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PERCEPTIONS OF TEACHERS TOWARD GAME-BASED PROGRAMMING TOOLS IN K-12 CLASSROOMS

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ABSTRACT

In recent years, game-based programming tools (GBPTs) such as Lightbot, Cargo-Bot, and Run Marco have been developed to help children worldwide better understand programming concepts through an interesting, enjoyable and visualizable programming learning experience. However, in-service teachers' perceptions regarding the use of these game-based programming tools in K-12 instruction have received little attention. To understand the perceptions of teachers, this study integrated perceived enjoyment into the Technology Acceptance Model (TAM) to explore the factors that influence the intentions of K-12 in-service teachers to use game-based programming tools in their instructional tasks. Thirty Chinese teachers in elementary and secondary schools were invited to finish at least one hour of code tutorial at the code.org site, and then undertake a paper-and-pencil questionnaire. We applied the partial least squares structural equation modeling technique to analyze the extended TAM model. Results demonstrated that teachers' behavioral intention was determined by their attitudes toward using GBPTs. Perceived usefulness and perceived ease of use had a significant and positive influence on teachers' attitudes. In addition, the results also indicated that perceived enjoyment has a significant influence on perceived usefulness and perceived ease of use, but no significant effect on the attitude of teachers regarding the use of GBPTs. Based on these findings, enjoyment can be considered as a determinant that influences teachers' perceptions toward using GBPTs in K-12 programming education. Some pedagogical and research implications are also presented.

KEYWORDS

Game-Based Programming Tools, Technology Acceptance Model, Perceived Enjoyment, K-12 Teachers

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1. INTRODUCTION

There is sufficient evidence to show that "learning to program" could benefit student's development of skills in general planning, problem-solving, creativity, and cooperation, as well as skills of computational thinking in other settings (Ching et al., 2018; Topalli and Cagiltay, 2018; Wing, 2006). Nowadays, some emerging game-based programming tools (e.g., Lightbot, Cargo-Bot, and Run Marco) have been designed to provide an easy-to-use, interactive, challenging and enjoyable learning environment to engage children and motivate them to learn programming. For example, Kazimoglu et al. (2012) designed a game-based programming tool named *Program Your Robot* to facilitate students' computational thinking and foster their learning motivation and problem-solving abilities. Tessler et al. (2013) examined the effects of teaching programming concepts on high school students by playing Cargo-Bot (http://twolivesleft.com/CargoBot). Kalelioglu (2015) used Code.org (https://code.org/) to teach 32 fourth-grade primary school students programming concepts and found that students developed a positive attitude toward programming and improved their programming, mathematical and geometrical knowledge. Lopez et al. (2016) applied an educational programming game called Lightbot (https://lightbot.com/flash.html) to teach university students programming concepts. They observed that students seemed to enjoy learning with Lightbot and attained a better understanding of programming concepts. They discovered that playing Cargo-Bot is indeed an enjoyable and effective way to learn programming. Similarly, Giannakoulas and Xinogalos (2018) utilized the programming game "Run Marco" (https://www.allcancode.com/web) to teach elementary school students introductory programming concepts. They founded the programming learning environment, which in conjunction with its game components that can help students in effectively comprehending basic programming concepts. As a result, students will then elect to use other similar game-based programming tools to further their understanding of programming. These GBPTs can make programming learning more enjoyable and may facilitate programming instruction applications, especially in existing K-12 education strategies (Rajeev et al., 2018). While some attention has been paid in the past to researching issues related to GBPTs, little is known about in-service teachers' perceptions of using GBPTs in K-12 education.

Therefore, the study presents an empirical investigation using TAM as a framework to explore K-12 in-service teachers' perceptions of utilizing GBPTs to reinforce their instruction. The technology acceptance model (TAM) (Davis et al., 1989) has been broadly applied to explore users' perceptions in the application of a particular learning system and its tools. However, the existing constructs of TAM are not adequate enough to fully reflect the enjoyment of the user experience when operating these game-based programming tools. Therefore, one determinant variable—perceived enjoyment—was added to enhance the understanding of perceptions of teachers with regard to utilizing GBPTs.

2. THEORETICAL BACKGROUND

2.1 Game-Based Programming Tools

Several game-based programming tools (GBPTs) have been developed to illustrate basic programming concepts and skills for K-12 students. These tools provide an attractive,

interesting and interactive learning environment in which students can learn programming with more enjoyment and initiative (Giannakoulas and Xinogalos, 2018). Examples include:

- Flappy Code (https://studio.code.org/flappy) is one of the representative Hour of Code activities on the Code.org website. Students are able to build their own Flappy Bird game according to the instructions provided by the game interface. This game-based programming tool contains 10 levels. Using the tool can effectively reinforce students' attitudes toward programming and self-efficacy with computer science. A captured screen of Flappy Code is shown in Figure 1.

Figure 1. A screenshot of the Flappy Code interface

- Light-Bot (https://lightbot.com/flash.html) is an educational Flash game with a strong focus on programming concepts, such as procedures, loops, and functions. The feature of Light-Bot is that a small robot is set up to complete the work of lighting the bulb. Students can drag and drop some limited command icons into the finite instruction space in order to complete each level of tasks. Figure 2 presents a screenshot of Light-Bot.

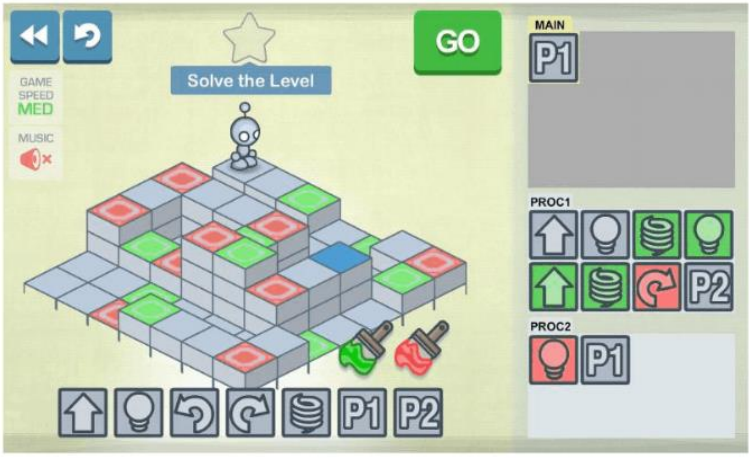

Figure 2. A screenshot of the Light-Bot interface

- Cargo-Bot (https://twolivesleft.com/CargoBot/) is a puzzle game that helps students to learn basic programming concepts. It is only be available on an Apple devices. In Cargo-Bot, students can drag and drop coding instructions to drive the robotic arm to move the wooden box. The game provides a number of challenges for students to improve programming ability.
- Run Marco (https://www.allcancode.com/web) is a free game-based programming application that can be used to teach some fundamental programming concepts such as sequence, iteration, conditions and so forth. This tool provides a storyline where the main character Marco is lost in a forest and cannot find his friends. Students need to help Marco find his friends in following the prescribed paths by using appropriate block commands. Run Marco contains 36 levels from simple to difficult in the current version and will allow teachers and students to design new levels by themselves in the future (Giannakoulas and Xinogalos, 2018).

2.2 Teacher Acceptance of Technology

Any initiative to integrate technology in classroom teaching and learning depends strongly upon the support of the teachers involved (Gibson et al., 2014). Researchers and educators have emphasized that the acceptance of teachers toward technology that plays an important factor for ICT integration into teaching and instruction (Al-Busaidi and Al-Shihi, 2010; Albirini, 2006; Birch and Irvine, 2009; Teo, 2009, 2015; Teo, Ursavas and Bahçekapili, 2012; Valtonen et al., 2015). For instance, some researchers have stated that teaching attitude is a powerful predictor of behavioral intention to use new technologies (Bullock, 2004; Teo et al., 2008). Moreover, earlier researchers have paid extra attention to the various factors involved, including the individual factors (such as demographic characteristics, beliefs, experience, preference and self-efficacy) and environmental factors (such as perceived usefulness, perceived ease of use, facilitating conditions, and technological complexity) that influence the acceptance of teachers toward using technology (Mulholland and Cumming, 2016). For example, Inan and Lowther (2010) investigated how the teachers' individual characteristics (e.g., teachers' age, years of teaching experience, computer proficiency) and perceptions of environmental factors (e.g., overall support, technical support, and computer availability) affect teachers' acceptance of technology integration in K-12 education. Wong et al. (2015) proposed and tested a research model to elucidate upon the variables (technology self-efficacy, performance expectancy, effort expectancy, social influence, facilitating conditions) which influence teachers' behavioral intentions toward using an interactive whiteboard. Teo and Milutinovi (2016) examined five factors (perceived usefulness, perceived ease of use, subjective norm, facilitating conditions, and technological complexity) that affect Serbian pre-service teachers' attitudes regarding the usage of computers in mathematics teaching. Baydas and Goktas (2017) proposed a model based on the factors of perceived usefulness, perceived ease of use, social influence, facilitating conditions, and computer anxiety to explain preservice teachers' intentions to use ICT in their future lessons. However, little attention has been focused on the attitudes and behavioral intentions of teachers with respect to the usage of GBPTs in K-12 education.

2.3 Technology Acceptance Model

The technology acceptance model (TAM) (Davis, 1989) is a well-recognized framework developed to explore user attitudes and behavioral intentions toward the use of different technology systems/tools. TAM was proposed by Davis in 1989, emphasizing that perceived usefulness and perceived ease of use are important for users who are deciding whether to accept or reject specific information technologies. Perceived usefulness is considered to be "the degree to which a person believes that using a particular system would enhance his or her job performance," and perceived ease of use is defined as "the degree to which a person believes that using a particular system would be free from effort" (Davis, 1989; Davis et al., 1989). Specifically, behavioral intention is determined by user attitudes toward, a particular technology system or tool, which in turn is determined by its perceived usefulness and perceived ease of use. In addition, perceived ease of use has a direct and significant influence on perceived usefulness.

TAM has been widely applied and modified to explore attitudes and intentions of teachers to utilize different e-learning systems/tools. For example, Chiu (2017) used TAM to investigate external factors such as anxiety, computer self-efficacy, voluntariness, and institutional support to determine how these factors affected in-service secondary school teachers' adoption of electronic textbooks. Liu et al. (2017) revised TAM by adding the pedagogical beliefs of teachers to investigate the acceptance of information and communication technology (ICT) for university teachers of English as a Foreign Language (EFL) in China. Su et al. (2018) extended TAM by additionally considering external factors such as management support, computer anxiety, intrinsic motivation, and job relevance to explore in-service teachers' attitudes and behavioral intentions to use ICT in primary and secondary school education in China.

2.4 Perceived Enjoyment

Perceived enjoyment is at the core of the media entertainment experience (Vorderer et al., 2004), and is defined as "the extent to which the activity of using technology is perceived to be enjoyable in its own right, apart from any performance consequences that may be anticipated" (Davis et al., 1989). Some studies emphasized that perceived enjoyment plays an important role, and as such have incorporated it to explain certain phenomena regarding teachers' perceptions of using an e-learning system/tool (Abdullah and Ward, 2016; Sun and Zhang, 2008). For example, Teo and Noyes (2011) incorporated perceived enjoyment into a TAM framework to explore pre-service teachers' intentions to use technology and found that perceived enjoyment had a significant impact on teachers' attitudes and intentions for computer usage. Elkaseh et al. (2015) extended TAM by incorporating perceived enjoyment and social influence to explore students' and university teachers' perceptions of e-learning tools for teaching and learning. This study showed that perceived enjoyment significantly affects perceived usefulness and perceived ease of use. Park and Kwon (2016) employed TAM, examining two external factors—perceived enjoyment and service quality—to forecast teachers' intentions in using teaching assistant robots. They demonstrated that perceived enjoyment and service quality were extremely significant influencing factors in which perceived enjoyment had a positive effect on perceived usefulness and perceived ease of use. Adukaite et al. (2017) conducted an empirical study to investigate South African tourism

teachers' perceptions regarding acceptance of a gamified application in tourism instruction, and demonstrated that perceived enjoyment was one important determinant affecting teachers' behavioral intentions to use gamified applications for tourism education. According to the relevant literature, perceived enjoyment seems to be a key influencing factor for teachers that may affect their perceived usefulness, perceived ease of use and attitude toward utilizing GBPTs in K-12 education.

3. RESEARCH MODEL AND HYPOTHESES

Based on the previous literature review, an extended technology acceptance model (TAM) was applied and integrated with perceived enjoyment to better investigate in-service teachers' perceptions regarding the use of game-based programming tools in K-12 instruction. Figure 3 shows the research model for this study.

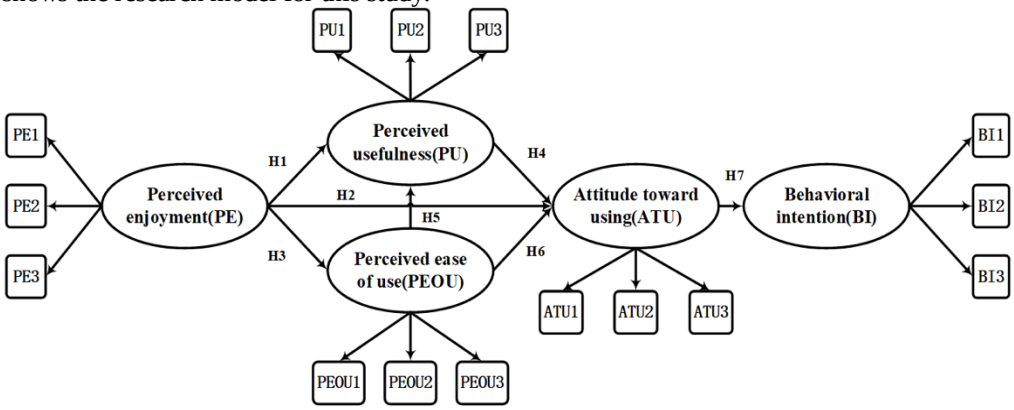

Figure 3. The hypothesis model

Specifically, this study attempts to answer the following research hypotheses:

H1. Perceived enjoyment will have a direct positive influence on K-12 in-service teachers' perceived usefulness.

H2. Perceived enjoyment will have a direct positive influence on K-12 in-service teachers' attitude toward using GBPTs.

H3. Perceived enjoyment will have a direct positive influence on K-12 in-service teachers' perceived ease of use.

H4. Perceived usefulness will have a direct positive influence on K-12 in-service teachers' attitude toward using GBPTs.

H5. Perceived ease of use will have a direct positive influence on K-12 in-service teachers' perceived usefulness.

H6. Perceived ease of use will have a direct positive influence on K-12 in-service teachers' attitude toward using GBPTs.

H7. Attitude toward using GBPTs will have a direct positive influence on K-12 in-service teachers' behavioral intention.

4. METHOD

4.1 Participants

A convenience sampling method was used, with 30 in-service teachers participating in this study hailing from elementary and secondary schools in Zhejiang Province, China. The participants totaled 28 females and 2 males, aged 26 to 40.

4.2 Instrument

A specific questionnaire containing 15 items were developed from the published items of previous studies (Ahn et al., 2004; Balog and Pribeanu, 2010; Davis 1989; Rubio et al., 2015; Taylor and Todd, 1995; Venkatesh, 2000). To ensure the clarity and validity of the aforementioned items, the contents of the questionnaire were reviewed and revised several times by two educational technology experts. Each item was measured on a 5-point Likert scale, with values ranging from 1 (strongly disagree) to 5 (strongly agree). The specific descriptions of the questionnaire items are shown in Table 1.

Table 1. The questionnaire items

Construct	Item	Description
Perceived usefulness	PU1	Using GBPTs will enhance my teaching effectiveness.
	PU2	I think GBPTs will help me improve my teaching.
	PU3	I find GBPTs useful in my programming teaching.
Perceived ease of use	PEOU1	My interaction with GBPTs is clear and understandable.
	PEOU2	Using GBPTs is easy for me.
	PEOU3	I find it is easy to use GBPTs in my teaching.
Perceived enjoyment	PE1	Using GBPTs will make my teaching more entertaining.
	PE2	Using GBPTs is fun.
	PE3	Overall, I enjoy using GBPTs.
Attitude toward using	ATU1	I believe that using GBPTs is a good idea.
	ATU2	I like using GBPTs in my teaching.
	ATU3	I like the idea of using GBPTs to teach programming.
Behavioral intention	BI1	I would use GBPTs in my classroom.
	BI2	I plan to use GBPTs for programming teaching in the future.
	BI3	I would recommend the use of GBPTs to my colleagues.

In addition, open-ended questions were also included in the questionnaire for evaluating the research model to assist with the interpretation of the quantitative findings, and to get a richer understanding of the teacher perceptions toward the use of game-based programming tools in K-12 education. These questions are as follows.

(1) What are the benefits of using GBPTs?
(2) What are the challenges or barriers regarding using GBPTs?
(3) Do you have any suggestions for using GBPTs in your classroom?

4.3 Procedure and Data Analysis

The paper-and-pencil questionnaire was administered once the K-12 teachers completed at least one hour of code activities from code.org. Partial Least Squares Structural Equation Modeling (PLS-SEM) was used to test our hypothesis model, as this approach has greater power for small sample sizes (Chin, 1998). SmartPLS 3.0 was adopted to present the PLS-SEM approach and to assess the measurements (reliability and validity) and structural model (all hypotheses in the research model) for this study. Moreover, an interview with open-ended questions was applied in order to more comprehensively explore the teacher's attitudes toward using GBPTs.

5. RESULTS

5.1 Measurement Model

Table 2. The measurement model

Construct	Item	Factor Loading	Cronbach's alpha	Composite reliability	Average extracted variance
Perceived usefulness			0.896	0.919	0.792
	PU1	0.888			
	PU2	0.871			
	PU3	0.911			
Perceived ease of use			0.940	0.961	0.893
	PEOU1	0.938			
	PEOU2	0.934			
	PEOU3	0.962			
Perceived enjoyment			0.915	0.947	0.855
	PE1	0.886			
	PE2	0.955			
	PE3	0.932			
Attitude toward using			0.872	0.922	0.797
	ATU1	0.856			
	ATU2	0.878			
	ATU3	0.943			
Behavioral intention			0.907	0.941	0.842
	BI1	0.919			
	BI2	0.935			
	BI3	0.899			

The measurement model was used for assessment in terms of the factor loading, Cronbach's alpha (CA), composite reliability (CR), average extracted variance (AVE), and discriminant validity. As shown in Table 2, factor loadings for the corresponding constructs are greater than the threshold value of 0.70 (Chin and Newsted, 1999), while the AVE values ranged from 0.792 to 0.893—exceeding the standard minimum level of 0.5, and as a consequence demonstrating adequate convergent validity (Hair et al., 2006). The reliability of the measures was acceptable, due to the values of CR and Cronbach's alpha being higher than 0.7 and 0.6,

respectively (Hair et al., 2006). The discriminant validity was assessed by the square root of AVE and latent variable correlations. Table 3 demonstrates that the results delivered by the measurement model were significant and acceptable, with all values meeting the required standards (Fornell and Larcker, 1981).

Table 3. Discriminant validity

Construct	1	2	3	4	5
1. Perceived usefulness	0.890				
2. Perceived ease of use	0.546	0.945			
3. Perceived enjoyment	0.600	0.546	0.925		
4. Attitude toward using	0.676	0.871	0.511	0.893	
5. Behavioral intention	0.665	0.736	0.400	0.827	0.918

5.2 Structural Model

The structural model was examined through assessing the path coefficients and R2 values; the former was used as the indicator for the statistical significance of these hypotheses, and the latter was used to assess the model's ability in explaining the variance in the dependent variables (Chin and Newsted, 1999). Figure 4 shows the path coefficients, path significance and variance explained for each dependent variable. It implies that the hypothesis model explained 43.1% of the variance in perceived usefulness, 29.9% of the variance in perceived ease of use, 82.1% of the variance in teachers' attitude, and 68.4% of the variance in behavioral intention. Figure 4 also illustrates the seven path coefficients among the variables of the model. It was also found that the perceived enjoyment had a direct positive and significant impact on perceived usefulness (β = 0.430, p < 0.05) and perceived ease of use (β = 0.546, p < 0.001), supporting H1 and H3. For the attitude, perceived usefulness (β = 0.286, p < 0.05) and perceived ease of use (β = 0.715, p < 0.001) were direct positive and significant factors, supporting H4 and H6. Attitude (β = 0.821, p < 0.001) had a direct positive and significant effect on behavioral intention, supporting H7. However, perceived enjoyment had no significant effect on attitude, and perceived ease of use also had no significant effect on perceived usefulness. Thus, results showed that all hypotheses were supported with the exceptions of H2 and H5.

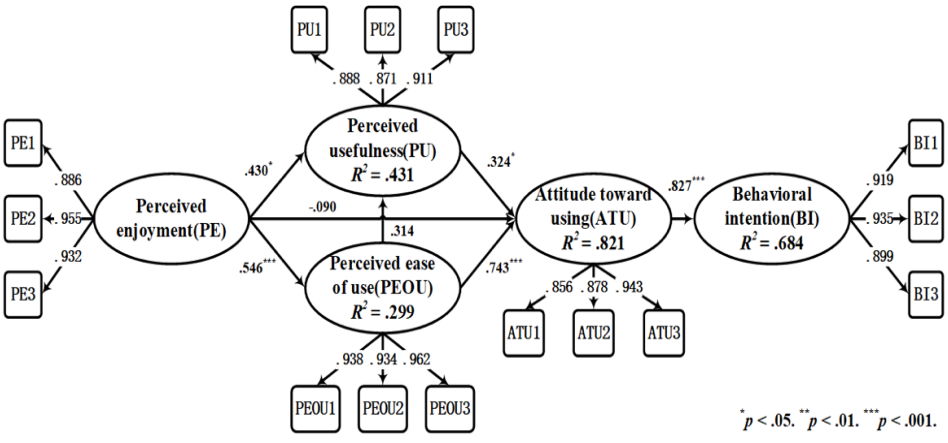

Figure 4. Path coefficients of the research model

5.3 Qualitative Results

Teacher responses with open-ended questions are organized and shown in Table 4. Seven K-12 teachers declared that GBPTs are useful to programming instruction, two teachers stated that using game-based programming tools can improve students' computational thinking, and two teachers pointed out that these GBPTs having an attractive game interface, a variety of difficulty/challenges, and interactive feedback could increase students' interest, learning motivation and engagement. In light of the challenges and barriers reported by teacher responses, eleven teachers said that there is not enough supporting material when they use these GBPTs in programming instruction. Four teachers said that the interface of GBPTs is not attractive enough, three teachers said that game levels of GBPTs are too difficult for novices, two teachers worried that using GBPTs may cause damage to the students' eyes if they play for too long, and one teacher said that there may not be much time to use these GBPTs in the classroom. In regard to suggestions for the use of game-based programming tools, eleven teachers said that they must improve their professional capabilities to guide students to use these GBPTs, eight teachers advised expanding the difficulty of GBPTs to satisfy diversity among students, five teachers hoped to have complementary instructional materials available to help programming instruction, and four teachers said that more hints and conclusions can be more added to the GBPTs in question.

Table 4. Viewpoints on using GBPTs in K-12 education

Themes	Number of responses
Benefits	**11**
• Improving programming learning	7
• Developing computational thinking	2
• Enhancing student motivations to learn programming	2
Challenges	**21**
• Not enough supporting material for teachers	11
• The interface of GBPTs is not attractive enough	4
• A bit difficult for novices	3
• May damage students' eyes	2
• Lack of time to use GBPTs in the classroom	1
Suggestions	**28**
• Providing professional guidance and training	11
• Increasing different difficulty levels in GBPTs	8
• Preparing complementary learning materials for teachers	5
• Adding hints and conclusions in GBPTs	4

6. DISCUSSION

This study attempted to investigate perceptions of in-service teachers with regard to using GBPTs in elementary and secondary schools by implementing an extended TAM integrated with perceived enjoyment as its theoretical base. All hypotheses, except two, were supported. The results demonstrated that the behavioral intention of teachers is determined by their

attitudes toward using GBPTs in K-12 education, which in turn is determined by perceived usefulness and perceived ease of use. These findings are in line with the results of some previous studies (Chiu 2017; Liu et al., 2017). However, this study found that perceived ease of use does not posit a significant impact on perceived usefulness, which is in agreement with the results by Su et al. (2018), but not in agreement with the findings by Chiu (2017) and Liu et al. (2017). Moreover, this study showed that perceived enjoyment is positively associated with the core constructs of TAM—perceived usefulness (β = 0.430) and perceived ease of use (β = 0.546)—suggesting that an enjoyable learning experience is increasing the utility and ease of use of GBPTs. This study confirms that perceived enjoyment has a positive influence on perceived usefulness and perceived ease of use, which is consistent with previous studies (Elkaseh et al., 2015; Park and Kwon, 2016; Teo and Noyes, 2011). If in-service teachers feel the GBPTs be enjoyable, they are more likely to perceive them as purposeful and easy to use. Surprisingly, perceived enjoyment is not found to posit a significant effect on teachers' attitudes toward using GBPTs. The results are not consistent with the findings by Cabada et al. (2018), which had previously found that perceived enjoyment does not influence students' attitudes toward using GBPTs. One possible explanation for this effect is that perceived enjoyment may affect attitude toward using only if the teachers themselves perceive GBPTs to be useful and easy to implement. Moreover, according to teacher response, most teachers agreed that using GBPTs would benefit students in acquiring programming knowledge, improving their computational thinking, and make them more motivated in programming learning, although there are some challenges, such as familiarity with the operation. Therefore, some teachers also suggested increasing the number of operating GBPTs in their programming instruction and wanted to obtain further relevant materials regarding GBPTs for programming teaching.

7. CONCLUSION

Our study provided several managerial implications of K-12 teachers' perceptions regarding the use of game-based programming tools in the classroom. These implications may serve to support academics, and assist academics, instructors and the general public in reaching a deeper understanding. Nevertheless, several limitations to this empirical study need to be acknowledged. First, this study did not perform a long-term investigation into teachers' use of GBPTs, nor did it consider individual differences such as gender (Venkatesh and Davis, 2000). Future research could examine other influencing factors/moderators on teachers' perceptions having previously used GBPTs in the classroom. Second, the study carried out a convenience sampling method in which just thirty Chinese K-12 teachers participated. The results may not be generalizable to the broader teacher population. Future studies could undertake multi-stage sampling to increase the sample size, or consider different user groups to examine and compare their perceptions regarding the use of game-based programming tools (GBPTs).

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REFERENCES

Abdullah, F. and Ward, R., 2016. Developing a General Extended Technology Acceptance Model for E-Learning (GETAMEL) by Analysing Commonly Used External Factors. *In Computers in Human Behavior*, Vol. 56, pp 238-256.

Adukaite, A. et al, 2017. Teacher Perceptions on the Use of Digital Gamified Learning in Tourism Education : The Case of South African Secondary Schools. *In Computers and Education*, Vol. 111, pp 172-190.

Ahn, T. et al, 2004. The Impact of the Online and Offline Features on the User Acceptance of Internet Shopping Malls. *In Electronic Commerce Research and Applications*, Vol. 3, No. 4, pp 405-420.

Al-Busaidi, K.A. and Al-Shihi, H., 2010. Instructors' Acceptance of Learning Management Systems: A Theoretical Framework, *In Communications of the IBIMA*, Vol. 2010, No. 2010, pp 1-10.

Albirini, A., 2006. Teachers' Attitudes Toward Information and Communication Technologies: The Case of Syrian EFL Teachers, *In Computers and Education*, Vol. 47, No. 4, pp 373-398.

Balog, A. and Pribeanu, C., 2010. The Role of Perceived Enjoyment in the Students' Acceptance of an Augmented Reality Teaching Platform: A Structural Equation Modelling Approach. *In Studies in Informatics and Control*, Vol. 19, No. 3, pp 319-330.

Baydas, O. and Goktas, Y., 2017. A Model for Preservice Teachers' Intentions to Use ICT in Future Lessons, *In Interactive Learning Environments*, Vol. 25, No. 7, pp 930-945.

Birch, A. and Irvine, V., 2009. Preservice Teachers' Acceptance of ICT Integration in the Classroom: Applying the UTAUT Model, *In Educational Media International*, Vol. 46, No. 4, pp 295-315.

Bullock, D., 2004. Moving From Theory to Practice : An Examination of the Factors that Preservice Teachers Encounter as the Attempt to Gain Experience Teaching with Technology during Field Placement Experiences, *In Journal of Technology and Teacher Education*, Vol. 12, No. 2, pp. 211-237.

Cabada, R. Z. et al, 2018. An Affective and Web 3.0-based Learning Environment for a Programming Language. *In Telematics and Informatics*, Vol. 35, No. 3, pp 611-628.

Chin, W. W., 1998. The Partial Least Squares Approach to Structural Equation Modelling. *In Modern Methods for Business Research*, Marcoulides, G. A. (eds.) Lawrence Erlbaum Associates, Mahwah, NJ, USA, pp. 295-336.

Chin, W. W. and Newsted, P. R., 1999. Structural Equation Modeling Analysis with Small Samples Using Partial Least Squares. *In Statistical Strategies for Small Sample Research*, Hoyle, R. H. (eds.) Sage Publications, Thousand Oaks, CA, USA, pp. 307-341.

Ching, Y. H. et al, 2018. Developing Computational Thinking with Educational Technologies for Young Learners. *In TechTrends*, Vol. 62, No. 6, pp 563-573.

Chiu, T. K. F., 2017. Introducing Eectronic Textbooks as Daily-use Technology in Schools : A Top-Down Adoption Process. *In British Journal of Educational Technology*, Vol. 48, No. 2, pp 524-537.

Davis, F. D., 1989. Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. *In MIS Quarterly*, Vol. 13, No. 3, pp 319-340.

Davis, F. D. et al, 1989. User Acceptance of Computer Technology: A Comparison of Two Theoretical Models. *In Management Science*, Vol. 35, No. 8, pp 982-1003.

Elkaseh, A. M. et al, 2015. The Acceptance of E-learning as a Tool for Teaching and Learning in Libyan Higher Education. *In International Journal of Information Technology*, Vol. 3, No. 4, pp 1-11.

Fornell, C. and Larcker, D. F., 1981. Evaluating Structural Equation Models with Unobservable Variables and Measurement Error. *In Journal of Marketing Research*, Vol. 18, No. 1, pp 39-50.

Giannakoulas, A. and Xinogalos, S. 2018. A Pilot Study on the Effectiveness and Acceptance of an Educational Game for Teaching Programming Concepts to Primary School Students, *In Education and Information Technologies*, Vol. 23, No. 5, pp 2029-2052.

Gibson, P.A. et al, 2014. Changing Teachers, Changing Students? The Impact of a Teacher-focused Intervention on Students' Computer Usage, Attitudes, and Anxiety, *In Computers and Education*, Vol. 71, pp 165-174.

Hair, J. F. et al, 2006. *Multivariate Data Analysis* (6th Ed.). Prentice Hall, New Jersey, USA.

Inan, F.A. and Lowther, D.L., 2010. Factors Affecting Technology Integration in K-12 Classrooms: a Path Model, *In Educational Technology Research and Development*, Vol. 58, No. 2, pp 137-154.

Kalelioglu, F., 2015. A New Way of Teaching Programming Skills to K-12 Students: Code.org. *In Computers in Human Behavior*, Vol. 52, pp 200-210.

Kazimoglu, C. et al, 2012. Learning Programming at the Computational Thinking Level via Digital Game-play, *In Procedia Computer Science*, Vol. 9, pp 522-531.

Liu, H. et al, 2017. Pedagogical Beliefs and Attitudes Toward Information and Communication Technology : A Survey of Teachers of English as a Foreign Language in China. *In Computer Assisted Language Learning*, Vol. 30, No. 8, pp 745-765.

Lopez, M. A. et al, 2016. Teaching Abstraction, Function and Reuse in the First Class of CS1: A Lightbot Experience. *Proceedings of the 2016 ACM Conference on Innovation and Technology in Computer Science Education (ITiCSE '16)*. Arequipa, Peru, pp. 256-257.

Mulholland, S. and Cumming, T.M., 2016. Investigating Teacher Attitudes of Disability Using a Non-traditional Theoretical Framework of Attitude, *In International Journal of Educational Research*, vol. 80, pp 93-100.

Park, E. and Kwon, S. J., 2016. The Adoption of Teaching Assistant Robots : A Technology Acceptance Model Approach. *In Program*, Vol. 50, No. 4, pp 354-366.

Rajeev, S. et al, 2018. Educational Game-theme Based Instructional Module for Teaching. *Proceedings of the IECON 2018 - 44th Annual Conference of the IEEE Industrial Electronics Society*. Washington, DC, USA, pp. 3039-3044.

Rubio, M. A. et al, 2015. Closing the Gender Gap in an Introductory Programming Course. *In Computers and Education*, Vol. 82, pp 409-420.

Su, C. Y. et al, 2018. A Path Analysis of In-Service Teachers' Intentions to Use ICT in Primary and Secondary Curricula: Applying and Extending the Technology Acceptance Model. *Proceedings of the 12th International Technology, Education and Development Conference (INTED 2018)*. Valencia, Spain, pp. 4433-4437.

Sun, H. and Zhang, P., 2008. An Exploration of Affect Factors and Their Role in User Technology Acceptance : Mediation and Causality. *In Journal of American Society for Information Science and Technology*, Vol. 59, No. 8, pp 1252-1263.

Taylor, S. and Todd, P. A., 1995. Understanding Information Technology Usage: A Test of Competing Models. *In Information Systems Research*, Vol. 6, No. 2, pp 144-176.

Teo, T. 2009. Modelling Technology Acceptance in Education: A Study of Pre-service Teachers, *In Computers and Education*, Vol. 52, No. 2, pp 264-272.

Teo, T. 2015. Comparing Pre-service and In-service Teachers' Acceptance of Technology: Assessment of Measurement Invariance and Latent Mean Differences, *In Computers and Education*, Vol. 83, pp 22-31.

Teo, T. et al, 2008. Understanding Pre-service Teachers' Computer Attitudes: Applying and Extending the Technology Acceptance Model, *In Journal of Computer Assisted Learning*, Vol. 24, No. 2, pp 128-143.

Teo, T. and Milutinovi, V., 2016. Modelling Serbian pre-service teachers ' attitudes towards computer use : A SEM and MIMIC approach, *In Computers and Education*, Vol. 94, pp 128-143.

Teo, T. and Noyes, J., 2011. An Assessment of the Influence of Perceived Enjoyment and Attitude on the Intention to Use Technology among Pre-Service Teachers: A Structural Equation Modeling Approach. *In Computers and Education*, Vol. 57, No. 2, pp 1645-1653.

Teo, T. et al, 2012. An Assessment of Pre-service Teachers' Technology Acceptance in Turkey: A Structural Equation Modeling Approach, *In The Asia-Pacific Education Researcher*, Vol. 21, No. 1, pp 191-202.

Tessler, J. et al, 2013. Using Cargo-Bot to Provide Contextualized Learning of Recursion. *Proceedings of the 9th Annual International ACM Conference on International Computing Education Research (ICER '13)*. La Jolla, CA, USA, pp. 161-168.

Topalli, D. and Cagiltay, N. E., 2018. Improving Programming Skills in Engineering Education through Problem-Based Game Projects with Scratch. *In Computers and Education*, Vol. 120, pp 64-74.

Valtonen, T. et al, 2015. The Impact of Authentic Learning Experiences with ICT on Pre-service Teachers' Intentions to Use ICT for Teaching and Learning, *In Computers and Education*, Vol. 81, pp 49–58.

Venkatesh, V., 2000. Determinants of Perceived Ease of Use : Integrating Control, Intrinsic Motivation, Acceptance Model. *In Information System Research*, Vol. 11, No. 4, pp 344-365.

Venkatesh, V. and Davis, F. D., 2000. A Theoretical Extension of the Technology Acceptance Model : Four Longitudinal Field Studies. *In Management Science*, Vol. 46, No. 2, pp 186-204.

Vorderer, P. et al, 2004. Enjoyment : At the Heart of Media. *In Communication Theory*, Vol. 14, No. 4, pp 388-408.

Wing, J. M., 2006. Computational Thinking. *In Communications of the ACM*, Vol. 49, No. 3, pp 32-35.

Wong, K.T. et al, 2015. Understanding the Intention to Use Interactive Whiteboards: Model Development and Testing, *In Interactive Learning Environments*, Vol. 23, No. 6, pp 731–747.