

Using the TPACK-G Model to Assess High School Teachers' Acceptance of Digital Game-Based Learning in View of Perceived Usefulness and Digital Self-Efficacy

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ABSTRACT

Background: The purpose of this paper was to assess Urmia high school teachers' acceptance of digital game-based learning in view of their perceived usefulness and digital self-efficacy.

Methods: A cross-sectional descriptive correlational study was conducted among the educational areas in the academic year 2019-2020 in the city of Urmia. Taking into account all high school teachers (n=436), using Cochran's formula, 205 teachers were chosen through a relative stratified sampling method, with the female teachers (n=258) and male teachers (n=178). Research instruments included questionnaires based on TPACK-G for evaluating perceived usefulness, computer self-efficacy, and acceptance of digital games. A path analysis was performed on the data using the Lisrel 8.50 and SPSS 22 procedures.

Results: The findings showed that the relationship between all the variables in the study and the acceptance of such learning was significant. The variables that had the smallest relationship with the acceptance of digital game-based learning was the pedagogical knowledge of games ($r=0.103$, $P<0.05$), while the most significant relationship was found with the technological knowledge of games ($r=0.274$, $P<0.01$). The direct impact (TPACK-G) on teachers' digital self-efficacy is equal to (0.219, 0.165, 0.187), and on acceptance (0.160, 0.142, 0.222), which is significant at ($P<0.01$). The most direct impact was found for the usefulness on acceptance (standardized parameter=0.365, $P<0.01$). The smallest indirect impact was found for the self-efficacy on usefulness (0.027). The direct impact of teachers' digital self-efficacy and the perceived usefulness on the acceptance of learning based on digital games is equal to (0.300, 0.365) which is significant at ($P<0.01$). In addition, findings of the study showed that the highest and lowest variances that accounted for the total variance were related to the acceptance of digital game-based learning (%31) and self-efficacy (%20), respectively.

Conclusion: Teachers' digital self-efficacy in terms of the ability to adopt technologies in learning and their perceived usefulness is an effective factor in teachers' decisions regarding the use of digital games in the classroom.

Keywords: Technological pedagogical and potent knowledge-games (TPACK-G); Acceptance; Digital games; Teachers' digital self-efficacy; Perceived usefulness

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Please cite this paper as:

Alizadeh S, Sarmadi MR,
Seif MH, Mazlounian S.
Using the TPACK-G Model
to Assess High School
Teachers' Acceptance
of Digital Game-Based
Learning in View of Perceived
Usefulness and Digital
Self-Efficacy. *Interdiscip
J Virtual Learn Med Sci.*
2021;12(4):275-286.doi:10.30476/
IJVLM.2021.90781.1098.

Received: 13-04-2021

Revised: 10-05-2021

Accepted: 14-05-2021

Introduction

The adoption of technologies in education is a major topic that has always attracted scientists and researchers' attention (1). In the meantime, digital games are considered a convenient tool to achieve educational goals due to their attractions and interactive features. In addition, such games provide a rich environment for learning since they help learners acquire new knowledge and deepen their existing knowledge on various educational grounds (2). Digital game-based learning occurs in a virtual environment with fantasy elements, and students work on learning activities using a technological tool such as a computer. Many teachers assign just a motivating or encouraging role for digital games (3), though the technology can only be useful for students' learning processes and their educational performance when teachers use it effectively in their classes (4). Researchers have concluded that games not only entertain students, but support their learning (5). Some studies have indicated that teachers' attitudes towards game-based learning play an important role in its acceptance and effectiveness (6, 7). Hsu et al. (8) found a positive relationship between higher education teachers' attitudes towards games and their approval to use such games in their classrooms.

The TPACK framework by Koehler and Mishra (9) has guided numerous inspiring studies on teacher education and educational technologies (10, 11) so that teachers can adopt educational games in their classrooms effectively and efficiently (12). Cam et al. (13) as well as Koehler et al., as cited in Tondeur et al. (14), argue that teachers have to be qualified in three knowledge areas (technological, content, and pedagogical), though most important of all is their capability to integrate the three areas.

Koehler et al. (15) consider technological knowledge (TK) as the amount of knowledge that a person acquires about technology, whether through education or exploration, and have defined pedagogical knowledge (PK) as a teacher's knowledge of educational

methods, strategies, and approaches to improve students' learning. In addition, content knowledge (CK) is the specialized knowledge of the teacher in his/her scientific field and refers to how technological and content knowledge are combined and how technological knowledge has been able to create new perspectives to understand particular topics (16).

Hsu et al. (17) focused on the technological, pedagogical, and content knowledge of pre-school teachers in relation to digital games, and their findings revealed that a positive correlation exists between various variables of the TPACK-G approach and factors affecting the acceptance of game-based learning.

According to Wu (18), "studies have shown that teachers' digital self-efficacy and perceived usefulness are among the major and effective factors in their acceptance of game-based learning."

Self-efficacy is among the main components of the Social Cognition Theory and refers to individuals' perceived ability to perform a particular task (s) to achieve special goals (19). Wu (18) argues that self-efficacy is related to teachers' adaption to digital games and their acceptance in classrooms. Hsu et al. (8) concluded that younger teachers showed higher technological knowledge, technological-pedagogical knowledge, and technological-pedagogical-content knowledge compared to older teachers, as well as higher self-efficacy, and as a result, were more inclined to accept learning based on digital games. In addition, findings by Hatlevik et al. (20) and Hatlevik (21) indicated that teachers' self-efficacy in using ICT is correlated with ICT self-efficacy. The findings of An (3) as well as An et al. (22) showed a significant correlation among teachers' perceptions, attitudes, and self-efficacy.

Perceived usefulness means the degree to which a person believes using a particular technology will improve his or her performance (23). Findings by Fathi and Seif (24) showed that the perceived usefulness influenced the staff's tendency and use of virtual learning significantly. An et al. (22)

showed the significant relationship between teachers' attitudes and self-efficacy with the perceived usefulness of using digital games. Siang et al. (25), Alshibly (26), and Kirmizi (27) showed that a significant correlation exists between perceived usefulness and the tendency to use technology.

Since the topic of the current study is new and due to its importance and vastness, and the influences and application of these digital games in the actual and virtual worlds, this study attempted to expand the domain of theoretical knowledge through making teachers and instructors familiar with such games and their application in the process of teaching in schools.

The present study sought to answer the problem of examining the effect of TPACK-G on the acceptance of digital game-based learning and, in addition, the effect of factors such as digital teacher self-efficacy and perceived usefulness, and determining whether these factors affect the acceptance of the game.

The purpose of this paper was to use the TPACK-G conceptual framework proposed by Hsu et al., as a predictor variable (17) that was first normalized in Iran by Alizadeh et al. (28). The current study attempted to investigate teachers' acceptance of learning based on digital games. The framework included three components: Game technological Knowledge (GTK), which assesses teachers' self-confidence regarding the knowledge of using digital games; Games-Pedagogical Knowledge (GPK), which assesses teachers' self-confidence regarding the knowledge of

using pedagogical techniques using digital games; and Games-Content Knowledge (GCK), which assesses teachers' self-confidence in using the particular content of digital games to facilitate students' learning.

Then, using Bandura's theory of social cognition (teacher digital self-efficacy) and the usefulness of Davis et al. As a mediator variable, it examined the acceptance of digital game-based learning as a dependent variable in the form of a causal model. The conceptual model of the current study has been illustrated in Figure 1. Research hypotheses were:

1. The technological pedagogical content knowledge of games has a direct and significant impact on teachers' digital self-efficacy and technology acceptance.

2. Teacher digital self-efficacy and perceived teacher usefulness have a direct and significant effect on the acceptance of digital games-based learning.

3. The technological pedagogical content knowledge of games has an indirect effect on the acceptance of learning based digital games and the perceived usefulness mediated by teachers' digital self-efficacy.

Methods

Study Design

The present cross-sectional descriptive correlational study was conducted in the semester of the academic year 2019-2020 with the aim of evaluating the acceptance of digital game-based learning according to the TPACK-G through perceived usefulness and digital self-efficacy among high school teachers of Urmia.

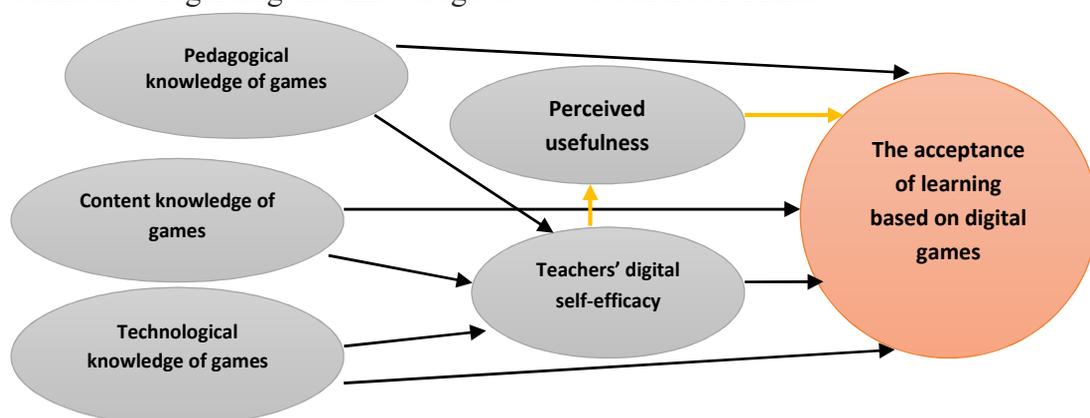


Figure 1: Conceptual model of the study

Participants

Eligibility Criteria for Participants

The inclusion criteria were all high school teachers of Urmia, Iran, who participated in game-based learning workshops in the university during the previous year and were willing to participate in this study. All those who had incompletely filled out the questionnaire and those with extended leave of absence during the study were excluded.

Data Collection Tool

1- The technological, pedagogical, and content knowledge in relation to digital games were measured using the 14-item questionnaire designed by Hsu et al. (17). This questionnaire included: game knowledge (4 questions), game pedagogical knowledge (5 questions), and game content knowledge (5 questions). The validity and reliability of TPACK-G questionnaire in previous studies were 0.94 and 0.96, respectively.

2- The questionnaire of Walters and Dougherty (29), which included eight items, was applied to investigate teachers' digital self-efficacy. The factor load of the questions in this questionnaire is between 0.61 and 0.83, which indicates its structural validity, and the Cronbach's alpha value is 0.94, so this tool has a good reliability.

3- The questionnaire of Kim et al. (30), including six items, was used to assess the perceived usefulness and the questionnaire of Chatzoglou (31), including 2 items was used to assess the acceptance of digital games. The factor load of the questions is between 0.85 and 0.92, which indicates its structural validity and the Cronbach's alpha value is 0.93.

All items of the integrated questionnaire were scored on a five-point Likert scale (strongly disagree=1, disagree=2, no opinion=3, agree=4 and strongly agree=5).

The validity of the questionnaires was established by confirmatory factor analysis, which showed an appropriate correlation coefficient between the variables. The face and content validity of the questionnaires in the Persian language was evaluated using

descriptive scales by a specialized group consisting of a group of 13 faculty members and educational science specialists who were selected through a purposive sampling method. Content validity ratio (CVR) was measured using the aspects of fluency and cultural acceptance in society based on a 6-point scale (very weak, weak, moderate, good, very good, and best) and was approved by experts. The results showed that the content validity rate for the TPACK-G questionnaire was above 0.77, teachers' digital self-efficacy was above 0.60, perceived usefulness was between 0.62 and 0.70, and acceptance of digital games was above 0.90. Also, content validity index (CVI) questionnaires were confirmed by Cronbach's alpha method. The questionnaire was distributed and collected among 30 teachers. The results of which are presented for the TPACK-G questionnaire (0.81), teachers' digital self-efficacy (0.84), and perceived usefulness (0.75). The questionnaires were distributed among the participants in person; the average time required to complete the questionnaire was 20 minutes. The respondents were assured that they were completely randomly selected, and that the details would not be mentioned in the questionnaire and that the information contained in the questionnaire would remain confidential. The collection of questionnaires started after one day and lasted an average of one week.

Sample Size and Randomization

The population of the study consisted of all high school teachers of Urmia, in the academic year 2019-2020. Considering the large number of statistical population that is teaching in Urmia, in order to collect the data, the researcher selected 205 teachers from among all high school teachers (n=436) using Cochran's formula as the sample size. Due to the fact that the number of female teachers (n=258) and male teachers (n=178) were different, the researcher considered (n=121) as female teachers and (n=84) as male teachers through the stratified sampling method. This formula is listed below:

$$n = \frac{Nt^2s^2}{Nd^2 + t^2s^2}$$

In this formula:

t=Percentage of standard error is acceptable
 d=Degree of probability or probable desired accuracy

s=ratio of population without definite attribute

N=number of people in the community

Using this formula, the sample size was estimated at n=205. Regarding the possibility of returning questionnaires, 230 questionnaires were distributed, and considering the non-returned questionnaires or the elimination of incomplete questionnaires, 205 questionnaires were examined.

Statistical Methods

It should be mentioned that the IBM SPSS and LISREL statistical packages were applied in the current study for the purpose of analyzing the data and performing the confirmatory factor analysis on them. Based on the skewness and kurtosis values (between -2 and +2), it could be concluded that all variables in the study were normally distributed. Thus, the path analysis model was applied for the purpose of analyzing the

research findings.

Results

Based on the demographic information, 41% and 59% of the 205 participants were male and female teachers, with 77% having bachelor's degree and 23% having postgraduate degree. The highest age group of respondents was 127 teachers, with an average of 23 years of service, and the lowest age group was six teachers, with an average of 30 years of service.

Descriptive statistics and correlation matrix of the research variables are represented in Tables 1 and 2.

Based on the skewness and kurtosis values illustrated in Table 1 (between -2 and +2), it could be concluded that all variables in the study were normally distributed. Thus, the path analysis model was applied for the purpose of analyzing the research findings.

Findings illustrated in Table 2 indicate that the relationship between all variables in the study and acceptance is significant. In addition, the relationships between acceptance and the pedagogical knowledge of games (r=0.103, P<0.05) and the technological knowledge of games ((r=0.274, P<0.01)) were found to be the least and most significant.

Table 1: Descriptive information of the TPACK-G and self-efficacy and the usefulness on acceptance of digital game among teachers

Variables	Mean	SD	Kurtosis	Skewness
Technological knowledge of games	16.25	8.53	1.33	-1.12
Pedagogical knowledge of games	10.50	5	0.89	1.21
Content knowledge of games	17.25	8.80	1.40	1.26
Teachers' digital self-efficacy	25.75	13.37	1.16	-0.50
The usefulness of using technology	20.75	10.68	-1.72	-1.68
Acceptance	7	3.55	0.26	0.67

Table 2: The matrix of correlations between variables the technological pedagogical and content knowledge-games, self-efficacy, the usefulness and acceptance

Variables	1	2	3	4	5	6
Pedagogical knowledge of games	1					
Content knowledge of games	0.127*	1				
Technological knowledge of games	0.185**	0.073	1			
Teachers' digital self-efficacy	0.180**	0.123*	0.113*	1		
Usefulness of technology use	0.166**	0.087	0.012	0.337**	1	
Acceptance	0.103*	0.122*	0.274**	0.127**	0.235**	1

*P<0.05; **P<0.01

Table 3 demonstrates the direct impact of variables on each other. The direct impact of TPACK-G on teachers' digital self-efficacy is equal to (0.219, 0.165, 0.187) and on acceptance was equal to (0.160, 0.142, 0.222), which is significant ($P < 0.01$). The most and least significant direct impacts were found for the impact of usefulness on acceptance (standardized parameters=0.365, $P < 0.01$) and the impact of the content knowledge of games on acceptance (standardized parameters=0.142, $P < 0.01$), respectively. The direct impact of teachers' digital self-efficacy and the perceived usefulness on the acceptance of learning based on digital games was equal (standardized parameters=0.300, 0.365), which is significant ($P < 0.01$). It should

be noted that all the direct effects of variables were significant at a level of 0.01.

Table 4 indicates the indirect effects of variables on each other, such that the highest indirect effect is pedagogical knowledge of games on usefulness (0.071, $P < 0.01$), and the least significant indirect impact is content knowledge of games on acceptance (0.049, $P < 0.01$). Another parameter that can be obtained from a combination of direct and indirect effects is the total effect of each variable in the study (Table 5). Table 5 indicates that the highest total effect is that of usefulness on acceptance (0.365, $P < 0.01$) and the lowest one is the effect of content knowledge of games on usefulness (0.053, $P < 0.01$). Furthermore, all the total effects were significant at the 0.01 level.

Table 3: Investigating the direct impacts of the variables on the acceptance of learning based on digital games

Variables	Standardized parameters	t	P value
Direct impact of the pedagogical knowledge of games on:	-----	-----	-----
Teachers' digital self-efficacy	0.219	2.898	0.01
Acceptance	0.160	2.213	0.01
Direct impact of the content knowledge of games on:	-----	-----	-----
Teachers' digital self-efficacy	0.165	2.240	0.01
Acceptance	0.142	2.033	0.01
Direct impact of the technological knowledge of games on:	-----	-----	-----
Teachers' self-efficacy	0.187	2.504	0.01
Acceptance	0.222	3.108	0.01
Direct effect of teachers' digital self-efficacy on:	-----	-----	-----
Acceptance	0.300	3.828	0.01
Direct effect of the perceived usefulness of game technology on:	-----	-----	0.01
Acceptance	0.365	4.808	0.01

Table 4: Estimation of the coefficients of the indirect impacts

Variables estimates	Standardized parameter	P value	t
The indirect impact of the pedagogical knowledge of games on:	-----	-----	-----
The acceptance of learning based on digital games	0.650	0.01	3.231
The indirect impact of the content knowledge of games on:	-----	-----	-----
The acceptance of learning based on digital games	0.049	0.01	2.897
The indirect impact of the technological knowledge of games on:	-----	-----	-----
The acceptance of learning based on digital games	0.56	0.01	2.987
The indirect impact of the pedagogical knowledge of games on:	-----	-----	-----
Usefulness	0.071	0.01	3.722
The indirect impact of the content knowledge of games on:	-----	-----	-----
Usefulness	0.053	0.01	2.889
The indirect impact of the technological knowledge of games on:	-----	-----	-----
Usefulness	0.060	0.01	3.203

Table 5: Estimates of total effect coefficients

Variables	Direct impacts	Indirect impacts	Total impacts
Impact on acceptance from:	-----	-----	-----
Pedagogical knowledge of games	0.160	0.065	0.225
Content knowledge of games	0.142	0.049	0.191
Technological knowledge of games	0.222	0.056	0.278
Self-efficacy	0.300	-----	0.300
Usefulness	0.365	-----	0.365
Impacts on usefulness from	-----	-----	-----
Self-efficacy	0.326	0.027	0.353
Pedagogical knowledge of games	-----	0.071	0.071
Content knowledge of games	-----	0.053	0.053
Technological knowledge of games	-----	0.060	0.060

Discussion

This study aimed to investigate the effect of TPACK-G on the acceptance of digital games-based learning among teachers. This study revealed that the relationship between all variables in the research (technological, pedagogical, and content knowledge), perceived usefulness, teachers' digital self-efficacy, and the acceptance of learning based on digital games was significant. Among these variables, the most and least significant relationships were found for the technological knowledge of games and pedagogical knowledge of games, respectively.

The results showed that the direct impact of the TPACK-G on teachers' digital self-efficacy and acceptance was positive and significant, and it was found to be in line with the findings obtained by Zare Moghaddam et al. (32), Hsu et al. (8), Stielor-Hunt et al. (7), Hsu et al. (33), Kavanoz et al. (34), Higde et al. (35), Hsu et al. (17), Stewart et al. (36), Abbitt (37), Lee et al. (38), Akman et al. (39), and Agyei et al. (40).

Thus, it can be argued that self-efficacy in adopting the technology of games in the process of learning is a factor that affects teachers' decisions on using technologies in the classrooms. Consequently, the more the teachers' self-efficacy, the higher will be their pedagogical knowledge of games and the higher will be their technological knowledge of games. In other words, teachers' technological self-efficacy will be enhanced when they improve their self-efficacy perceptions. Hence, teachers will be

readier to adopt technology in their classes and enhance active learning and the teacher with the technological knowledge of games can use it freely in their classes, and are inclined towards the acceptance of learning based on digital games. Another results of this study showed that the perceived usefulness and teachers' digital self-efficacy has a direct and significant effect on the acceptance of learning based on digital games, which is in line with the studies of Dehghanzadeh et al. (41), Hatlevik (20), An (3), Stielor-Hunt et al. (7), Al-Harbi (42), Lee et al. (38), Scott et al. (43), Nov et al. (44), Seif (45), Talebi et al. (46), Akbari et al. (47), Siang (25), Min Ma et al. (48), Karali et al. (49). On the other hand, it was found to contradict the findings of Alshibly (26), Kirmizi (27) Yuen et al. (50) and Rose et al. (51).

Based on these results, it can be argued that teachers with higher rates of self-efficacy and those who understand the advantages of adopting digital games tend to work more with digital games, which results in obtaining more knowledge and experience in digital games. In addition, they decided to use such games in the future to enhance their performance and recommend them to their colleagues to use the technology of digital games in their teaching.

The findings of the study showed that technological pedagogical content knowledge of games has an indirect effect on the acceptance of learning-based digital games and the perceived usefulness mediated by teachers' digital self-efficacy. This was found

to be in line with the findings of An et al. (22), Siang et al. (25), Alshibly (26), Kirmizi (27), and Bourgonjon et al. (6).

Overall, this study showed that the technological pedagogical content knowledge of high school teachers in Urmia in using digital games has good structural validity in studies related to high school teachers. This is a clear reflection of technological pedagogical content knowledge among teachers and shows high reliability for examining teachers' attitudes toward games and their use in teaching. This is a confirmation of its applicability in internal research related to technological pedagogical content knowledge in the use of digital games.

Thus, educational institutions should provide their teachers with the required courses and workshops on how to use digital games for the purpose of enhancing their teachers' technological pedagogical knowledge. In addition, the offices of education should equip schools with the required instruments and tools to make efficient and effective use of digital games. That is because teachers will be encouraged to make use of such equipment when they see their colleagues using it.

Limitations

One of the main limitations of this research is the lack of similar research in the country, which originates from the novelty of this issue in the global arena. Furthermore, we need further empirical studies to document the processes and tutorials involved in combining digital games into the K-12 curriculum. Another limitation is that the data collection tool is limited to the questionnaire and other research tools such as interviews and observation are not used.

Ethical Considerations

This research was conducted under the supervision of Payame Noor University. The researchers introduced themselves to the participants and informed them of the purpose of the study. Teachers were assured that their information would remain confidential. The participants' informed personal consent was

obtained before the start of the study.

Authors' Contributions

SA: proposed the research idea and wrote the paper.

MHS: collected the research resources and monitored the writing process.

MRS: revised the paper.

SM: responded to the reviewers.

Conflict of Interest

The authors declare that there is no conflict of interest in this study.

Acknowledgments

The authors sincerely appreciate their colleagues from Payame Noor University and the vice chancellery for research who approved the research proposal. They also thank all the participants who completed the questionnaires and everyone who contributed to the progress of this work.

Funding/ Support

No financial support has been received by the authors of this study.

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