Factors Influencing the use of Digital Games in Teaching: An Exploratory Study in the Context of Digital Transformation in Northern Vietnam

https://doi.org/10.3991/ijet.v18i08.36243

Thao Trinh Thi Phuong[1], Nam Danh Nguyen[2(✉)], Dinh Ngo Van[3], Hang Nguyen Thi Thu[4], Thanh Nguyen Chi[5]
[1]Thai Nguyen University of Education, Thai Nguyen, Vietnam
[2]Thai Nguyen University, Thai Nguyen, Vietnam
[3]Culture School – Training Department, Ministry of Public Security, Thai Nguyen, Vietnam
[4]Thai Nguyen University of Agriculture and Forestry, Thai Nguyen, Vietnam
[5]VNU University of Education, Vietnam National University, Hanoi, Vietnam
danhnam.nguyen@tnu.edu.vn

Abstract—In recent years, "digital transformation" has been mentioned more and more in most social aspects of life, including education. Digital transformation takes advantage of every opportunity that technology offers and can create an ecosystem in digital education to connect teachers, learners, and countries with new learning models. Besides, a technology trend that has been gaining traction is "gamification." In many countries, games are used in education to engage students through digital media, utilizing platforms or applications that require digital devices such as tablets, smartphones, or computers. However, to be able to apply it in Vietnam, various issues need to be addressed. The study polled 245 secondary and high school teachers in Vietnam to find out what factors influence the use of digital games in teaching in high schools in Northern Vietnam. The findings revealed that the teacher factor significantly affects the usage of digital games in the classroom. In addition, there are other factors, such as information technology tools for digital games in education, external resources, and available inherent resources. This can be used as a guide for adjusting the curriculum or developing pedagogical training programs to improve innovation and effectively use digital games in teaching.

Keywords—gamification, digital games in teaching, influencing factors, teachers

1 Introduction

Digital transformation is applying digital technology to change operating models (organizations, people, processes) to create new values, products, and experiences. Digital transformation is a mindset shift from an individual development model to

a connection and sharing model. Therefore, technology creates rapid changes in the model, organization, and teaching methods, such as traditional classrooms being replaced by online classes, virtual classrooms, and more diverse learning spaces. Big data will be an endless source for students to participate in experiential learning with rich digital learning resources. The curriculum is designed to be more diverse, more specific, and more responsive to individualized learning needs [1]. Technological advancements and their rapid development always create new and exciting possibilities to engage students in learning and meet the growing demands of education; at the same time, traditional teaching methods or even their applications being used today have been proven insufficient. In recent years, a technology trend that has been gaining traction in various fields, including education, is "gamification" [2][3]. The Covid-19 pandemic has helped accelerate the global digital transformation process by about 3 to 7 years [4]. To cope with the epidemic situation, students must change the way they learn, have self-study skills, and aim to personalize learning with the support of technology, in which online learning plays a decisive role. Digital games can be integrated into online learning activities to help students be more active in discovering knowledge, discovering problems, and applying new knowledge in practice. In addition, digital games also promote group activities, create excitement, learning motivation, and develop students' ability to cooperate in the learning process. Therefore, digital games can motivate learning more effectively than traditional courses. Especially for online courses, digital learning games create a positive learning environment with completed challenges, thereby helping to develop students with the necessary skills for life, and teachers could measure the student's progress throughout the learning process.

Studies demonstrate that game-based learning is well-liked by kids and teenagers, and educational games are frequently utilized as teaching and learning methods [5]. Gamification has quickly emerged as one of the favorite persuasive technologies widely used to promote positive changes in user behavior by utilizing typical gaming elements such as scoring, competing with others, rules of play, etc., in non-game contexts [6]. Using game elements and aesthetics can enhance student motivation and encourage learning in education. The core idea of gamification lies behind the logic that the motivational power of game elements can be transferred to the educational context. The implementation of gamification in education has been an attractive area for many researchers because games are popular among students while also catching their interest. Furthermore, it can facilitate scientific thinking compatible with scientific theories, methodologies, and learning strategies related to education and gamification.

In recent years, "digital transformation" has been mentioned more and more in most social aspects of life, including education. Digital transformation takes advantage of every opportunity that technology offers and can create an ecosystem in digital education to connect teachers, learners, and countries with new learning models [7]. Digital transformation in education creates unique learning opportunities when learners join online, with better conditions and diverse, flexible, and ever-changing teaching methods. Digital learning is also the driving force for developing skills to drive digital transformation in other fields. For Vietnam, the Prime Minister has approved the "National Digital Transformation Program to 2025, with orientation to 2030" together with Decision No. 749/QD-TTg dated June 3rd 2020, according to which education is one of eight

areas that need to accelerate digital transformation. Digital transformation in education includes four factors: inputs, educational process, output factors, and educational environment. Input factors such as learning materials, documents, textbooks, data on learners, teaching and learning equipment, and facilities for education. Process factors include digitization of lessons, application of software to prepare studies, teaching methods, classroom management techniques, interaction with learners in digital space, all data about students' learning process is tracked and stored by technology, digitizing management information, connecting database system. Output factors such as digitized results are evaluated, lessons focus on teaching and are free from administrative work, score management records, academic records management, etc. Decision 749/QD-TTg also specifies "Developing a support platform for teaching and learning remotely, thoroughly applying digital technology in management, teaching, and learning; digitizing documents and textbooks; building a platform to share teaching and learning resources in both face-to-face and online forms. Developing technology for education, towards personalized training" [8]. Thus, digital transformation in education in Vietnam is an urgent requirement. Vietnam's newly promulgated general education curriculum and textbooks have created more opportunities for digital transformation in education. Facing this requirement, there have been several studies and proposals to promote digital transformation in Vietnam. According to this trend, the use of digital games as a teaching tool can be considered one of the more effective educational strategies to improve the quality of education in future classrooms [9].

Although digital games have already been used and proven to be effective in teaching in many countries around the world, many issues still need to be addressed to utilize them effectively in Vietnam. Based on determining the model of factors influencing the use of digital games in teaching, the study focuses on determining the factors influencing the usage of digital games in teaching in high schools in Vietnam. The study aims to answer the following: Which factors influence the usage of digital games in teaching in Vietnam? What is the magnitude of influence of each factor on the choice of using digital games in teaching? To make appropriate recommendations to contribute to the utilization of digital games in teaching more effectively in Northern Vietnam.

2 Research topic overview

2.1 Digital games in teaching

Gamification was introduced in the last decade and has been developed in various areas, including education [10]. According to Kapp [11] gamification is defined as "the use of game design elements, gameplay mechanics, aesthetics, and game thinking for non-game applications to engage students." Although there is no universal definition for gamification, most share some standard features. Recently, however, gamification has shifted to engaging students with digital media, using platforms or applications that utilize digital devices such as tablets, smartphones, or computers [12].

All game apps have either of the two sets of goals, learning goals corresponding to the content and play goals related to user experiences they stimulate, such as enjoyment and fulfillment [13]. Game content defines learning goals, while play goals are linked

to game design elements implemented in the game application, motivational strengths, type, and their corresponding psychological needs [10]. Learning objectives and play goals are similar. The primary purpose of gamification is to influence factors, such as motivation, to influence learning-related behavior, such as interacting with educational content and achieving learning outcomes. Therefore, the role of gamification is to "influence the psychological factors that indirectly affect academic performance" [14]. However, how the content is presented is equally important for learning outcomes as it can lead to a decline in effectiveness or acquisition of knowledge and skills despite increased engagement and effort. A "gamified" learning environment should be carefully designed, especially around the game elements it utilizes, and with clear instructions [15]. Students may need to be more focused on learning goals [16].

According to Thao et al. [17], digital games comprise various genres and can be played using multiple digital technologies such as computers, tablets, and mobile devices. Digital games have been developed and applied in several educational environments. Thanks to the game elements, learning becomes more accessible and fun for learners, making them more motivated to learn. Digital games are an example of computer-aided learning media, which is also an approach for math educators because they provide learners with environments that encourage students to practice their skills, which can maintain children's concentration and provide an alternative solution for math operations, mathematical notation. This group of authors defines that: Digital games are games made on a wide range of digital models, allowing players (learners) to make choices based on the state of those models; in other words, the player (learner) performs a series of experiential activities, overcoming the game's challenges in a specific order, based on a set of rules established by the creator, with clearly-defined educational and recreational goals, to form a relaxed environment, create interest in learning, improve participants' cognitive ability, accumulate knowledge, thereby becoming an effective learning method in education.

The following common characteristics can be found in the definition of a digital game. Mayer and Johnson [18] assert that: A digital game-based learning environment has: (1) A set of mandatory game rules; (2) A set of dynamic, positive responses of learners; (3) Appropriate, challenging activities to help learners feel the real experience through the game; (4) The difficulty of the game increases gradually towards the learning results.

Huizenga et al. [19] provide general characteristics of digital games in teaching. Each game has 1) one goal, one objective to achieve; 2) game activities, referring to the fact that the game is an activity, a process, an event; the player is doing something; 3) the rules of the game, i.e. some rules must be followed, a rule-based game; 4) the outcome(s), referring to the score and specific game actions that lead to a win or lose, e.g. points or virtual currency; 5) conflict or competition, which means some competition, with the system (PvE) or with other players (PvP), or even with the players themselves, to improve their scores. This group of authors' viewpoint regarding digital games are games played with digital devices, distinguishing between teachers' perceptions of learning outcomes and students' motivations for playing and creating a game.

Thao et al. [17] have identified some approaches to applying learning games in teaching, including using learning games to evoke learning motivation in students, using learning games to allow students to discover knowledge by themselves in the process

of forming new knowledge, using learning games to consolidate knowledge after each lesson; using learning games to allow students to test their knowledge on their own; using learning games in organizing extracurricular activities and experiences.

2.2 Factors influencing the use of digital games in teaching

Multiple studies have determined the factors influencing the usage of digital games in teaching worldwide. In this section, we compile the factors proposed by previous studies to build a theoretical framework for the research.

Many previous studies have confirmed that the extent to which teachers consider video games relevant to their educational practice seems an essential factor leading to changes [20]–[24]. Therefore, it can be argued that usefulness and learning opportunities should be considered in a model to describe and predict teachers' acceptance of digital games in teaching. Such a model should also address teachers' concerns about the complexity of games used in the classroom, although its relationship to other factors remains unclear [24]–[26].

Becker and Jacobsen [27] assert that the lack of time and technical problems are the most critical barriers to using games in education. In his study with 444 Korean teachers, Baek [28], six factors hindering teachers' use of digital games in the classroom were discovered: Inflexible curriculum, Negative effects of gaming, Lack of student readiness, Lack of supporting materials, Fixed class schedules, and Limited budget. Lack of supporting materials, fixed class schedules, and limited budget are factors that female teachers consider more severe obstacles to using games in the classroom than male teachers. Experienced teachers believe that the inflexibility of the curriculum and the adverse effects hinder the application of games in teaching.

One of the significant barriers preventing the adoption of digital games in education is the complexity they present in learning. While a regular lecture requires little investment in technology, using digital games in teaching requires a lot of equipment, such as computers, other digital devices, and a controlled environment. Therefore, the difficulty posed is that schools often need more facilities. In addition, even when these tools are fully provided in schools, using digital games in teaching usually requires more preparation and time to arrange the lessons. Accordingly, teachers' unwillingness to learn new technology, the complexity of education, and the lack of technological infrastructure are also considered significant problems hindering game-based learning [29].

Bourgonjon et al. [30] relied on the technology acceptance model (TAM) to describe and explain the factors influencing the acceptance of digital games as a learning tool in the classroom by secondary high school teachers, considering the direction of the relationship between factors, both behavioral theory and information system research are further explored. Survey results of 505 teachers showed that factors influencing the acceptance of using digital games in teaching include: teachers' perceptions of ease of use, usefulness, learning opportunities and personal experiences with video games in general, however, this study also showed that ease of use does not affect teachers' acceptance of games as much as expected. Other factors that did not affect teachers' acceptance of games were their personal experience with video games as well as their tendency to use information technology.

According to Saleh et al. [31], many factors affect or influence digital games, including usability (defined as the extent to which a product can be used for specific purposes and by a particular user); ease of use (whether there are flexible environments in the game so that users can set their plans and repeat the tests of an experiment in a particular period easily when using them); usefulness (Recreational games with management benefits that can be applied in many different areas of knowledge, virtual reality provides an opportunity for students to experiment with exciting entertainment environments, they also provide students important skills such as adapting quickly to changing positions and managing difficult tasks); The effectiveness of games (they motivate students to discover new things, increase students' attention to educational material, and raise their scores).

Teachers face major technical hurdles because they need help learning modern hardware and its maintenance. Meanwhile, the cost is considered one of the most realistic obstacles, and these costs can be an obstacle to the adoption of these technologies in schools [31], [32]. Another problem when applying digital games in education is the need for more professionalism and sufficient knowledge to deal with the external resources of digital games. Culture is another obstacle, and many people see digital games as an effective way of education. Still, their culture prevents them from exploiting this technology in education because they believe these games will isolate learners from early childhood activities [31].

Table 1. Factors and topics contribute to teachers' acceptance of learning tools with gamification [33]

Factor	Topic
Teacher factor	Teacher's control
	Teacher's skills
	Teacher's attitude
	Risk avoidance
Instrumental factor – educational perspective	Available resources
	Compatibility
	Relevance to the curriculum
	Interaction effectiveness
	Effectiveness in learning outcomes
	Cost effectiveness
Instrumental factor – IT perspective	Ease of use perception
	Cost
	Negative influence
	Learning game design
	Interface aesthetics
External support	Student, parent and administrative support

Research results of Huizenga et al. [19] showed that most teachers who use games in class perceive students' engagement with games and cognitive learning outcomes

as the impact of using games in a formal teaching environment. Teachers reported that teaching with games engaged their students. Teachers believe that game-based teaching encourages students to learn; teaching by games affects students' learning outcomes.

Luo et al. [33] surveyed 347 people. They conducted in-depth interviews with 14 teachers from secondary schools in China to understand better what encourages and restricts teachers' use of gamified learning tools in secondary schools. Using the topic analysis method, the author has obtained 16 topics affecting the intention of teachers to accept games (see Table 1).

2.3 Research model

Derived from the study of Luo et al. [33], we have selected the factors that are likely to influence the use of digital games in teaching students in secondary and high schools and developed a research model as shown in Figure 1. The model developed by Luo et al., was built on the reference of many previous studies on the same topic. At the same time, this theoretical model has also been applied in a qualitative and quantitative study with teachers in China – A country with many similarities with the context in Vietnam. The study by Luo et al., published in 2021, is consistent with the digital transformation context at the time of this study.

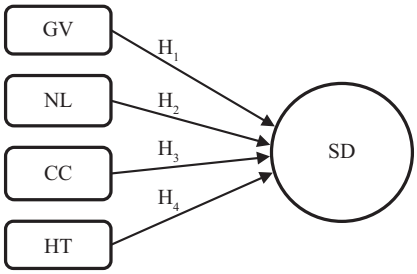

Fig. 1. Research model

In this model, SD is the dependent variable corresponding to the factor of using digital games in teaching. Including: using learning games to evoke learning motivation in students (SD1), using learning games to allow students to discover knowledge by themselves in the process of forming new knowledge (SD2), using learning games to consolidate knowledge after each lesson (SD3), using learning games to allow students to test their knowledge on their own (SD4).

GV, NL, HT, and HT are independent variables influencing the ability to use digital games in teaching.

GV is the teacher's subjective factor about digital games in teaching. This factor includes teacher control (GV1), teacher knowledge and skills (GV2), teacher attitude (GV3), teaching effectiveness (GV4), and teacher information update (GV5).

NL is the tool factor-educational for the use of digital games in teaching. This factor includes learning materials availability (NL1), software availability (NL2), equipment availability (NL3), and curriculum relatedness (NL4).

CC is the IT tool factor for using digital games in teaching. This factor has four themes: Perceived ease of use (CC1), reasonable costs to organize activities (CC2), negative effects on students (CC3), the attraction of digital games in learning (CC4), and aesthetic interface(CC5).

HT factor belonging to external sources of support. Includes active participation of students (HT1), students' parents' support (HT2), administrative support (HT3), and support from colleagues (HT4).

With the above research model, we have carried out an exploratory study to test the hypothesis:

H1: The teacher's factor positively influences the use of digital games in teaching.
H2: Available resources positively influence the use of digital games in teaching.
H3: The IT tools positively influence the use of digital games in teaching.
H4: Factor belonging to external sources of support positively influences the use of digital games in teaching.

The results of testing the hypotheses will contribute to answering the two questions posed by the study:

RQ 1: What factors will influence the use of digital games in teaching?
RQ 2: How are these factors' influence on the use of digital games in teaching shown?

3 Method of research

The quantitative research method is applied to research and evaluates the impact of factors on the use of digital games in teaching. We have designed a questionnaire consisting of two sections: Section 1 collects information about individual respondents, and section 2 examines factors influencing the use of digital games in teaching, including 22 questions on a 5-point Likert scale: From (1) Completely disagree to (5) Completely agree; These questions are built on the research model described above.

The study sample is teachers teaching at secondary and high schools in the Northern mountainous provinces of Vietnam, with a total of more than 200,000 teachers. A stratified, multi-stage sampling method was applied. The author selected teachers who work in all three areas: mountainous, urban, and rural areas, of both public and private schools. The questionnaire is sent to teachers through an online survey on the Google Form platform. The time to conduct the survey and collect data was two weeks (from June 15, 2022 to June 30, 2022). We received 245 responses from the survey respondents. Information about the study sample is shown in Table 2:

Table 2. Statistics on the characteristics of the study sample

Study Sample N = 245	Gender		Workplace			Level of Education			Type of Schools	
	Male	Female	Mountainous	Urban	Rural	Secondary School	High School	General Level	Public	Private
Number	51	194	94	62	89	55	170	20	224	21
Percentage	20.80	79.20	38.40	25.30	36.30	22.40	69.40	8.20	91.40	8.60

According to Table 2, the percentage of female teachers conducting the survey is quite large, four times higher than the number of male teachers. In the survey areas where the teachers work, the mountainous area accounts for the most significant proportion at 38.4%; the minor ratio is the urban area at 25.3%; the number of teachers teaching at high schools accounted for the majority (69.4% rate). In the two types of schools that the study conducted the survey, the number of public schools accounted for 91.4%. Thus, the collected sample data, despite a relatively high difference in gender characteristics or the type of schools where the teachers work, still ensure the requirement of allocating questionnaires to teachers in the northern mountainous areas with all the features and research components.

The survey data was synthesized, analyzed by mathematical statistical methods, and processed by SPSS 20 software. The Cronbach's Alpha reliability test method was used to test each scale, unsatisfactory observed variables will be removed. According to Peterson [34], any scale with the Cronbach's Alpha coefficient greater than 0.6 will be accepted; observed variables with a corrected item-total correlation less than 0.3 are considered bad variables and will be removed from the scale. Next, the exploratory factor analysis (EFA) method was performed to find out the extracted factors in the model that met the testing requirements. With the following conditions: (1) The factor loading of the observed variables is greater than 0.5; (2) The KMO coefficient satisfies $0.5 \leq KMO \leq 1$ [35]; (3) The Sig. value of Bartlett's test is less than 0.05; (4) Value of extracted or cumulative variance > 50% [36]; The Eigenvalue is used to identify the number of factors to be extracted from a value greater than 1.

4 Results

4.1 Test for the reliability of the scale

The research model is designed with four independent variables (GV, NL, CC, HT) and one dependent variable SD. Each factor is measured indirectly through 4 to 5 questions, equivalent to 4 to 5 observed variables. The study tests the scale's reliability with the cleaned data set through Cronbach's Alpha. The results of the analysis are listed in Table 3:

Table 3. Results of the cronbach's alpha analysis

No.	Factors	Observed Variables	Cronbach's Alpha	Min–Max Corrected Item – Total Correlation
1	Teacher (GV)	GV1, GV2, GV3, GV4, GV5	0.893	0.633–0.796
2	Available resources (NL)	NL1, NL2, NL3, NL4	0.850	0.599–0.781
3	IT Tools (CC)	CC1, CC2, CC3, CC4, CC5	0.852	0.505–0.774
4	External Support (HT)	HT1, HT2, HT3, HT4	0.861	0.651–0.795
5	Use of digital games (SD)	SD1, SD2, SD3, SD4	0.932	0.819–0.866

Table 2 shows that the Cronbach's Alpha of all scales for factors GV, NL, CC, HT, and SD ranges from 0.850 to 0.932 and is all greater than 0.6; the Corrected Item – Total Correlation of all observed variables is greater than 0.3. Thus, it proves that the observed variables in the factors are consistent, the scale of the factors has high reliability, and no observed variables are excluded from the scale.

4.2 The fitness of observed variables and factors in the model

To test the convergence and discrimination of observed variables with factors extracted in the theoretical model, we have applied the EFA exploratory factor analysis for a research model consisting of four hypotheses H1, H2, H3, and H4 corresponding to four independent variables and one dependent variable. The KMO coefficient, in Table 4, of the independent variable and the dependent variables, respectively reached 0.862 and 0.830, satisfying the condition $0.5 \leq KMO \leq 1$, showing that factor analysis is suitable with the research data set; The Sig. value of Bartlett's test of the independent variable and the dependent variable is equal to $0.000 < 0.05$, showing that the observed variables in the factor are correlated with each other and the factor analysis is statistically significant; The Eigenvalues are all greater than 1, the data can extract 04 independent factors with a total variance explained of 70.76%, 01 dependent factor with a total variance explained of 83.287% (satisfying the condition greater than 50%); The minimum factor loading is 0.559, satisfying the minimum condition for the observed variable to be retained and no variables to be excluded.

Table 4. Table of exploratory factor analysis EFA

Parameters	EFA for Independent Variables	EFA for Dependent Variables
KMO Value	0.862	0.830
Sig. of Bartlett's test	0.000	0.000
Eigenvalue	1.285	3.331
Total variance explained	70.76	83.287
Minimum factor loading	0.559	0.899
Number of extracted factors	4	1
Number of variables to be excluded	0	0

Through the rotation of factors, the observed variables of the factors are converged respectively as shown in Table 5:

Table 5. Table of rotated component matrix

Observed Variables	Components				
	GV	NL	CC	HT	SD
GV4	0.869				
GV2	0.843				
GV3	0.835				
GV1	0.827				
GV5	0.658				
NL2		0.848			
NL1		0.803			
NL3		0.725			
NL4		0.716			
CC4			0.830		
CC5			0.817		
CC2			0.704		
CC1			0.685		
CC3			0.559		
HT2				0.845	
HT3				0.804	
HT1				0.756	
HT4				0.738	
SD1					0.926
SD2					0.921
SD3					0.903
SD4					0.899

At the end of the EFA step, we obtained the five factors, including GV, NL, CC, HT, and SD, most suitable with the 22 best-observed variables. Therefore, to change the measurement of observed variables to the measurement of factors to test the recommended hypotheses, we conducted to create representative factors and performed Pearson correlation and linear regression analysis.

4.3 Correlation and regression results

We conducted the Pearson correlation test between the independent and dependent variables. The results from Table 6 indicated that all variables had a relatively close linear relation (correlation coefficient r is all greater than 0), and the results were statistically significant (Sig. < 0.05).

Table 6. Correlation analysis results

Variables		SD	CC	HT	NL	GV
Pearson correlation coefficient	SD	1				
	CC	0.643	1			
	HT	0.588	0.544	1		
	NL	0.541	0.560	0.421	1	
	GV	0.593	0.384	0.408	0.322	1
Sig.	SD	.				
	CC	0.000	.			
	HT	0.000	0.000	.		
	NL	0.000	0.000	0.000	.	
	GV	0.000	0.000	0.000	0.000	.

An analysis was conducted to test the four hypotheses of the theoretical model. The results of multivariable regression analysis in Table 7 indicate that the Sig. values of the F test < 0.05, so the regression coefficient is significant, and the regression model is suitable with the obtained data set; the Durbin-Watson value is 1.827 satisfying the condition in the range of 1.5–2.5, which indicates that the first-order sequence auto-correlation does not appear in the model; The significance test value of the regression coefficients Sig. < 0.05 shows the significant effects of independent variables on dependent variables. At the same time, the VIF coefficient of independent variables are all less than 10. The data, therefore, does not violate the assumption of multicollinearity.

All values of the standardized regression coefficient Beta in Table 7 bear positive ones, showing that the independent variables have a positive effect on the dependent variables; the hypotheses H1, H2, H3, and H4 have all been accepted. The research model is rewritten according to the standardized regression equation as follows:

$$SD = 0.333*GV + 0.174*NL + 0.301*CC + 0.216*HT + \varepsilon$$

Of which ε is the remainder.

The equation contains the adjusted R^2 value of 0.606, showing that the independent variables GV, NL, CC, and HT have well-explained 60.6% of the change of the dependent variable SD, and 39.4% are due to out-of-model variables and random errors.

Table 7. Regression results

Variables	SD			
	Std. Error	**Standardized Beta Coefficient**	**Sig.**	**VIF**
(Constant)	0.204		0.000	
GV	0.052	0.333	0.000	1.269
NL	0.063	0.174	0.001	1.514
CC	0.071	0.301	0.000	1.791
HT	0.060	0.216	0.000	1.549
Number of observations	245			
Adjusted R^2	0.606			
Sig. of the F test	0.000			
Durbin-Watson value	1.827			

The regression equation above also indicates the degree of impact of independent variables on the dependent variable. In particular: with the maximum Beta coefficient of 0.333, the factor with the most influence is GV (teacher), and the factor with the minor impact is the available resources (Beta coefficient equal to 0.174).

5 Discussion

Digital transformation positively helped the teaching and learning process, promoting the student's ability to think creatively, master knowledge, master the program, and use learning materials and digital games effectively. Vietnam has digitized and identified the data of about 53,000 schools, 1.4 million teachers, 23 million students and 82% of schools use school management software, electronic grade books, electronic school records. Regarding learning materials, the Vietnam Ministry of Education and Training has developed a shared digital repository of 5,000 E-learning lectures, more than 2,000 lectures on television, 200 virtual experiments, 35,000 multiple-choice questions, thousands of digital games, and nearly 200 textbooks, according to the general education curriculum [37]. Therefore, it can be said that the educational sector is very interested in training Vietnamese citizens with digital transformation knowledge and skills to become global citizens. Therefore, digital transformation is identified by the industry as a breakthrough, an important task that needs to be implemented in the coming years. Doing well digital transformation not only helps improve the quality of education but more importantly contributes to improving labor productivity, creating great opportunities for international integration.

From the results of the test, the analysis, and the linear regression equation, it can be found that the research model with four hypotheses H1, H2, H3, and H4 corresponds to four factors, including teachers, available resources, IT tools, external support, has a positive impact on the use of digital games in teaching by teachers in secondary and high schools.

The teacher (GV) factor is expressed through five fundamental issues: students' control of activities in the process of organizing digital games; skills and techniques necessary to manage digital games well; the use of a lot of digital games in the teaching process; regular update of digital games in the teaching process. In the standardized regression equation, the GV factor obtains the highest Beta coefficient (Beta = 0.333), showing that the GV factor has the most considerable influence on the use of digital games in teaching. This result is consistent with previous studies by Luo et al. [33], in which teachers doubt students' self-control, so they are worried whether students will use digital devices for other purposes, distract from learning, and this will lead to addictive behaviors or not. Teachers also complain that the use of gamified learning tools during class hours presents challenges in discipline management. For teachers who fail to own enough knowledge, using technological innovations can cause anxiety, Game-Based Learning, or deceptive learning processes. Therefore, the sufficient confidence of teachers in their ability to process control the teaching well with the support of digital games in education will be an essential factor. This result is also a suggestion to assist pedagogical universities in updating their requirements for skills when training students and developing re-training programs for teachers, especially re-training programs to improve skills in using IT for teachers. Thus, through digital transformation, teachers must constantly improve their knowledge and learn to adapt to technological changes. Teachers must apply digital technology most effectively in their teaching activities and be ready to participate in programs to improve their ability to use technology in teaching [38], [39]. Digital games also allow for organizing learning activities associated with real-life situations. Therefore, students are motivated to solve complex problems, open problems related to the knowledge of the lesson, and develop student's creativity.

The IT tools factor for the use of digital games in teaching (CC) are presented in 4 contents: tools used to organize easy-to-use digital games; Reasonable costs of managing digital game activities; negative effects on students; the play method is increasingly attractive to students; Digital games in learning have a beautiful, friendly, easy-to-use interface. In the standardized regression equation, the CC factor obtains the second highest Beta coefficient (Beta = 0.301), showing that the influence of the CC factor on the use of digital games is second only to the impact of the teacher factor. This factor is quite similar to some studies using the technology acceptance model (TAM) [29]–[31], which also affirm that the ease of use, usefulness, and effectiveness of the game affect the decision to use digital games in teaching. Several other studies also demonstrate that cost is one of the most realistic obstacles, and such costs can be an obstacle to adopting these technologies in schools [31], [32]. This result is reasonable in the context of teaching in secondary and high schools in Vietnam, especially schools in mountainous and rural areas, modern IT tools such as computers, projectors, Internet connection, etc., have not satisfied the learning and teaching needs of students and teachers. However, according to our observations, this factor only ranks second because, in Vietnam, the role of teachers is often quite substantial. When teachers feel appropriate and effective and that they love and are capable enough to perform, they can try to overcome external difficulties on their own to seek to support and teach their students in the best way. In the online environment, teaching still operates according to teaching principles. However, technical factors and teaching techniques have changed, and the teaching environment has also changed. These factors affect the whole teaching system, making

the teaching method and organization of teaching change. But in essence, teaching has not changed. Digital games in teaching will support teaching more effectively and help differentiate instruction more thoroughly. Digital games are a tool and mean creating a technical environment in which educational activities take place to achieve optimal goals. Digital games are also a practical teaching approach that encourages students to participate in learning activities actively and provides quick feedback to teachers on student performance, enhancing student learning interest and achievement.

The factor of external support resources (HT) is reflected in the following contents: Active participation from students; Support from the student's parents; Encouragement form from schools; Regular share and update from colleagues in the school. In the standardized regression equation, the HT factor ranks third in influence (Beta coefficient = 0.216). According to Luo et al. [33], the support and facilitation from the students' parents for teachers to perform games in the learning process are significant resources. In terms of students, surveys and interviews show that students may also refuse to use gamified tools for learning; therefore, active participation is essential for the effective use of digital games in learning. Regarding school managers, the Principals of schools showed a negative view of learning tools related to gambling and betting. Schools also need to invest more in equipment and technical support, which significantly limits the application of gamification by teachers in the classroom. Furthermore, digital transformation is not only the digitization of lessons or the application of software to prepare lessons but also the transformation of the entire way, teaching methods, classroom management techniques, interaction with students in the digital space, and exploiting information technology to organize successful teaching. This changing environment helps teachers and learners promote initiative, thinking ability, and creativity with high quality and efficiency. The introduction of digital games into teaching has gradually changed the centralized classroom model, which has shifted to online teaching models, using technology to support teaching and learning activities.

The least influential factor (Beta coefficient equal to 0.174) is the tool factor-educational (NL) for the use of digital games, including the following specific issues: materials and software for teaching and learning through digital games; devices that allow teachers to use digital games with the subject flexibly; The subject's curriculum that enables the use of digital games; Students' readiness to cooperate. This result is different from Baek's study; the author believes that among the six identified factors, the inflexible curriculum has the most significant influence on the use of digital games in teaching, and the factor with the third influence is the lack of student readiness. This may be explained by the fact that the study context in Vietnam in 2022 is different from the context of Baek's study [28]; the currently available resources in Vietnam have significantly improved so that teachers can carry out education for students through digital games. Thus, enhancing digital technology in education to create a system of learning materials, virtual laboratories, and virtual reality models capable of interacting with students. Digital transformation creates a flexible and equal study space and time. Therefore, students save on tuition fees, living expenses, and study materials. Significantly digital learning games have increased interactivity and practicality – application, students can answer teachers' questions through teaching software so that teachers can accurately assess learners' knowledge effectively.

6 Conclusion

This study used an exploratory research method based on the theoretical framework developed by Luo et al. to develop a survey toolkit to determine the factors affecting the use of digital games in teaching high school teachers in Vietnam. The research findings have pointed out four factors with their influence in descending order: teacher, IT tools for using digital games in teaching, external support resources, and available support resources. For the teacher factor, teachers' information technology capacity is essential, which helps teachers to transform ideas of organizing learning activities into digital games. In particular, studies showed that digital games allow students to be active and proactive in cognitive activities and the formation of new knowledge. This can be a suggestion for adjusting the curriculum or developing re-training seminars for teachers to enhance the ability to design and effectively use digital games in teaching.

A limitation of this study is that it still needs to build its theoretical framework to analyze the factors influencing the use of digital games in teaching for Vietnamese teachers, but mainly based on the existing theoretical framework. Furthermore, the study only surveyed teachers from schools in the Northern mountainous areas of Vietnam with their characteristics. Therefore, the research findings may only be appropriate if applied to some teachers in Vietnam.

7 References

[1] N. D. Nguyen and Q. H. Pham, "Key Pedagogical Universities and Restructuring Teacher Education Institutions: A Case Study of Vietnam," *Eur. J. Contemp. Educ.*, vol. 11, no. 3, pp. 858–872, Sep. 2022, https://doi.org/10.13187/ejced.2022.3.858

[2] M. Kalogiannakis, S. Papadakis, and A.-I. Zourmpakis, "Gamification in Science Education. A Systematic Review of the Literature," *Educ. Sci.*, vol. 11, no. 1, p. 22, Jan. 2021, https://doi.org/10.3390/educsci11010022

[3] L. Bennis and S. Amali, "From Learning Game to Adaptive Ubiquitous Game Based Learning," *Int. J. Emerg. Technol. Learn.*, vol. 14, no. 16, pp. 55–65, 2019, https://doi.org/10.3991/ijet.v14i16.10701

[4] T. T. D. Ngo, "Digital Transformation in University Teaching," in *Proceedings of the National Conference on Digital Transformation in Higher Education*, pp. 249–258, 2021.

[5] H. A. Jalil *et al.*, "Systematic Review of Enjoyment Element in Health-Related Game-Based Learning," *Int. J. Emerg. Technol. Learn.*, vol. 15, no. 21, pp. 40–57, 2020, https://doi.org/10.3991/ijet.v15i21.17345

[6] M. Trinidad, M. Ruiz, and A. Calderon, "A Bibliometric Analysis of Gamification Research," *IEEE Access*, vol. 9, pp. 46505–46544, 2021, https://doi.org/10.1109/ACCESS.2021.3063986

[7] C. G. Demartini, L. Benussi, V. Gatteschi, and F. Renga, "Education and Digital Transformation: The 'Riconnessioni' Project," *IEEE Access*, vol. 8, pp. 186233–186256, 2020, https://doi.org/10.1109/ACCESS.2020.3018189

[8] Vietnamese Government, "Decision No.749/QD-TTg dated June 3rd, 2020 of the Prime Minister approving the 'National Digital Transformation Program to 2025, with orientation to 2030'," 2020. [Online]. Available: https://datafiles.chinhphu.vn/cpp/files/vbpq/2020/06/749.signed.pdf

[9] L. Bertram, "Digital Learning Games for Mathematics and Computer Science Education: The Need for Preregistered RCTS, Standardized Methodology, and Advanced Technology," *Front. Psychol.*, vol. 11, Oct. 2020, https://doi.org/10.3389/fpsyg.2020.02127

[10] G. Richter, D. R. Raban, and S. Rafaeli, "Studying Gamification: The Effect of Rewards and Incentives on Motivation," in *Gamification in Education and Business*, T. Reiners and L. C. Wood, Eds. Cham: Springer International Publishing, pp. 21–46, 2015. https://doi.org/10.1007/978-3-319-10208-5_2

[11] K. M. Kapp, *The gamification of learning and instruction: Game-based methods and strategies for training and education*. John Wiley & Sons, 2012. https://doi.org/10.1145/2207270.2211316

[12] A. C. T. Klock, A. N. Ogawa, I. Gasparini, and M. S. Pimenta, "Does Gamification Matter?: A Systematic Mapping About the Evaluation of Gamification in Educational Environments," in *Proceedings of the ACM Symposium on Applied Computing*, Apr. 2018, vol. 7, pp. 2006–2012. https://doi.org/10.1145/3167132.3167347

[13] M. Sailer, J. U. Hense, S. K. Mayr, and H. Mandl, "How Gamification Motivates: An Experimental Study of the Effects of Specific Game Design Elements on Psychological Need Satisfaction," *Comput. Human Behav.*, vol. 69, pp. 371–380, Apr. 2017, https://doi.org/10.1016/j.chb.2016.12.033

[14] A. H. Kam and I. N. Umar, "Fostering Authentic Learning Motivations Through Gamification: A Self-Determination Theory (SDT) Approach," *J. Eng. Sci. Technol.*, vol. 13, pp. 1–9, 2018.

[15] D. Strmečki, A. Bernik, and D. Radošević, "Gamification in E-Learning: Introducing Gamified Design Elements into E-Learning Systems," *J. Comput. Sci.*, vol. 11, no. 12, pp. 1108–1117, Dec. 2015, https://doi.org/10.3844/jcssp.2015.1108.1117

[16] H.-M. Huang, U. Rauch, and S.-S. Liaw, "Investigating Learners' Attitudes Toward Virtual Reality Learning Environments: Based on a Constructivist Approach," *Comput. Educ.*, vol. 55, no. 3, pp. 1171–1182, Nov. 2010, https://doi.org/10.1016/j.compedu.2010.05.014

[17] T. T. P. Thao, L. T. D. Quynh, D. M. Hoang, and V. T. Tuyet, "Thiết kế và sử dụng trò chơi kĩ thuật số trong dạy học môn Toán lớp 6 ở trường trung học cơ sở [Design and use of digital games in teaching 6th grade Math in secondary school]," *Tạp chí Giáo dục*, vol. 22, no. 7, pp. 14–18, 2022, [Online]. Available: https://tcgd.tapchigiaoduc.edu.vn/index.php/tapchi/article/view/380

[18] R. E. Mayer and C. I. Johnson, "Adding Instructional Features that Promote Learning in a Game-Like Environment," *J. Educ. Comput. Res.*, vol. 42, no. 3, pp. 241–265, Apr. 2010, https://doi.org/10.2190/EC.42.3.a

[19] J. C. Huizenga, G. T. M. ten Dam, J. M. Voogt, and W. F. Admiraal, "Teacher Perceptions of the Value of Game-Based Learning in Secondary Education," *Comput. Educ.*, vol. 110, pp. 105–115, Jul. 2017, https://doi.org/10.1016/j.compedu.2017.03.008

[20] A. Bakar, Y. Inal, and K. Cagiltay, "Use of Commercial Games for Educational Purposes: Will Today's Teacher Candidates use Them in the Future?" in *EdMedia + Innovate Learning*, 2006, pp. 1757–1762. [Online]. Available: https://www.learntechlib.org/primary/p/23243/

[21] M. Barbour, M. Evans, and S. Toker, "Making Sense of Video Games: Pre-Service Teachers Struggle with this New Medium," in *Society for Information Technology & Teacher Education International Conference*, pp. 1367–1372, 2009.

[22] G. Can and K. Cagiltay, "Turkish Prospective Teachers' Perceptions Regarding the use of Computer Games with Educational Features," *J. Educ. Technol. & Soc.*, vol. 9, no. 1, pp. 308–321, 2006.
[23] S. M. Hord, W. L. Rutherford, L. Huling-Austin, and G. E. Hall, *Taking charge of change*. 1987. [Online]. Available: https://files.eric.ed.gov/fulltext/ED282876.pdf
[24] M. D. Proctor and Y. Marks, "A Survey of Exemplar Teachers' Perceptions, use, and Access of Computer-Based Games and Technology for Classroom Instruction," *Comput. Educ.*, vol. 62, pp. 171–180, Mar. 2013, https://doi.org/10.1016/j.compedu.2012.10.022
[25] S. Kennedy-Clark, "Pre-Service Teachers' Perspectives on using Scenario-Based Virtual Worlds in Science Education," *Comput. Educ.*, vol. 57, no. 4, pp. 2224–2235, 2011. https://doi.org/10.1016/j.compedu.2011.05.015
[26] R. F. Kenny and R. McDaniel, "The Role Teachers' Expectations and Value Assessments of Video Games Play in their Adopting and Integrating Them into their Classrooms," *Br. J. Educ. Technol.*, vol. 42, no. 2, pp. 197–213, 2011. https://doi.org/10.1111/j.1467-8535.2009.01007.x
[27] K. Becker and M. Jacobsen, *Games for learning: Are schools ready for What's to come?* PRISM, 2005. https://doi.org/10.11575/PRISM/10182
[28] Y. K. Baek, "What Hinders Teachers in using Computer and Video Games in the Classroom? Exploring Factors Inhibiting the Uptake of Computer and Video Games," *CyberPsychology Behav.*, vol. 11, no. 6, pp. 665–671, Dec. 2008, https://doi.org/10.1089/cpb.2008.0127
[29] J. Torrente, P. Moreno-Ger, I. Martínez-Ortiz, and B. Fernandez-Manjon, "Integration and Deployment of Educational Games in E-Learning Environments: The Learning Object Model Meets Educational Gaming," *J. Educ. Technol. & Society*, vol. 12, no. 4, pp. 359–371, 2009.
[30] J. Bourgonjon, F. De Grove, C. De Smet, J. Van Looy, R. Soetaert, and M. Valcke, "Acceptance of Game-Based Learning by Secondary School Teachers," *Comput. Educ.*, vol. 67, pp. 21–35, Sep. 2013, https://doi.org/10.1016/j.compedu.2013.02.010
[31] N. Saleh, E. Prakash, and R. Manton, "Factors Affecting the Acceptance of Game-Based Learning," *Int. J. Comput. Appl.*, vol. 92, no. 13, pp. 1–10, 2014. https://doi.org/10.5120/16066-5201
[32] S. Egenfeldt-Nielsen, "Beyond Edutainment. Exploring the Educational Potential of Computer Game," IT-University of Copenhagen, Denmark, 2005.
[33] Z. Luo, C. Brown, and B. O'Steen, "Factors Contributing to Teachers' Acceptance Intention of Gamified Learning Tools in Secondary Schools: An Exploratory Study," *Educ. Inf. Technol.*, vol. 26, no. 5, pp. 6337–6363, Sep. 2021, https://doi.org/10.1007/s10639-021-10622-z
[34] R. A. Peterson, "A Meta-Analysis of Cronbach's Coefficient Alpha," *J. Consum. Res.*, vol. 21, no. 2, p. 381, Sep. 1994, https://doi.org/10.1086/209405
[35] J. F. Hair, R. E. Andreson, R. L. Tahtam, and C. W. Black, *Multivariate Data Analysis*. New Jersey: Prentice-Hall International Inc, 1998.
[36] D. W. Gerbing and J. C. Anderson, "An Updated Paradigm for Scale Development Incorporating Unidimensionality and its Assessment," *J. Mark. Res.*, vol. 25, no. 2, pp. 186–192, May 1988, https://doi.org/10.1177/002224378802500207
[37] Ministry of Education and Training (Vietnam), "Final Report of Academic School Year 2021–2022." Hanoi, Vietnam, 2022.
[38] Q. H. Pham and N. D. Nguyen, "Restructuring the Teacher Education System in Vietnam," *Int. J. Learn. Teach. Educ. Res.*, vol. 19, no. 4, pp. 29–43, May 2020, https://doi.org/10.26803/ijlter.19.4.3
[39] T. Trinh Thi Phuong, N. Nguyen Danh, T. Tuyet Thi Le, T. Nguyen Phuong, T. Nguyen Thi Thanh, and C. Le Minh, "Research on the application of ICT in Mathematics education: Bibliometric analysis of scientific bibliography from the Scopus database," *Cogent Educ.*, vol. 9, no. 1, Dec. 2022, https://doi.org/10.1080/2331186X.2022.2084956

8 Authors

Thao Trinh Thi Phuong is an Associate Professor, Doctor of Education, and a senior lecturer at the Thai Nguyen University of Education, Vietnam. Associate Professor Trinh Thi Phuong Thao has published many articles in prestigious scientific journals in the list of ISI, Scopus. The main research interests of Associate Professor Trinh Thi Phuong Thao include mathematics education; information and communication technology application in education; teacher training and fostering and ethnic education. email: trinhthao.sptn@gmail.com; ORCID: https://orcid.org/0000-0001-6277-4907

Nam Danh Nguyen graduated with a PhD in Mathematics Education from the University of Würzburg (Federal Republic of Germany), currently Associate Professor, Doctor of Education, senior lecturer, and Head of Science Management Division of Thai Nguyen University of Education, Vietnam. The main research interests of Associate Professor Nguyen Danh Nam include mathematical modeling, mathematics associated with practice, teaching technology, mathematical competency development, curriculum development, training innovation and teacher fostering. email: danhnam.nguyen@tnu.edu.vn; ORCID: https://orcid.org/0000-0002-0302-8047

Dinh Ngo Van holds a Master's degree in Computer Science and is currently working at the School of Culture (Department of Training, Vietnamese Ministry of Public Security). He is a member of the VSE Research Group (Vietnamese Science Editors). Master Ngo Van Dinh has research interests focusing on the directions of quantitative science, computer science, data science, and information technology application in educational science research. email: nvdinh81anh@gmail.com; ORCID: https://orcid.org/0000-0002-0297-1754

Hang Nguyen Thi Thu is a lecturer working at the Faculty of Basic Science – University of Agriculture and Forestry – Thai Nguyen University. She is also a doctor of Physics and Teaching Methodology at University of Education – Thai Nguyen University. Her main research direction is to renovate teaching methods and test learners and assess them towards capacity development. Besides, she also focuses on scientific research with topics in the field of social sciences, a system of research methods and tools in the context of Industry 4.0, asymptotic to national publications reputable. email: nguyenhangtuaf@gmail.com; ORCID: https://orcid.org/0000-0003-2737-833X

Thanh Nguyen Chi – Associate Professor of Education, graduated with a Ph.D. in Didactic Mathematics from Grenoble I University (France), currently a lecturer at the University of Education, Vietnam National University, Hanoi. The main research directions are Didactic Mathematics; Application of Information Technology in teaching and learning Mathematics; Professional development of Math teachers; Developing school programs in Mathematics; STEM education; Mathematical thinking and Informatics thinking in high school teaching. email: nchithanh@gmail.com; ORCID: https://orcid.org/0000-0001-8533-2925

Article submitted 2022-10-19. Resubmitted 2023-01-11. Final acceptance 2023-02-22. Final version published as submitted by the authors.