Effects of Touch-type Online Educational Games on Learners' Learning Motivations

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Abstract—With the advancement of science and technology, electronic devices are more extensively popularized, and students are being exposed to touch-type online at an early age, thus promoting the digitalization of children's education and contributing to the proliferation of learning resources. Touch-type educational games emphasize learning autonomy, integrate teaching knowledge contents with games, and highlight that when using educational games, learners can obtain immediate and real feedback and identify learning and game objectives, thereby intensifying their learning. In this study, a questionnaire regarding the effect of touch-type online game education on learners' learning motivations was designed on the basis of educational game theory. The mediating role played by learning immersion between the two was also measured. Results show that the overall Cronbach α coefficient is 0.825, the KMO value is 0.688, and the corresponding *P* value of Bartlett sphericity test is 0.0. In touch-type online game education, multi-organ sensing, touch gesture, and multi-hotspot response significantly affects learners' learning motivations. Learning immersion exerts a masking effect on teachers' initiatives in promoting learning motivations. The proportion of touch games play during class hours has different effects on learning motivation ($p = 0.020<0.05$). The findings are critical for investigating the effects of touch interaction models on learners' learning motivations, developing a set of evaluation indexes for educational game learning accessibility, and perfecting their evaluation methods.

Keywords—touch-type online educational games, game education, learning motivations, masking effect, questionnaire technique, variance test

1 Introduction

With the development of science and technology, digitalized products have become increasingly popular in the daily lives of Chinese people, becoming an integral part of family life. Nowadays, college students are introduced to computers at an earlier age as the prices of electronic devices gradually decrease and the demands for their use rapidly increase. The prevalence of intelligent devices has promoted the digitalization of children's education and has contributed to the availability of learning resources. Educational informatization has aroused increasing social attention, and educational games may become one of the main concerns in educational reform and development

in the future [1]. Among educational games, touch-type games have the best interaction performance. Touch technologies do more than just transmit game operators' gestures; multi-point information sensing technologies are used to support multi-user interactions, raising the bar for game interaction and sharing. Despite the widespread use of touch technologies in games, how to apply them in the educational field has received little attention. By using touch-type games to drive learners' efficient learning and developing the corresponding game learning system to realize multiplayer online interactive operations, the classroom atmosphere of game education can be vivified, and the classroom teaching quality and effectiveness can be improved. Touch-type online games can continuously stimulate learners' learning motivations and establish a discovered incentive mechanism, allowing learners to feel completely satisfied and accomplished.

Learning motivation refers to the internal force stimulating and maintaining college students to accept a certain behavior in touch-type online game education. Motivation, which governs behaviors, is essential for any action. Learning motivations are especially important for the learning behaviors in touch-type online game education, given that learning is a long-term behavior, during which many difficulties will be encountered, making it difficult to maintain students' learning motivations [2]. Educational games that embody the thought of "teaching through lively activities," conform to the instinct of human beings in pursuing happiness, intensifying the vividness of the simple and boring traditional classroom learning, enhancing learners' learning interests, and stimulating more intense learning motivations. The reward contents of educational games must meet students' needs so that students will strive to gain such rewards. In essence, game education refers to learners' experiential learning and a learning environment created through games, endowing students with multiple sensory stimuli. Subsequently, students will continuously reflect on and summarize the experiential process, eventually generalizing principles so that perceptual cognition ascends to rational cognition and knowledge is internalized. Touch-type online games provide learners with sufficient space for reflection and action through the appeal of games, thereby deepening the learning immersion of learners who can acquire knowledge and skills through entertaining games that can influence their emotions, attitudes, and values. The goals of educational games can be finally reached only by continuously stimulating students' learning motivations through game education. Overall, touch-type online games can stimulate learners' learning motivations. However, the influencing degree of touch-type online game education on learners' learning motivation must be further explored, which will be crucial for designing and developing online educational games.

2 Theoretical foundation and hypothesis development

2.1 Theoretical foundation

Sara [3] comprehensively summarized educational games. No consensus has been reached on the definition of educational games in academic circles. Generally, game education entails decomposing daily teaching contents into game operations, using a game system as the platform and means, and combining knowledge and amusement

to achieve the teaching goal of happy learning. In game education, learners conduct game operations themselves or through a team formed with other partners according to teachers' instructions, aiming to enhance their knowledge and skill levels, fulfill their emotional exchange in learning, and construct a comprehensive knowledge system. Educational games, which are rich in game elements, can stimulate learning initiatives and enthusiasm for teaching objects. Moreover, educational games can transfer the interest of teaching objects to the learning of knowledge points, thus reaching the effect of happy learning. Hence, the game educational mode is not only recreational but also educational, and the game presentation form of its teaching contents has changed the traditional teaching model of "teaching by teachers and learning by learners," developing into an ideal educational media product under the high-speed development of educational technologies.

Kotkov [4] analyzed learning motivations. He defined learning motivation as a type of inherent psychological dynamics of learners to complete learning tasks, which can stimulate individual learners' learning behaviors and keep them in a highly concentrated learning state. Moreover, learning motivation is the core factor to be considered to analyze learners' learning behaviors, which is closely related to learners' task completion, efforts, and perseverance. In addition, the learning motivation is not generated spontaneously but proactively adjusted by learners on basis of theories and practices, to keep their learning enthusiasm at a high level.

2.2 Hypothesis development

New technologies, such as big data, artificial intelligence, and multi-touch technology, have developed rapidly, providing good technical support for mobile and online learning. How to use touch game technologies to promote learners' learning motivations and continuous learning under the new technologies and learning styles has become an important research topic. As for how online game education influences learning motivations, extant literature has shown that online game education relatively and affects learners' learning motivations and achievements, and digital games can significantly enhance learners' learning motivations. Game-based teaching also evidently and positively affects the migration of teachers' information technology application ability. Harvey et al. [5] deemed that game-centered approaches can promote educational and teaching reform. Watson et al. [6] attempted to understand teachers' and students' experiences and viewpoints on using educational video games in class. The results demonstrate that students are more active and engaged in learning owing to electronic games, and the teacher formulates implementation strategies to facilitate game-based concentrated learning to the greatest extent. Liao et al. [7] described this game and its theoretical foundation, discussed its teaching values, and thought that game development can exert an evident promoting effect on learners' learning motivations. Meriläinen et al. [8] deemed that digital games can generate obvious effects on learners' collaboration and communication skills. Wangenheim et al. [9] thought that game-based teaching lets students be immersed in learning tasks, and the results show that the game-based teaching method is a low-cost alternative solution to school education, which can supplement traditional classroom teaching strategies. Cagiltay [10] improved students' abilities

through the computer game development course, specifically, their abilities to solve problems, use the knowledge previously learned, and learn by doing and their autonomous learning ability is enhanced. Giannakoulas et al. [11] pointed out that educational game help students understand basic programming concepts and be active to accept game results in the learning process. Zin et al. [12] stated that the success of digital games as learning media depends on, to the greatest extent, the ability of new teachers and practitioners to take full advantage of such media. Rahmawati et al. [13] deemed that English writing ability and level can be improved through game-based teaching. Blum-Dimaya et al. [14] concluded that the learning ability of autistic children can be strengthened through game-based teaching. Mathew et al. [15] introduced a game to improve junior programmers' skills in solving problems in introductory programming courses. The results show that this game helps most students to understand programming concepts, structures, and problem-solving strategies. This game is believed by teachers to be an additional auxiliary teaching tool. García et al. [16] thought that the game-based learning method and teaching design support the mathematical education of undergraduate freshmen with engineering majors. The results indicate that computer games increase learners' learning experience and motivations when learning mathematical themes. Reyes [17] improved students' self-efficacy through the touch game-based teaching strategy and relieved their anxiety. The results manifest that touch game teaching and the teaching games-based evaluation can actively reduce students' mathematical anxiety, enhance their self-efficacy, and improve their academic performance. Jong et al. [18] analyzed the effect of interactive games on learners' learning effectiveness. The results show that in the two games, participants in the touch-based interaction (TBI) group performed better in mathematical counting than those in the gesture-based interaction (GBI) group. Jin et al. [19] investigated the interaction of tactile stimuli in tactile sense-based computer games, and the results reveal that tactile computer games if embedded can regulate user trust in brands. Thus, the following four hypotheses were proposed:

Hypothesis H1: In touch-type online game education, multi-organ sensing significantly promotes learners' learning motivations.

Hypothesis H2: In touch-type online game education, touch gestures significantly promote learners' learning motivations.

Hypothesis H3: In touch-type online game education, multi-hotspot response significantly promotes learners' learning motivations.

Hypothesis H4: In touch-type online game education, teachers' initiatives significantly promote learners' learning motivations.

Players' self-involvement is mostly required in touch-type online games, so learners' immersion plays a critical role. As for the relationship between immersion and learning motivations, Georgiou's [20] research results show that an educational environment rich in technologies is beneficial to immersion-type learning, thus enhancing students' learning abilities. Huang et al. [21] pointed out that French immersion-type schools can stimulate learners' motivations to study second languages. Tanaka et al. [22] showed that in the immersion-type environment, participants with Japanese as their mother tongue

and those with English as their mother tongue study English together, and their internal motivations are significantly enhanced from intermediate grades to senior grades. Huang et al. [23] concluded that medium and high-level immersion can stimulate learning motivations, participation in, and support of learning. Bazargani et al. [24] stated that the HMD VR-based learning method contributes to a higher immersion level than the tablet PC-based method. Cheng's [25] research shows that students' learning motivations can be significantly regulated by their immersion-type attention and enjoyable experience. Hence, the fifth hypothesis was raised:

Hypothesis H5: Immersion plays a mediating role in the promoting effect of touch-type online games on learners' learning motivations.

Thus, the conceptual framework of this study is displayed in Figure 1.

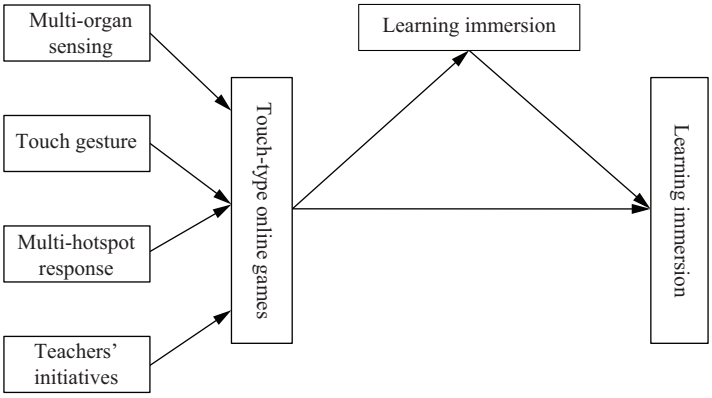

Fig. 1. The conceptual framework of this study

3 Methodology

3.1 Questionnaire design

This study aims to explore the effects of touch-type online game education on college students' learning motivations through scales. Hence, related questionnaires were designed, mainly involving the following four aspects. First, learners' basic information was surveyed, including gender, grade, major, and the proportion of touch games during class hours. Second, touch-type online game education was measured, and 3, 3, 3, and 5 questions were designed specifically to the four characteristics of touch-type online game education. Third, learning motivations were measured using 8 questions in the research literature of Schiefele [26]. Fourth, learning immersion was measured through the related results obtained by Georgiou [20] together with 6 questions redesigned in this study. All items were calculated via the Likert 5-point scale, followed by data processing, reliability and validity calculation, regression analysis, mediating effect analysis, and analysis of variance (ANOVA) via SPSS statistics 22.0.

3.2 Research objects

In Guangdong Province—a developed province in the eastern coastal areas of China—the reform of higher education has been carried out comprehensively. Educational information technology has been comprehensively adopted in many colleges and universities in Guangdong Province, and online learning has been reformed continuously by more emerging means of educational informatization, which lays a good foundation for teachers to learn cutting-edge means of teaching informatization and transforming the concept of educational informatization. Hence, undergraduates from physical culture institutes in a provincial-level university in Guangzhou were selected given their flexible bodies and operational ability. Furthermore, being more typical, these respondents were more interested in touch-type online game education.

Table 1. Descriptive statistical results of respondents

Name	Option	Frequency
Gender	Female	98
	Male	162
Grade	Freshman	30
	Sophomore	88
	Junior	99
	Senior	43
Major	Physical education	35
	Sports training	41
	Human sports science	46
	Exercise rehabilitation	65
	E-sports and management	42
	Intelligent sports engineering	31
Proportion of touch games in class hours (unit: %)	0–20	34
	21–40	59
	41–60	75
	61–75	47
	76–90	24
	91–100	21

4 Results analysis

4.1 Reliability and validity analysis

The reliability test, which is the first step of data analysis to test whether research data is true and reliable, is generally performed using Cronbach's coefficient (also called the reliability coefficient or internal consistency coefficient).

Table 2. Reliability test results

Variable Type	Concrete Variable	Number of Test Questions	Cronbach's α	Cronbach's α
Independent variable	Multi-organ sensing	3	0.771	0.825
	Touch gesture	3	0.732	
	Multi-hotspot response	3	0.756	
	Teachers' initiative	5	0.920	
Dependent variable	Learning motivation	8	0.795	
Mediator variable	Learning immersion	6	0.713	

Table 2 exhibits that the Cronbach α coefficients of all variables were greater than 0.7, indicating good reliability. The overall Cronbach α coefficient of the questionnaire was 0.825, manifesting the high reliability of the questionnaire.

Validity analysis aims to test and evaluate the effectiveness of system requirements and results, in which the construct validity is the main analysis object. As for the construct validity, the correspondence between the questionnaire system and measured data was explored through the factor analysis method. The factor analysis mainly aimed to check whether KMO was higher than 0.5 and whether the significance level of Bartlett's sphericity test was 0.00.

Table 3. Validity test

KMO Value		0.688
Bartlett's sphericity test	Approximate cardinality	2678.983
	Degree of freedom	378
	P value	0.00

First, the KMO and Bartlett sphericity tests were performed on the questionnaire. The KMO value was obtained as 0.688, the approximate Chi-square value in the Bartlett sphericity test was 2,678.983, the degree of freedom was 378, and the corresponding P value was 0.000, which was smaller than 0.01, indicating a significant level and reflecting the high reliability of this questionnaire and its favorable construct validity.

4.2 Linear regression analysis

Table 4. Linear regression results

Variable	Standardization Coefficient	T	P	VIF	F
Constant	–	8.104	0.000***	–	F (4,255) = 4.219, P = 0.003
Multi-organ sensing	0.147	2.385	0.018**	1.032	
Touch gesture	0.111	1.802	0.073*	1.031	
Multi-hotspot response	0.106	1.722	0.086*	1.036	
Teachers' initiative	0.055	0.900	0.369	1.034	

Note: D-W value: 1.325; *p<0.05; **p<0.10; ***p<0.01.

Table 4 presents that the three aspects—multi-organ sensing, touch gesture, and multi-hotspot response—in touch-type online game education were significant at levels of 5%, 10%, and 10%, respectively, indicating their significant effects on learners' learning motivations.

(1) H1 is true. In touch-type online game education, multi-organ sensing technology is applied to touch games, enabling learners to adopt more learning strategies during online games with more intense learning motivations and more fruitful learning results. The complexity of learning tasks is set for most touch-type online games so that more team members can participate in games, thus embodying teamwork. Learners will establish their learning objectives, and teachers and students will strive to complete tasks based on such learning objectives during online games. Owing to the multi-organ sensing technology, learners' knowledge acquisition and task completion abilities are more obviously enhanced with stronger learning motivations.
(2) H2 is true. In touch-type online game education, touch gestures significantly promote learners' learning motivations. The main reason is that in touch-type games, different game indicator signals can be completed through operations, such as single-and double-finger translations and double-finger zooming and rotation. With more abundant touch gestures used, touch technology can combine rich and diversified knowledge expression instructions, thus becoming more vivid and diversified, making it possible for learners to be more willing to master such learning opportunities. Learners express their behaviors, such as information processing of learning materials, knowledge classification, and knowledge construction, through different touch gestures to comprehensively promote knowledge transformation and absorption and effectively facilitate learners' knowledge system construction and improve their technical skills.
(3) H3 is true. In touch-type online game education, multi-hotspot response significantly promotes learners' learning motivations. In the early stages of simple game-based learning, learners generally complete specific tasks by relying on personal computer (PC) alongside companions; however, emotional exchanges in such simple operations are not as many, so team spirit cannot be effectively exerted. Given the multi-hotspot response advantage of touch technology, learners can conduct smoother face-to-face game operations and voice exchanges. In the learning team, learners' opinions can be shared more efficiently.
(4) H4 is not true. In touch-type online game education, teachers' initiatives significantly promote learners' learning motivations. This conclusion appears to be illogical, but careful examination reveals that teachers play an important role in educational informatization and even technology integration. How teachers exercise their influence in game-based learning is a relatively new field of study. With the introduction of touch technologies, teachers can now completely articulate their teaching ideas, allowing them to better prepare for game-based learning and provide feedback. However, the majority of teachers have not mastered these cutting-edge touch game technologies, e.g., they have not proficiently mastered the technologies of giving real-time comments and annotations over text messages and pictures on the touch screen, modifying, drawing and editing them, amplifying

the contents to be highlighted, and providing a more intuitive visual effect. Consequently, teachers fail to timely guide learners' touch game-based learning. This conclusion enlightens teachers in higher education institutions to pay closer attention to the relationship between education, teaching technologies, and educational outcomes. The educational effect is achieved not only by playing games but also by fully mobilizing students' initiatives so that game-based learning is more appealing to students and their learning motivations can be enhanced.

4.3 Mediating effect analysis

Given that H4 is not true, the regression result between teachers' initiatives and learning motivations is not significant, indicating that independent variables are uncorrelated with dependent variables. Hence, learning immersion was taken as a mediator variable to further analyze the correlation between touch-type online games and learning motivations.

Table 5. Regression of the mediating effect

	Learning Motivation	**m**	**Learning Motivation**
Constant	3.584** (20.881)	3.740** (20.012)	4.054** (14.894)
Touch-type online games	0.112** (2.864)	0.097* (2.270)	0.125** (3.167)
Learning immersion	–	–	−0.126* (−2.213)
F value	F (1,258) = 8.202, p = 0.005	F (1,258) = 5.153, p = 0.024	F (2,257) = 6.612, p = 0.002

Note: *p<0.05; **p<0.01; T values are enclosed in brackets.

Table 6. Summary of the mediating effect test results

Item	**Touch-Type Online Games=>Learning Immersion=>Learning Motivation**
c total effect	0.112**
a	0.097*
b	−0.126*
a*b mediating effect	−0.012
a*b (Boot SE)	0.012
a*b (z value)	−1.018
a*b (p value)	0.309
a*b (95% Boot CI)	−0.047 ~ −0.001
c' direct effect	0.125**
Test conclusion	Masking effect

Note: *p<0.05; **p<0.01.

As seen in Table 6, independent variables can influence dependent variables only through masking variables, indicating that learning immersion masks the promoting effect of teachers' initiatives on learning motivations. The main reason for the masking

effect is that immersion is one of the core concepts in the field of educational games and reflects that learners complete their established learning state through multiple senses, such as visual sense, auditory sense, and tactile sense. Touch technology allows learners to touch intuitive simulated objects and timely observe the problem execution results, thereby substantially enhancing the real extent of learners as the protagonists in the virtual environment. Therefore, touch technology provides exceptional technical and scenario support for establishing multi-sensory, real, and high-immersion learning environments and serves as a powerful activity platform stimulating and strengthening game-based learning.

4.4 Variance test

Table 7. Different effects of the proportion of touch games in class hours on learning motivations

Major (Mean ± SD)						F	P
1.0 (n = 34)	2.0 (n = 59)	3.0 (n = 75)	4.0 (n = 47)	5.0 (n = 24)	6.0 (n = 21)		
4.11 ± 0.41	3.90 ± 0.50	4.18 ± 0.36	4.03 ± 0.61	4.07 ± 0.45	4.06 ± 0.27	2.733	0.020*

Note: *p<0.05; **p<0.01.

Table 7 exhibits that the proportion of touch games in class hours exerted different effects on learning motivations (p = 0.020<0.05). The variance test results revealed that when touch game education accounted for 40%–60% of class hours, the mean value of learners' learning motivation was the highest. At the proportion of 20%–40%, the mean value of learners' learning motivations was the minimum. Given that touch games are only one method of education, university teachers must achieve teaching objectives through course introduction, course summary, and student evaluation rather than simply remaining in the learners' game playing stage. This conclusion implies that university teachers should fully consider the effect of the proportion of touch games in class hours on learning motivations in touch game education, prevent learners from a "game addiction" state, and realize the fundamental teaching goal of the game-based interaction of students in the classroom teaching process. Moreover, game teachers should further explore the potential relationship between classroom teaching forms and goals in the era of educational informatization.

5 Discussion

Touch-type online game education aims to solve realistic problems in higher education and teaching by affecting users' behaviors by reasonably utilizing game elements and game mechanisms under the guidance of a game framework, and it is unrelated to the simple game-playing of students. Currently, game-based education is widely promoted in developed countries, such as European and American countries [27]. In China's higher education, game-based education refers to the problem of attracting learners and guiding them to solve problems using game elements, game design technologies, and game mechanisms. Nowadays, China is comprehensively implementing a new and

efficient curriculum reform, among which an important aspect lies in changing the excessive curriculum emphasis on knowledge imparting, highlighting the formation of proactive learning attitudes and transforming the knowledge and skill acquisition process into a process of learning to learn and form values. Regarding touch-type online game education, teaching objectives are integrated into games, which can improve learning efficiency and attraction. Owing to touch technology, students can participate in games in person through mutual exchanges and competition, thus enhancing group consciousness, cultivating team spirit and interpersonal skills, and realizing relaxed and efficient learning. Finally, setting a scientific proportion of touch games during class hours is a problem that university teachers in touch-type online game education should pay close attention to.

6 Conclusion

In the Internet era, learners' learning states should be transitioned to a pleasant state. Educational games should meet the teaching needs of teachers and parents while also being appealing to students. When using educational games, learners must define their learning objectives and construct knowledge systems. Touch-type educational games combine knowledge in textbooks with games to truly realize the goal of teaching through lively activities and significantly enhance learners' learning motivations. In this study, a questionnaire regarding the effects of touch-type online game education on learners' learning motivations was designed, and the mediating role played by learning immersion in the promoting effect of touch-type online game education on learners' learning motivations was measured. Conclusions show that the overall Cronbach α coefficient was 0.825 and the KMO value was 0.688, indicating very good questionnaire reliability and validity. In touch-type online game education, the three aspects—multi-organ sensing, touch gestures, and multi-hotspot response—can exert significant effects on enhancing learners' learning motivations. Learning immersion masks the promoting effect of teachers' initiatives on learning motivations. The proportion of touch games in class hours exerts different effects on learning motivations. In-depth research on the following aspects is warranted: the acceptance level of students from different educational backgrounds for game education, whether learners' learning performance is closely related to game time, and the perfection of the evaluation index system for the accessibility of educational game-based learning.

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