game-playing.

1.3. The present study

Student, parent, and teacher perceptions towards digital educational games play an important role in adopting and disseminating game-based learning. As the key stakeholders in education, students, parents, and teachers may have different perceptions and attitudes towards game-based learning. However, it remains unclear how the perceptions of these different stakeholders may differ and influence each other and how individual perceptions are developed as a result of multiple factors. This study aimed to address the gap by exploring the perceptions of students, parents, and teachers on digital educational games, the differences and relationships between their perceptions, and possible sources of their perceptions. This study was conducted in China, a country that has tension between play and learning in its traditional values. Game-based physics learning was selected as the focus of this study since digital games have shown their potential in science education and physics is a core subject in science education.

The research questions (RQ) of the study are specified as follows.

- RQ1: How do students', parents' and teachers' perceptions of digital educational games differ and relate to each other?

- RQ2: How do students, parents and teachers develop their perceptions of digital educational games?

To answer RQ1, a set of questions adapted from relevant previous studies were used in the questionnaire to elicit the participants' perceptions of digital educational games. Relevant statistical tests including correlational analysis, simple linear regression, one-way ANOVA were carried out to investigate the relationship among different perceptions.

To answer RQ2, a specific game for secondary physics learning was introduced to the participants in order to examine their possible changes of perceptions after the introduction. In addition, the participants were invited to a follow-up interview to elicit their reasons for recommending or not recommending digital game-based learning.

2. Method

This study used a mixed-method approach to collect and analyse student, parent, and teacher perceptions of digital educational games. The mixed methods included survey questionnaire and semi-structured interviews. This study was approved by the Human Research Ethics Committee of the researchers' university.

2.1. Participants

The study involved 415 volunteer participants, with 254 students, 142 parents and 19 physics teachers. They were recruited from 6 local mainstream secondary schools in Southern China. The classes of students were randomly selected by lottery from Grade 8 to Grade 9. Not all of their parents agreed to participate in the study, so the number of parent participants was lower than that of the students'. Since one teacher would be responsible for multiple classes of students, the number of teacher participants (i.e., the teachers of the student participants) was the smallest among the three groups of participants.

2.2. Procedure

Consent forms with introduction of the study were distributed to teachers, students and parents and returned to the researcher the next day. For parents, consent forms were taken home by their children. All participants were asked to respond to the questionnaire and their responses were guaranteed confidentiality. The questionnaire was taken home as a weekend task and returned to the researcher the next week. The participants were asked to complete the first and second parts of the questionnaire to collect their background information and their perceptions toward game-based learning in general. Then, a specific prototype game was demonstrated to the participants. Later, they were asked to complete the third part of the questionnaire to rate the quality of the demonstrated game. Finally, 22 respondents with extreme preference or dislike towards game-based learning in the questionnaire were invited for an interview conducted via telephone. The interviews were audio-recorded with consent.

2.3. Measures and instruments

2.3.1. Survey questionnaire

The questionnaire contained three parts to collect the participants' (1) background information; (2) perceptions toward game-based learning; and (3) perceived quality of a demonstrated game. As most of the participants had insufficient English proficiency, they were given a Chinese version of the questionnaire to answer. The items in the questionnaire were first translated from English into Chinese by the first author, and backward translated into English by a bilingual Ph.D. in linguistics. Then, two Ph.D. in education rated the level of agreement between the original and back translated versions to ensure reliability of the Chinese version.

The *first* part of the questionnaire elicited participants' background information including gender, age, region, educational level, frequency of using digital devices, frequency of digital gaming, attitudes toward digital gaming, attitude towards physics (students only), academic performance in physics (students only), 'ever heard about digital educational games' and 'describe if yes'.

The *second* part of the questionnaire tested participants' perceptions toward game-based learning in general with the adapted Technology Acceptance Model (Bourgonjon et al., 2010). The instrument was comprised of 22 items in five dimensions including Usefulness; Ease of use; Learning opportunities; Experience with digital educational games; and Preference for digital educational games. Internal consistency was indicated by Cronbach alpha, which was 0.83 for Usefulness, 0.79 for Ease of Use, 0.75 for Learning Opportunities, 0.85 for Experience with Digital Educational Games, and 0.75 for Preference for Digital Educational Games. All the Cronbach coefficients were over 0.70, confirming that all the sub-scales are reliable.

In addition, participants were asked whether they would recommend the use of digital educational games in learning. For teachers and parents, they needed to answer all the questions from their students' or children's perspectives. For example, whether they think their students or children would improve performance with the digital educational games.

In the *third* part of the questionnaire, the participants were asked to rate the quality of the demonstrated game with a scale developed by Papastergiou (2009). In addition, they were asked again about their intention to recommend game-based learning. The instrument for rating a game was comprised of 11 items in four dimensions including Overall appeal; Quality of the user interface; Accessibility of the contained learning material and questions; Perceived educational value. Internal consistency was indicated by Cronbach alpha, which was 0.78 for Overall appeal, 0.82 for Quality of the user interface, 0.71 for Accessibility of the contained learning material and questions, and 0.73 for Perceived educational value, suggesting that all of the sub-scales are reliable.

To rate the quality of the demonstrated game, the participants were presented with a prototype game and scripted scenario designs, which resembled those in other studies (e.g., Lowry et al., 2013). The game was designed aligned with the curriculum for electricity and circuits in secondary physics in Mainland China. The major expected learning outcomes of the game include understanding related concepts such as series circuits, resistance, electrical appliances, identifying the problems of given circuit connection, applying the circuital laws to create workable circuits. Fig. 1 presented a screenshot of the game.

Fig. 1. A screenshot of the game

In the game, the user acts as an electro master to repair the circuits in a city suffered from electricity outage by manipulating relevant items provided (e.g., electric

wires, switch, electrical appliances). To increase student engagement, the design adopted the elements proposed by Mayer and Johnson (2010), which include: (a) a set of rules and constraints (e.g., the objective of each challenge and the available items are clearly stated at the beginning of each challenge); (b) dynamic responses to the learners' actions (e.g., the response time is instantaneous); and (c) gradual and learning outcome-oriented (e.g., the level of challenge ranges increases).

2.3.2. Interview

To investigate the sources of perceptions, the participants with extreme preference or dislike towards digital educational games as indicated in the questionnaire were invited to attend a semi-structured interview. The interview focused on two issues, i.e., reasons for recommending or not recommending digital game-based learning.

2.4. Data analysis

Cronbach's a was run to assess the internal consistency of the questionnaire. Descriptive statistics including mean and standard deviation of the perceptions of students, parents and teachers were reported. The differences in the mean values were compared.

To examine the relationship between the perceptions of students, parents and teachers, students whose parents did not participate in the study would be excluded. Correlational analysis and one-way ANOVA analysis were carried out to compare the perceptions. In addition, simple linear regression was implemented to test any predictive relationship between the perceptions.

To investigate the differences in perceptions before and after introducing the specific game, paired-sample t-test was performed to test the possible changes in acceptance, and chi-square test of independence was conducted to measure the change in the intention to recommend game-based learning.

Besides, a simple linear regression analysis between the perceived quality of the game and acceptance of the game for learning was performed.

The participants' responses to interview questions were transcribed and analysed through open coding (Corbin & Strauss, 1990). The coding scheme including the themes and codes was created and refined based primarily on the participant responses in a comparative and iterative manner.

3. Results

3.1. Participant demographics

Participant demographics captured from the questionnaire are presented in Table 1. The number of male and female participants were almost equal, and they were from 4 major cities in Southern China. Teachers generally were younger and had higher educational attainment than parents. Parents and teachers tended to spend more time on mobile phone use, but less on mobile game play than students. Most of the student participants reported that they had average or above average academic performance in physics subject. The majority of the participants were reported not to have heard about digital educational games.

Table 1
Background data of the students, parents and teachers

Aspects	Frequency		
	Students (N = 254)	Parents (N = 142)	Teachers (N = 19)
Gender			
Male	137 (53.9%)	66 (46.5%)	7 (36.8%)
Female	117 (46.1%)	76 (53.5%)	12 (63.2%)
Region			
Guangzhou	35 (13.7%)	4 (2.8%)	1 (5.3%)
Shenzhen	102 (40.2%)	35 (24.7%)	14 (73.7%)
Zhuhai	38 (15.0%)	27 (19.0%)	1 (5.3%)
Dongguan	79 (31.1%)	76 (53.5%)	4 (21.1%)
Age			
Below 20	254 (100%)	-	-
20-30	-	6 (4.2%)	11 (57.9%)
30-35	-	11 (7.7%)	1 (5.3%)
35-40	-	48 (33.8%)	0 (0)
Above 40	-	77 (54.2%)	7 (36.8%)
Educational level			
Grade 8	106 (41.7%)	-	-
Grade 9	143 (56.3%)	-	-
Grade 10	2 (0.8%)	-	-
Grade 11	3 (1.2%)	-	-
Below high school	-	56 (39.4%)	0 (0)
High school	-	41(28.9%)	0 (0)
Associate degree	-	24 (16.9%)	0 (0)
Bachelor's degree	-	12 (8.5%)	10 (52.6%)
Master's degree or above	-	9 (6.3%)	9 (47.4%)
Frequency of mobile usage			
Less than once a week	23 (9.1%)	0 (0)	0 (0)
1-3 times a week	73 (28.7%)	0 (0)	0 (0)
4-7 times a week	70 (27.6%)	0 (0)	0 (0)
More than 7 times a week	88 (34.6%)	142 (100%)	19 (100%)
Frequency of playing mobile games			
Less than once a week	90 (35.4%)	86 (60.6%)	10 (52.6%)
1-3 times a week	101 (39.8%)	34 (23.9%)	6 (31.6%)
4-7 times a week	32 (12.6%)	11 (7.7%)	1 (5.3%)
More than 7 times a week	31 (12.2%)	11 (7.7%)	2 (10.5%)
Attitude towards playing mobile games			
Extremely dislike	23 (9.1%)	54 (38.0%)	5 (26.3%)
Dislike	39 (15.4%)	39 (27.5%)	7 (36.8%)
Neutral	83 (32.7%)	38 (26.8%)	5 (26.3%)
Like	60 (23.6%)	6 (4.2%)	1 (5.3%)
Extreme like	47 (18.5%)	5 (3.5%)	1 (5.3%)

[Missing data]	[2 (0.8%)]	-	-
Attitude towards physics			
Extremely dislike	2 (0.8%)	-	-
Dislike	9 (3.5%)	-	-
Neutral	78 (30.7%)	-	-
Like	80 (31.5%)	-	-
Extreme like	83 (32.7%)	-	-
[Missing data]	[2 (0.8%)]	-	-
Physics Academic performance			
Extremely poor	12 (4.7%)	-	-
Poor	32 (12.6%)	-	-
Average	100 (60.6%)	-	-
Good	78 (30.7%)	-	-
Extremely good	32 (12.6%)	-	-
Ever heard about digital educational games			
Yes	64 (25.2%)	23 (16.2%)	5 (26.3%)
No	188 (74.0%)	119 (83.8%)	14 (73.7%)
[Missing data]	[2 (0.8%)]	-	-

3.1.1. Attitude towards playing mobile games

The one-way ANOVA analysis revealed a significant difference among the three groups on attitudes towards playing mobile games, $F(2, 410) = 51.47$, $p < 0.001$, $\eta 2 = 0.201$. From the post-hoc Tukey tests, student group ($M = 3.27$, $SD = 1.20$) had significantly higher preference rating than the parent group ($M = 2.08$, $SD = 1.07$), $p < 0.001$, and the teacher group ($M = 2.26$, $SD = 1.10$), $p < 0.001$. Nevertheless, there is no significant difference between the parent group ($M = 2.08$, $SD = 1.07$) and the teacher group ($M = 2.26$, $SD = 1.10$), $p = 0.786 > 0.05$.

3.1.2. Ever heard about digital educational games

One-way ANOVA analysis showed no difference among the three groups (Student $M = 1.75$, $SD = 0.436$; Parent $M = 1.84$, $SD = 0.370$; Teacher $M = 1.78$, $SD = 0.452$) regarding the question of whether they have heard about digital educational games before, $p = 0.099 > 0.05$. Even some reported yes to this question, when asked to name or describe the game, almost all of the entries did not accurately reflect digital educational games. Some frequently stated game include the King of Glory developed by Tencent Mobile Games, online dictionaries, online Mahjong, and online tutoring platform.

3.2. Perceptions of digital educational games

Linear regression analysis found a significant correlation between teachers' ratings and parents' ratings on the perceptions of digital educational games, as shown in Table 2. Non-significant correlation was found between students' ratings and the two other groups' ratings.

Table 2
Correlation between teachers' ratings and parents' ratings on perceptions

Item	R^2	$F(1, 17)$	p
Perceived usefulness	0.217	4.713	$0.044 < 0.05$
Perceived ease of use	0.230	5.092	$0.037 < 0.05$
Perceived learning opportunities	0.497	16.825	< 0.001
Experience with games	0.312	7.720	$0.013 < 0.05$
Preference for digital educational games	0.246	5.556	$0.031 < 0.05$

3.3. Intention to recommend game-based learning

A chi-square test of independence found a significant difference in the intention to recommend game-based learning before and after introducing a game for all the participants, as shown in Fig. 2 and Table 3. The pre-post difference is significant for students and parents, but not for teachers.
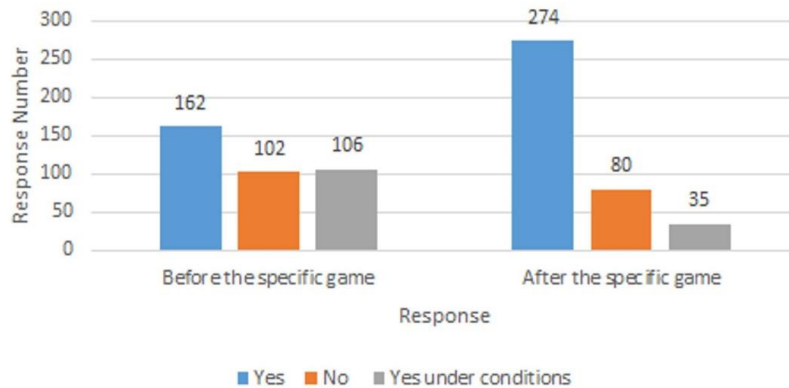

Fig. 2. Recommendation intention before and after introducing the game

Table 3
Chi-square test for the difference in recommendation intention before and after introducing the game

Identity	$\chi^2(4)$	p	Cramer's V
All participants	153.558	0.001	0.465
Students only	84.303	0.001	0.455
Parents only	67.889	0.001	0.507
Teachers only	2.551	$0.636 > 0.05$	0.259

3.4. Perceived game quality and intention to recommend game-based learning

Correlational analysis showed a significant and strong correlation among the constructs for quality rating developed by Papastergiou (2009), as shown in Table 4. Therefore, an average of the four constructs was calculated for the overall perceived quality.

Table 4
Pearson correlations among the constructs for quality rating

	(a)	(b)	(c)	(d)
(a) Overall appeal	1	0.913**	0.858**	0.900**
(b) Quality of the user interface	0.913**	1	0.871**	0.846**
(c) Accessibility of the contained learning material and questions	0.858**	0.871**	1	0.825**
(d) Perceived educational value	0.900**	0.846**	0.825**	1

A simple linear regression was calculated to predict the recommendation intention based on the ratings of the quality of the game. A significant regression equation was found ($F(1, 387) = 151.954$, $p < 0.001$), with an R^2 of 0.269 and $\beta = 0.494$. That is, perceived quality of the game could significantly predict the recommendation intention.

3.5. Interview results

Based on their responses in the questionnaire, 13 student participants, 7 parent participants and 2 teacher participants were selected to be interviewed. Two trained researchers coded all of the responses, and their inter-coder reliability (Cohen's kappa 0.84) indicated a high level of agreement. According to the interview result, the stated reasons for using digital educational games are summarized in Table 5.

Table 5
Reasons for recommending digital game-based learning

Themes	Examples	Frequency		
		Students ($N = 13$)	Parents ($N = 7$)	Teachers ($N = 2$)
1. Learning through playing is interesting.	The form of digital games could boost intrinsic learning motivation.	13 (100%)	6 (86%)	2 (100%)
2. Digital educational games are effective and useful for learning.	Learning is more effective with interactive graphics and animations in digital educational games.	8 (62%)	2 (29%)	0

| 3. Digital educational games are innovative. | Learning through digital educational games differs from traditional teaching and learning. | 10 (77%) | 7 (100%) | 1 (50%) |
| 4. Technology-enhanced learning is the trend. | We need to embrace the technological trend in education. | 11 (85%) | 7 (100%) | 2 (100%) |

The interview results on the stated reasons for not recommending digital game-based learning are summarized in Table 6.

Table 6
Reasons for not recommending digital game-based learning

Themes	Examples	Frequency		
		Students (*N* = 13)	Parents (*N* = 7)	Teachers (*N* = 2)
1. Digital educational games are not recommended for senior students.	Senior students need to focus on exam preparation, which is more about systematic review and exam techniques.	13 (100%)	7 (100%)	2 (100%)
2. The availability of quality digital educational games is in great concern.	It seems that there is no available digital educational games designed aligned with the formal curriculum.	10 (77%)	4 (57%)	2 (100%)
3. Digital educational games might not be effective in terms of learning.	The form of digital games can only immerse students in playing rather than learning.	3 (23%)	6 (86%)	1 (50%)
4. Children might get addicted to the games.	The form of digital games is attractive to children, which could make them addicted to playing.	8 (62%)	6 (86%)	1 (50%)

During the interview, all the 4 parents with negative attitudes towards digital game-based learning as shown in the questionnaire showed that they could not differentiate digital educational games and video games for pure entertainment, even after introducing a prototype game to them. They further expressed the trust and belief in traditional teaching and learning, for example, listening to teachers in the classroom quietly and completing written homework in time.

4. Discussion

The findings of this study are discussed around the two research questions.

4.1. *How do students', parents' and teachers' perceptions of digital educational games differ and relate to each other?*

Overall, the study suggested that while students generally had more positive comments, parents and teachers remained more conservative. Students were found to have significantly stronger preference for general mobile game play than teachers and parents. This echoed the study conducted by Lenhart et al. (2010), which found that teenagers and adolescents were more likely to own gaming devices and gaming applications than their adult counterparts.

The significantly different attitudes between students and parents might be explained in two ways. On one hand, younger generations in general prefer game play (Lenhart et al., 2010). It is plausible that digital educational games as one type of digital games are regarded more favorable by students. On the other hand, the traditional Chinese philosophy distinguished playing and learning (Bai, 2005). As Western ideas are gaining momentum among younger generations in Asian countries, they may not accept the separation of playing and learning as their parent counterpart.

For teachers and parents, their perceptions toward digital educational games were shown significantly correlated with each other. School teachers were found to play an essential role in deciding learning materials for students (Bourgonjon et al., 2010). In particular, in Chinese culture where teachers were expected to be an epistemic model of teaching (Cortazzi & Jin, 1996), parents tend to seek advice from teachers academically. This might be able to explain their similar attitudes towards given learning materials. Moreover, parental expectations as a source of pressure could also impact teachers' attitudes and practice (McMullen et al., 2005). It was found that teachers' autonomy is diminishing in a global study (Ballet, Kelchtermans, & Loughran, 2006) and that pressure from parents could positively predict teacher burnout (Stoeber & Rennert, 2008). It is reasonable that if parents perceive digital educational games as harmful to their children, the teachers are likely to hold a less favorable attitude as well.

Given their preference for mobile game play, students were believed to be more familiar with digital games in general. However, in the questionnaire, few participants, including the students, reported to have heard about digital educational games before, showing a common unfamiliarity with digital educational games among the respondents. This is also in line with the concern about limited availability of relevant digital educational games in China as revealed in the interview. For those with positive response, their descriptions of the games did not conform to the definitions of digital educational games as well. To be more specific, they were inclined to confuse digital educational games with entertainment games or other applications on digital devices. For example, one frequently mentioned game was the King of Glory, developed by Tencent Mobile Games, which has been popular among teenagers in China and has been greatly criticized by the public and the state press for bringing harmful effects to students academically and psychologically.

While all the interviewees agreed that the form of digital game-based learning could increase students' learning motivation, which echoed with previous studies (e.g., Papastergiou, 2009; Hamari, Koivisto, & Sarsa, 2014), some specific preferred conditions of using digital educational games for learning were found in the interviews. To begin

with, the type of learning content was believed to be critical. Students were reported in favour of using digital educational games to learn 'difficult and abstract concepts', which corresponded with the findings of previous studies on adopting digital game-based approach in science education (e.g., Hsu, Tsai, & Liang, 2011). Furthermore, all the interviewees mentioned that digital game-based learning was not appropriate for senior grade students, as students need to get focused on preparation for exams in the senior grade. The consensus of associating the use of digital educational games to school grade could be recognized as a reflection of the exam-centric education system and pedagogy in China. The backwash effect of examinations refers to the influence of examinations on teaching and learning (Qi, 2007). The effect is more predominant in the context of high-stakes exams where results can significantly influence one's life, such as 'Gaokao', the College Entrance Examination in China (Brandenburg & Zhu, 2007). As a result, despite the stronger learning motivation associated with digital educational games, such innovative approach might not be able to cater for the needs of exam preparation, the primary task of senior students as perceived by students, parents, and teachers. Another explanation may be that younger students usually have lower expectations of game quality than older students, and therefore, are more willing to play games for educational purposes (Watson & Yang, 2016).

4.2. How do students, parents and teachers develop their perceptions of digital educational games?

As discussed previously, the significant correlation between parent and teacher perceptions indicates the role of perceived teachers' advice (e.g., Bourgonjon et al., 2010; Cortazzi & Jin, 1996) and parental expectations (e.g., Ballet, Kelchtermans, & Loughran, 2006; Stoeber & Rennert, 2008) in the formation of parent and teacher perceptions towards digital educational games respectively.

Participants were more likely to recommend game-based learning after being introduced a specific prototype. The first reason might be related to their unfamiliarity with digital educational games before the game was introduced. As shown in the previous paragraph, most of the respondents in the questionnaire had little experience with digital educational games and some even held misconceptions towards this form of games. The relatively negative perceptions or low recommendation intention before might be an influence of the media that reported digital games with concerns about mobile addiction (Bourgonjon et al., 2011). The common reference to a controversial entertainment game in the questionnaire as mentioned previously also indicated the influence of the media over one's perceptions. Such result also echoed with the previous studies that perceptions towards the educational value of games could be positively modified by participations in a series of learning games (Ray & Coulter, 2010).

Secondly, the perceived quality of the game was found to be able to predict recommendation intention. That is, respondents who perceived the specific game to be high quality would be more willing to recommend digital game-based learning. This also echoed the responses in the questionnaire that effectiveness and relevance of the digital educational games represented the major reasons for as well as concerns about using digital educational games. Previous studies found that parents would advocate information technologies as long as they explicitly foster learning (Kong, 2008; Kerawalla & Crook, 2002). As all the student, parent and teacher interviewees mentioned, the availability of quality digital educational games is in great concern. In short, the perceived deficiency of quality digital educational games might reinforce their

misconceptions of digital games, contributing to a low level of willingness to recommend game-based learning before a quality game was presented.

It is noteworthy that the change of recommendation intention was not significant for teachers after the introduction of a specific game. This could be related to the teachers' beliefs and habits in traditional teaching. Teachers generally face significant challenges when considering digital games as an innovative pedagogy in a school context, for school environments are regarded as traditionally sanctioned cultural spaces or direct instructions and high-stakes tests (Chee, Mehrotra, & Ong, 2015). In addition, teacher education is lagging compared to the rapid development of the information technologies. A study on the readiness of secondary preservice teachers in using technology in teaching in China found that teachers overall reported a low level of ability to use technology and shared concerns about technology training from teacher education programs (Zhou, Zhang, & Li, 2011) In this light, digital educational game, a representative of the recently emerging high-tech tools for enquiry learning, is not well accepted, or at least the use of it is not comfortably recommended by the teachers.

4.3. Limitations of the study

It should be noted that the participants in this study were recruited from four major cities in Southern China. The representativeness could be increased by expanding future studies in other smaller cities. In addition, due to the availability of relevant digital educational games aligned with mainstream physics curriculum in China, only a prototype of the game was provided to students. Future studies may benefit from including a real game in the research. Besides, the relation between teacher and parent perceptions was found only correlational. The causal mechanisms behind should be further tested.

5.   Conclusion

The study examined the perceptions of students, teachers, and parents on using educational digital games. The findings reveal how the perceptions towards digital learning games differ among different stakeholders and can be influenced by multiple factors. It was found that students, parents, and teachers overall have limited understanding towards digital educational games. Parents and teachers in general have more negative perceptions toward digital educational games than students, and the perceptions of parents and teachers influence each other. Besides, digital educational games are perceived more effective for the learning of difficult and abstract science concepts and for useful for junior students. Lastly, teachers' advice, parents' expectations, media influence, the availability of quality digital educational games, and teachers' habitual use of technology may contribute to the development of relevant perceptions towards digital educational games.

The findings of this study may help educational researchers and practitioners to have a better understanding of different stakeholders' perceptions of digital game-based learning, which is crucial to the adoption and dissemination of game-based learning. The findings also provide implications for effective promotion of game-based-based learning in educational practice. *First*, given the prevalent misconceptions or unfamiliarity of digital educational games as well as the media influence, advocators may need to distinguish between educational and entertainment games in their promotion. *Second*, the lower acceptance of game-based learning by teachers and parents indicates a need for game designers to incorporate the expectations of teachers and parents in game design.

Third, since the quality of games was found to be a key concern of students, parents, and teachers, game developers need to pay high attention to the rules of high-quality games if they would like to dive deep into the digital educational game sphere. *Last but not least*, the potential tension between learning and play in traditional school environment suggests the need for building a more open school atmosphere to realize the potential of game-based learning.

Author Statement

The authors declare that there is no conflict of interest.

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