



# Empirical Study on the Effect of Digital Game-Based Instruction on Students' Learning Motivation and Achievement

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## ABSTRACT

As pupils are largely increased the opportunities to contact digital games, the effect of digital games has been broadly discussed and studied. Digital games no longer play the function of entertainment, but could assist students in more active learning and deeper and broader learning, when being applied to instruction. It is limited to learn in classes that combining courses with situated digital games presents the immersive feeling. This study therefore intends to discuss the effect of digital game-based instruction on students' learning motivation and achievement. Three universities in Taiwan, which are listed on top universities in Taiwan province, are selected as the research subjects in this study. With experimental research, total 326 students of two classes each from the three universities are preceded the experimental teaching for 3 hours per week for 16 weeks (total 48 hours). The research results are summarized as below. 1. Game-based instruction would affect learning motivation. 2. Game-based instruction would influence learning achievement. 3. Learning motivation presents significantly positive effects on learning effect in learning achievement. 4. Learning motivation shows remarkably positive effects on learning harvest in learning achievement. Aiming at the research results, it is expected to propose suggestions for education studies and talent cultivation.

**Keywords:** digital game-based instruction, learning motivation, learning achievement

## INTRODUCTION

In the modernized society with advanced technology, the use of the Internet becomes so popular that the popularization of the Internet has greatly changed people's lifestyles and an option for talent cultivation or education studies, e-learning, is included. Such a learning method applying network delivery and extracting learning information and content could break through the restriction of time and space for efficient learning of knowledge and skills. Games are the critical factor in children's cognitive development and social skill development. Since games present challenge and complexity, children have to precede cognitive thinking to overcome the challenge in games in the gaming process as well as learn knowledge skills and interaction skills in the competition or cooperation process. Game-based instruction advocates

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### **State of the literature**

- Educators have considered game-based learning as a method to induce children's learning motivation. Children's development process is bonded to games, and toys are always surrounding them.
- Since games present challenge and complexity, children have to precede cognitive thinking to overcome the challenge in games in the gaming process as well as learn knowledge skills and interaction skills in the competition or cooperation process.
- In consideration of increasing opportunities for pupils contacting digital games, the effect of digital games has been broadly discussed and researched.

### **Contribution of this paper to the literature**

- Students would appear burnout in the gaming process, which requires constant thinking. Offering different encouragement could have them continuous think.
- In order to have students be familiar with the problem-solving model, the digital game should be designed with multiple challenges.
- Digital game-based instruction could enhance students' learning motivation and learning achievement in short time. When the teaching time is increased, the problem-solving concept which students acquire in digital game-based instruction could be deepened.

developing interesting unit activity to improve teaching and learning situations and regards the key factor in students' cognitive inference process as students constantly establishing an objective system for affairs, actions, and entity through the actual actions and perception in the development to form the conceptual structure and enhance the problem-solving ability. Educators have considered game-based learning as a method to induce children's learning motivation. With the innovation of network technology and the popularity of broadband environments, the effective combination of 3E, "education", "entertainment", and "e-commerce", to form game-based learning is a potential new choice in e-learning. In consideration of increasing opportunities for pupils contacting digital games, the effect of digital games has been broadly discussed and researched. Digital games no longer play the function of entertainment. A lot of past research also proved the essential learning effect. In sum, applying digital games to instruction would assist in students' active learning and the learning is deeper and broader, as it is limited to learn in classes. Combining courses with situated digital games would have the immersive perception. This study therefore intends to discuss the effect of digital game-based instruction on students learning motivation and achievement.

## **LITERATURE AND HYPOTHESIS**

### **Game-based instruction**

Children's development process is bonded to games, and toys are always surrounding them. Psychologists in recent years stressed on the necessity for children learning through gaming processes. Games, like lubricant and catalyst, could help children learn without

burden, and game-based learning has learning not turn into the anti-learning effect (Daubert et al., 2015) of driving a duck onto a perch or pulling up seedlings to help them grow. Aghlara & Tamjid (2011) regarded games as a primary method to connect intrinsic psychological process, logical memory, and abstract thinking. Johnson et al. organized the research after 1960s and found out the positive effect of games on children' intellectual skills, including "IQ", "conservation", "problem-solving ability", and "creativity" (Byun & Lee, 2014). (1) IQ could be enhanced through game-based training, and the effect was persistent. (2) Games could assist children in changing role and transforming in the awareness phase to present better conservation. (3) Games could enhance children's choices for behaviors to further promote the problem-solving ability. (4) Children gaining higher scores on games would show better divergent thinking ability on intelligence tests. Greenhill & Montenegro (2015) proposed that game-based instruction should design story situations and skills based on learning goals in order not to become the master. Since games are the method to induce learning motivation, not the learning focus, it is necessary to have clear rules and attractive situations and understand learners' knowledge and skills to design activity with the practice goal and difficulty suitable for various stages. Anastasiow et al. (2012) considered that games were to induce competition and cooperation spirits and were funny and challengeable. Hwang et al. (2012) indicated four points to enhance the function of current education in order to achieve the function of educational entertainment. (1) Educational ideas and philosophy should get rid of essentialism, but adopted experiment orientation so that the acquisition of knowledge was constructed through active exploration, observation, and interaction. (2) To master learners' self-construction. The acquisition of knowledge relied on children themselves, while the relevant course design should match children' development ability, which better overpassed children's ability level so that children could face some challenge and acquire the experience in success. Course design could not overpass too much of children's ability, as children could easily appear learning helplessness because of frustration. On the contrary, children would soon lose interests and learning motivation when it was too easy. (3) Adults should assist children in the learning, rather than played the role with requests and authority. In this case, children would present better spontaneous learning behaviors. (4) To master the playfulness in learning. The intrinsic essence of games was humor, joy, and spontaneity; therefore, the learning situation should be to relieve pressure.

By organizing several researchers' points of view about "characteristics of games", Cheng et al. (2012) proposed that games with teaching meanings should cover the characteristics of challenge, fantasy, and fun.

- (1) **Challenge:** i.e. difficulty of games. The factors contained difficulty setting of game goals, degree of freedom of game rules and the basic restriction, strategies which could be used by gamers when competing with time, computer, oneself, and even real people.
- (2) **Fantasy:** i.e. imagination ability required in the gaming process. It mainly induced gamers' motivation to complete the process and enhance the attraction of games.

- (3) **Fun:** i.e. entertainment in the gaming process. In addition to inducing learning motivation and reinforcing learning effect with entertainment, it could enhance the recreational meaning of games.

### **Learning motivation**

Dennis & Stockall (2015) pointed out motivation as the requirement for long-term, effective, and meaningful learning. Learning motivation is a kind of motivation. Lai (2010) regarded learning motivation as the inherent belief to guide individual learning goals, induce learning behavior for continuous efforts, reinforce cognitive process, and enhance and improve learning outcome. According to value-expectancy model, proposed by Bakar & Nosratirad (2013), ability belief, success expectancy, and work value are important variables of learning motivation in student' self-learning regulation process. Ability belief refers to students perceiving personal ability when engaging in learning. Success expectancy refers to students' expectation of success during learning. Such expectation is efficacy expectation, rather than outcome expectancies, i.e. learners' perceived learning performance and selection, rather than the expectation of results. Work value contains important achievement value to do tasks well, intrinsic value to enjoy the harvest of doing something, practical value of tasks conforming to personal future plans, cost of devoting to an activity but restricting to approach another activity, and interests in learning. Learning motivation is an intervening variable between stimulus and response. That is, learning motivation is personal opinions about affairs and learners would appear different knowledge needs because of distinct opinions. Call et al. (2012) revealed that learning motivation was the intrinsic psychological process to induce students' learning activity, maintain the learning activity, and have the learning activity approach the goal set by teachers so as to achieve the teaching goal; and, the teachers could precede effective teaching. Cheng et al. (2013) defined motivation as individual extrinsic behaviors and intrinsic motivation of learning.

According to Huang et al. (2013), students' learning motivation is divided into learners' intrinsic learning motivation orientation and extrinsic learning motivation orientation in this study.

(1) Intrinsic orientation: containing being fond of challenge courses and treating learning as interests and hobby; regarding that learning could expand perspective and being able to actively learning new courses; and, learning for developing self-potential and fulfill ideal.

(2) Extrinsic orientation: covering learning for acquiring affirmation from others, obtaining better performance, passing examinations or assessment, showing off to others, competing with classmates, receiving appreciation and attention from the elderly or the opposite gender, preventing from punishment and scold, avoiding the shame of fail, and getting into an ideal school.

### **Learning achievement**

The so-called learning achievement is the evaluation of learners after completing certain learning activity and the achievement of learning activity to expected effect (Camp, 2012). In other words, learners would change the knowledge, skills and behaviors, and attitudes after the instruction (Lederer & Battaglia, 2015). Students' learning outcome is a major measuring indicator of learning achievement as well as a major item to evaluate teaching quality (Bornstein & Bruner, 2014). Effect therefore aims to test the achievement of learning or teaching goals and timely make modification or feedback for the improvement of the next course. Erhel & Jamet (2013) indicated that the indicator to evaluation students' learning outcome is a major item to evaluate teaching quality, learning achievement would be affected by course design, teaching approach, and learning behavior, and student learning aims to monitor self-learning, retrospect the learned knowledge, and learn how to learn. As a result, learning achievement would be the most directly presentation of learning outcome. Lee (2011) pointed out two dimensions of learning achievement.

(1) Learning effect, including test performance, completion time, and term performance.

(2) Learning harvest, covering learning satisfaction, achievement, and preference.

Learning effect and learning harvest therefore are regarded as the dimensions to measure teaching efficiency in this study.

### **Research hypothesis**

Game-based instruction has been considered as the teaching method which could best induce students' learning motivation because games present active activity that the learning process could be designed as interesting as games; it is therefore an ideal learning method (Liu et al., 2010). Applying games to learning situations not only could enhance fun, but also induce children's learning motivation through the challenge and excitement of games so as to acquire continuous irritation. Yoon (2014) argued that games could break the ice between learning goals and teaching tactics as well as reduce teaching seriousness so that children could freely develop the creative thinking in the learning process. The function of games and the meaning of education have been affirmed by experts. With the fun from games, children could complete learning goals in thinking and experiencing and satisfy the fun of gaming and learning that it is a meaningful activity (Maes et al., 2014). Blackwell et al. (2015) agreed with the great benefit of digital games to teenagers' learning motivation. Huang et al. (2013) discovered that gamers would be induced psychological reactions of higher intrinsic learning motivation in computer game situations and under the atmosphere of competition or cooperation. Viggiano et al. (2015) also mentioned that matching computer games with animation software could have children develop the understood scientific concepts, create experimental results, and enhance learning motivation. Accordingly, the following hypothesis is proposed in this study.

H1: Game-based instruction would affect learning motivation.

Digital game is a kind of teaching technology, as digital games present challenge and fantasy and could induce pupils' curiosity; besides, the feedback in the playing process could enhance pupils' learning knowledge (William et al., 2011). Sancar-Tokmak (2015) indicated that computer games could enhance high-grade pupils' creativity, problem-solving ability, and achievement motivation. Cheng et al. (2012) considered that computer games could train a person's induction skills. Game-based instruction is an educational game program designed by integrating teaching content and game characteristics. Yoon (2014) stated that a game program could induce a learning cycle, including allowing learners making judgment and practice and having the system give feedback. Such a cycle allows learners feeling happy and being willing to continuously spending time on such a learning cycle; besides, continuously participating in such games could achieve certain training goals or specific learning outcome. Such a game-based learning model also corresponds to that good educational game design should have good learning scaffolding to facilitate learners' learning. It seems to be the second step in the model that good educational games should know how to construct a learning cycle attracting learners' continuous learning (Huang et al., 2013). The following hypothesis is therefore proposed in this study.

H2: Game-based instruction would influence learning achievement.

Snow et al. (2013) also discovered that students who played the computer game of Newton's mechanics could more correctly answer questions related to object movement and force than those who did not play such a game. Besides, Yoon (2014) indicated that computer games could enhance students' performance on algebra learning, reading ability, problem-solving thinking ability, strategic planning ability, cooperation ability, and self-learning regulation ability and presented great benefits on the learning motivation and learning achievement (Cheng et al., 2013). Yang et al. (2012) mentioned that the content design of computer games, in addition to the characteristics of setting goals and setting game rules, presented challenge, in which players had to achieve tasks with distinct strategies for challenge containing different types of competition and cooperation, and included some imagination to induce gamers' curiosity, and induced learning motivation with entertainment so that gamers were willing to proceed meaningful and discovery learning. The following hypotheses are further proposed in this study.

H3: Learning motivation presents significantly positive effects on learning effect in learning achievement.

H4: Learning motivation shows remarkably positive effects on learning harvest in learning achievement.

## RESEARCH MEHODOLOGY

### Measurement of research variable

#### (1) Learning motivation

Referring to Huang et al. (2013), learning motivation contains two dimensions of 1.intrinsic orientation and 2.extrinsic orientation.

#### (2) Learning achievement

Referring to Lee (2011), it is divided into 1.learning effect and 2.learning harvest.

### Research subject and sampling data

Three universities in China which are listed on top universities in Taiwan province are studied, including National Taiwan University of Technology, National Taiwan Normal University, and National Taiwan University of Education. With the experimental research, total 326 students of two classes each in the three universities are selected for the experimental instruction for 3 hours per week for 16 weeks (total 48 hours). The collected copies of questionnaire are analyzed the data with SPSS, and Factor Analysis, Reliability Analysis, Regression Analysis, and Analysis of Variance are applied to test various hypotheses.

### Analysis

Analysis of Variance is utilized in this study for discussing the effect of game-based instruction on learning motivation and learning achievement, and Regression Analysis is further used for understanding the relationship between learning motivation and learning achievement.

## ANALYSIS RESULT

### Reliability and validity analysis

With Factor Analysis, learning motivation is extracted two factors of "intrinsic orientation" (eigenvalue=3.128,  $\alpha=0.85$ ) and "extrinsic orientation" (eigenvalue=2.756,  $\alpha=0.83$ ). The accumulative covariance explained achieves 80.417%.

Learning achievement is extracted, with Factor Analysis, two factors of "learning effect" (eigenvalue=2.462,  $\alpha=0.84$ ) and "learning harvest" (eigenvalue=2.328,  $\alpha=0.81$ ). The accumulative covariance explained reaches 82.512%.

### Effects of game-based instruction on learning motivation and learning achievement

#### (1) Variance analysis of game-based instruction on learning motivation

Analysis of Variance is applied to discuss the effect of game-based instruction on learning motivation. From [Table 1](#), game-based instruction shows significant effects on

**Table 1.** Variance analysis of game-based instruction on learning motivation

	Variable	F	P	Scheffe post hoc
Game-based instruction	Intrinsic orientation	8.652	0.000*	fun(3.21)>fantasy(4.93) >challenge(4.16)
	Extrinsic orientation	9.721	0.000*	challenge(4.16) >fantasy(4.93)>fun(3.21)

\* stands for  $p < 0.05$

**Table 2.** Variance analysis of game-based instruction on learning achievement

	Variable	F	P	Scheffe post hoc
Game-based instruction	Learning effect	16.752	0.004*	fun(3.21) >fantasy(4.93)>challenge(4.16)
	Learning harvest	13.261	0.012*	fantasy(4.93)>fun(3.21) >challenge(4.16)

\* stands for  $p < 0.05$

intrinsic orientation opinion in learning motivation, where the effects of fun (3.21) and fantasy (4.93) in game-based instruction are higher than challenge (4.16). Game-based instruction reveals remarkable effects on extrinsic orientation opinion in learning motivation, where the effects of challenge (4.16) and fantasy (4.93) in game-based instruction are higher than fun (3.21). H1 is therefore supported.

(2) Variance analysis of game-based instruction on learning achievement

With Analysis of Variance, the effect of game-based instruction on learning achievement is discussed. From **Table 2**, game-based instruction appears notable effects on learning effect in learning achievement, where the effects of fun (3.21) and fantasy (4.93) in game-based instruction are higher than challenge (4.16). Game-based instruction presents significant effects on learning harvest, where the effects of fantasy (4.93) and fun (3.21) are higher than challenge (4.16). Accordingly, H2 is supported.

**Correlation analysis of learning motivation and learning achievement**

(1) Correlation analysis of learning motivation and learning effect

From the test of H3, **Table 3**, intrinsic orientation ( $\beta=1.942^*$ ) and extrinsic orientation ( $\beta=2.231^*$ ) show remarkable effects on learning effect that H3 is supported.

(2) Correlation analysis of learning motivation and learning harvest

From the test of H4, **Table 3**, intrinsic orientation ( $\beta=2.323^{**}$ ) and extrinsic orientation ( $\beta=2.124^{**}$ ) reveal notable effects on learning harvest that H4 is supported.

**Table 3.** Analysis of learning motivation to learning achievement

Dependent variable→	Learning achievement			
	Learning effect		Learning harvest	
Independent variable↓	β	Beta	β	Beta
Intrinsic orientation	1.942*	0.183	2.323**	0.225
Extrinsic orientation	2.231**	0.211	2.124**	0.203
F	23.162		27.554	
Significance	0.000***		0.000***	
R2	0.216		0.254	
Adjusted R2	0.019		0.023	

Note: \* stands for  $p < 0.05$ , \*\* for  $p < 0.01$ .

Data source: Self-organized in this study

## CONCLUSION

The research findings show that digital games could help construct the scaffolding for problem-solving ability so that the problem-solving model learned in the games could be utilized when encountering problems or being requesting for help from others. As the learning motivation of students with distinct self-efficacy is induced differently in games, students with high self-efficacy would have more elaborative problem-solving ability, while those with low self-efficacy could also be enhanced the problem-solving ability once modifications are made. Some students might draw back when encountering frustration; however, their problem-solving ability would be largely enhanced with time. Teachers could use digital game systems to enhance the self-confidence of students with low efficacy and have them face problems with positive attitudes. Digital game-based instruction could enhance students' learning motivation and learning achievement in short time. When the teaching time is increased, the problem-solving concept which students acquire in digital game-based instruction could be deepened. The research result therefore presents better meanings.

## RECOMMENDATIONS

Aiming at above research results, the following suggestions are proposed in this study.

1. In the teaching process, diversified encouragement could have students be willing to think, especially for students with low efficacy, because students would appear burnout in the gaming process, which requires constant thinking. Offering different encouragement could have them continuous think.
2. In order to have students be familiar with the problem-solving model, the digital game should be designed with multiple challenges. The situation and tasks of each challenge are distinct. Moreover, the extrinsic problem-solving model should also be diversified, such as detective, graphical, and reading, allowing students continuously thinking problems in various surprises. The increase in small games can also have students take a rest in the problem-solving process, but not separate from the course content. In this case, integrating small games in the knowledge concept could receive the effect.

Conflict, dilemmas, or existing misconception in life could be included in games, allowing students thinking with existing ideas and concepts and having better interests to spend time on thinking. It also allows students actively search for relevant people, affairs, and objects, when executing tasks, to complete the later tasks, rather than being passively given problems. Students could directly think of answers, as problem solvers in real life present active attitudes, are aware of problems, and search for relevant supports.

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