COMPARISON OF VARIOUS FORMS OF SERIOUS GAMES: EXPLORING THE POTENTIAL USE OF SERIOUS GAME WALKTHROUGH IN EDUCATION OUTSIDE THE CLASSROOM

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ABSTRACT

The advantages of using serious games for education have already been proven in many studies, especially narrative VR games, which allow players to remember more information. On the other hand, game walkthrough can compensate for the disadvantages of gaming, such as pervasiveness and convenience. This study investigates whether game walkthrough of serious games can have the same learning effect as serious games. Use game creation (samples) and questionnaires, this study will compare the information that viewers remember from game walkthrough and actual game play, analyze their strengths and weaknesses, and examine the impact of the VR format on the results. The results proved that while game walkthrough allows subjects to follow the experiences of actual game players with a certain degree of empathy, they have limitations when it comes to compare with actual gameplay, especially when it comes to topics that require subjects to think for themselves. Meanwhile game walkthrough of VR game is not a medium suitable for making the receiver memorize information. For prevalence and convenience, however, serious games walkthrough is a viable educational option outside the classroom.

KEYWORDS

Serious game, multimedia, educational game, virtual reality, narratology，Education Outside the Classroom (EOTC).

1. INTRODUCTION

In recent years, there has been a growing body of research on the gamification of education. Some studies use the elements and aesthetics of games to motivate students to learn [1], while others claim the advantage of gamification that games are a familiar medium for students and are more interesting than written media [2]. In addition to this, there is already abundant evidence that video games have a more or less positive impact on the cognitive domain. For example, games can improve visual spatial resolution [3], reaction time [4], spatial awareness [5], probabilistic reasoning [6], and visual short-term memory [7]. Overall, games have been shown to lead education into a new realm.

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However, it is worth mentioning that games are a comprehensive medium. Especially when compared to written media, which are still the most used in education. This means that the results obtained are also comprehensive. If the importance of a particular attribute in a game needs to be examined, the results can be made clearer by focusing the sample on that attribute of the game. In previous studies, we have chosen "narrative" and "immersion". In other words, we created a sample of serious VR games with narrative content.

The reason for this choice is that serious and educational games are closely related. Both are trying to use some aspect of the game to achieve some goal other than entertainment [8]. On the other hand, according to neurologist Michael Smith, when people watch narrative images that induce empathy, the brain automatically filters out external influencing factors to focus on learning and cognition, indicating that the human mind wants to know the unknown from a narrative perspective. He believes that without a narrative connection, people cannot stay in the brain for long [9]. There is also considerable research showing that memories of events with a strong narrative component are more likely to be remembered [10]. And many studies have revealed that an immersive virtual reality system can better facilitate situational memory performance [11], [12].

Consequently, we reinforce memory through narrative and immersion, and bring players into an independent worldview in the form of VR games to increase the target ability of information transfer and reduce the psychology of distributed responsibility. Our previous research proposes that using virtual reality technology to gamify narrative Contents is a way to make information more deeply memorable.

Previous studies have confirmed the above. In the case of a VR game that presents the story in images versus a game that presents the story in text, that presents the story in images is a better way to remember the information. The study also found a positive correlation between subjects' experience and their self-reported confidence in their memory. The researchers believe that gaming experience and short text reading experience are the reasons for the subjects' better self-perceived confidence [13].

This result and the information provided in the subject interviews have attracted the attention of researchers. In previous experiments, subjects in the non-VR group watched game walkthrough more often than they played the games themselves. Game walkthrough is when players record their own gameplay, and the video content is often uploaded to video sharing sites (such as YouTube) or streamed live on streaming sites (such as Twitch). There are millions of potential recipients for these contents [14].

The researchers conducted additional interviews with all groups of subjects and found that 95% of the subjects had watched game walkthrough, 74.16% watched at least 7 hours per week, and they were in the habit of watching them while eating. Their reasons for watching game walkthroughs were as follows:

- Watching game walkthroughs allows them to be exposed to games anytime and anywhere.
- They don't have the hardware for a particular game, or the hardware doesn't meet the requirements of the game. So they can only get to know a game by watching it.
- They have some game walkthrough players who are particularly fond of.
- By watching the game, they can find the hidden elements of the game quickly, or see the hidden ending without having to play the game for long time by themselves.

- Finally, the most common reason was that the videos can be viewed at any time on cell phones. From these reasons, it is clear that video media is certainly more accessible to users' fragmented time compared to game media.

From the above survey, we found that game walkthrough is convenient and accessible, so why not use it in the educational field.

The main theoretical idea of this study is based on Self-Determination Theory (SDT) [15]. This means that it is argued that the essence of behavior is motivated by interest and enjoyment [16]. Through our survey, we found that most college student gamers are interested in game walkthrough. In addition, the data on the time spent watching game walkthrough suggests that they are not just a way to pass the time, but that they enjoy them. Against the above background, This study investigates whether game walkthrough of serious games can have the same learning effect as serious games. Use game creation (samples) and questionnaires, this study will compare the information that viewers remember from game walkthrough and actual game play, analyze their strengths and weaknesses, and examine the impact of the VR format on the results.

2. METHODS

We create a VR game and a not VR game and record the game walkthroughs. And we divide the subjects into four groups: who play a not VR game (NVR group), who watch the walkthrough of the not VR game (group GW), who play a VR game (group VR), and who watch the walkthrough of the VR game (group GWVR). A questionnaire will be used to find out which group's subjects remember the game story. The sample is based on actual events. More than 80% of the text is taken directly from the news interviews. References are to newspaper articles about the incident from 2006 to 2015. These news stories were distributed across diverse media platforms over a long period of time. They were selected as scenarios for the serious game because of their integrative nature and the narrative nature required for this experiment.

2.1. Sample

The game is divided into four stages in total, each with 1-2 enemies and 2 key items, and players must collect key items while avoiding enemy pursuit. The key items in each stage are related to the storyline of that stage.

First, Design the game characters and draw the front and side views of the characters for modeling. After completing the design of the game's characters and scenes, modeling is done in 3ds Max. Before modeling, import the front and side views into the background to build the character model more accurately. Once the modeling is complete, create the texture. In order to make the texture position correspond to the model position, the model is introduced into UNFOLD3D and the texture is expanded. The next step is to import the model into Mudbox and draw the texture. Back in 3ds Max again, bound the bones, moved the bones in the model, and used keyframe animation to animate the character walking, running, and attacking. Finally, import the characters and scenes into Unity to create the game. Screenshots of the game are shown in Figure 1.

Also, the game walkthrough is actually divided into various genres. For example, “Speedrun” [17], which aims to finish a game as quickly as possible. “Longplay” [18] focuses on completely documenting the gameplay process, with little commentary from the player. “Let's play” [19] focuses on the player's in-game experience and sharing.

Considering the possibility of experimentation, research first consider eliminating the live broadcast type of play. Next, according to the interviews with the subjects, most of the game walkthrough they watch are of the “let's play” type. And in “let’s play” type the player’s comments and reactions will be more sympathetic to the audience than in the other types. So in the “let’s play” type game walkthrough the viewers can be able to relate to the players more than in the other types. And the researchers expect that the “let’s play” type can reduce the lack of immersion which is one of the problems of using game walkthrough. Therefore, the game walkthrough used in this project is of the "let's play" type. The game walkthrough will be recorded by inviting two female game walkthrough players who post videos, and they have never been exposed to the sample information until the game walkthrough is recorded.

Figure 1. Screenshots of the game

2.2. Questionnaire

All subjects were recruited through convenience sampling and snowball sampling. The original plan was for some subjects to experience the VR face-to-face with the researchers, but this was all changed to online for the new Corona. Subjects were asked to download the samples themselves through a link provided by the researcher, experience the samples on their respective devices, and mail in a questionnaire and recording. All subjects were aware of and consented to the experiment before it was conducted.

The questionnaire is divided into four written questionnaires and one recorded questionnaire. The written questionnaire consists of basic information, recognition check, correctness check, and empathy check, while the recorded questionnaire consists of subjects telling a story and giving their impressions of the sample. The basic information questionnaire asks the subjects their age, gender, major, gaming experience, experience using VR, and the theme of the sample.The recognition check and the correctness check use the same 10 questions. The purpose of the recognition check is to find out how much the subjects themselves think they know about the sample story, and their actual cognitive status is not important in this research.In the empathy check, the strength of the empathic emotion for each subject is investigated through a self-report questionnaire. Questionnaire as shown in Figure 2.

Basic information			
Age	***Gender***	***Game experience***	***major***

Have you ever used VR?	No	Yes
Have you paid attention to the news of female population sales?	No	Yes
Have you read related articles on this game?	No	Yes

Recognition check					
Question	***Get it***	***Maybe Get it***	***Not sure***	***Maybe don't get it***	***Don't get it***
Where the protagonist was kidnapped?					
Who bought the protagonist?					
What is the attitude of the protagonist 's husband towards her?					
What are the protagonists' means of suicide?					
Why the protagonists left the village?					
What reminds the protagonist of life's hopes?					
How is the protagonist known to the public?					
Why doesn't the local government want the public to know about the protagonist?					
What is the attitude of the villagers towards this?					
Did you understand the ending?					
Correctness check					
Full score 100	***Correct answer +10***			***score:***	

Empathy check	
Stage	No feeling ⟶ felt a strong emotion
1	
2	
3	
4	

 : No feeling
 : Feeling emotions, but not enough to take action.
 : Feels emotional and takes short-term/single/simple actions.
 : Feels emotional and takes long-term/ continuous/ /complex actions.

Figure 2. Questionnaire

3. EXPERIMENTAL RESULTS AND ANALYSIS

3.1. Basic Information

The subjects were 120 university students (62 females, 59 males, mean age 21.183 years, age range 18-24 years, SD=1.402). 120 subjects were divided into 4 groups of 30 each:

Group NVR: 19 females, 11 males, age range 19-23 years, mean age 20.733 years, SD=1.263.
Group VR: 13 females, 17 males, age range 19-23 years, mean age 20.833 years, SD=1.240.
Group GW: 15 females, 15 males, age range 18-24 years, mean age 21.3 years, SD=1.486.
Group GWVR: 14 females, 16 males, age range 19-24 years, mean age 21.866 years, SD=1.309).

The overall gender ratio is basically the same, but the gender ratio of each group is different; As can be seen from the gender ratios of the four groups, the sex ratio of the game walkthrough group appears to be average when compared to the large number of females in the group and the large number of males in the group. In a gender survey on VR and AR device Ownership rate conducted in 2017 [20], 43% of device owners were female and 31% of those planning to purchase a device were female. According to data from another U.S. gamer gender survey, the highest percentage of female gamers has only been 48% since 2006 [21]. Combining the data from this survey and its collection process, we can assume that although the number of women who own VR devices is smaller than men, the number of women interested in gaming is not small.

The majors of the 120 subjects included 21 in Science and Engineering, 20 in Education, 18 in Arts, 14 in Management, 12 in Architecture, 12 in Literature, 9 in Economics, 6 in Sociology, 3 in Physical Education, 3 in Philosophy, and 2 in History. The diversity of the subjects' majors is beneficial in obtaining more diverse perspectives in the recording survey.

When the subjects self-reported their gaming experience, 71 said they had "a lot of gaming experience," 15 said they had "normal gaming experience," and 34 said they had "little gaming experience. Overall, the subjects had a lot of gaming experience.

3.2. Recognition Check

Figure 3 shows the percentage for each option chosen by each group. Overall, Group NVR is the most confident in their own memory, followed by Group GW, then Group VR, and finally Group GWVR.

As can be seen from Figure 3, the selection tendencies of Group NVR and Group GW are very close. More than half of the respondents chose "Get it", and around 30% of the respondents chose "Maybe Get it". "Not Sure" was selected slightly more often by Group GW, but the difference between the two groups was not large. Group VR and Group GWVR not only differed from these two groups, but even in the same VR-related sample, their selection trends were not consistent.

the options for Group GWVR are distributed on average compared to the other groups. The percentage of times Group GWVR chose "Not Sure" was the highest among all options for this group, reaching 3%. The number of times they chose "Get it" and "Maybe get it" was equal, both accounting for 25%. "Get it" was chosen the most by the other three groups, with 18%, three times as many as the group VR chose the same item.

Studies have shown that the more experienced a person is, the more confident he or she is in identifying memories [22]. This may explain the greater confidence in self-recognition of memories in Group NVR and Group GW. Although the subjects in this experiment had more gaming experience, in daily life, visual media is more accessible than gaming media and does not require more energy or two hands. In addition, Chinese college students, the age group of the subjects, spend less time in contact with game media than video media. By combining the data of group NVR, group GW and group VR, it was proved that the memory discrimination and experience of the test takers are positively correlated [23].

The data of group GWVR shows different characteristics from this. The researchers made an additional visit to the group on this issue. "More than half of the subjects who chose "Not Sure" said that they could not concentrate on the GWVR sample throughout. There are two main reasons for this:

1. They are not used to VR game walkthroughs from the beginning. These subjects found it more distracting to watch a VR game walkthrough than to watch a regular game walkthrough.
2. At first, they were able to enjoy the VR game walkthrough, but later in the video, they felt uncomfortable due to the constant shaking of the camera.

Researchers believe that these two cases, especially the former one, reaffirm the positive correlation between media experience and subjects' memory.

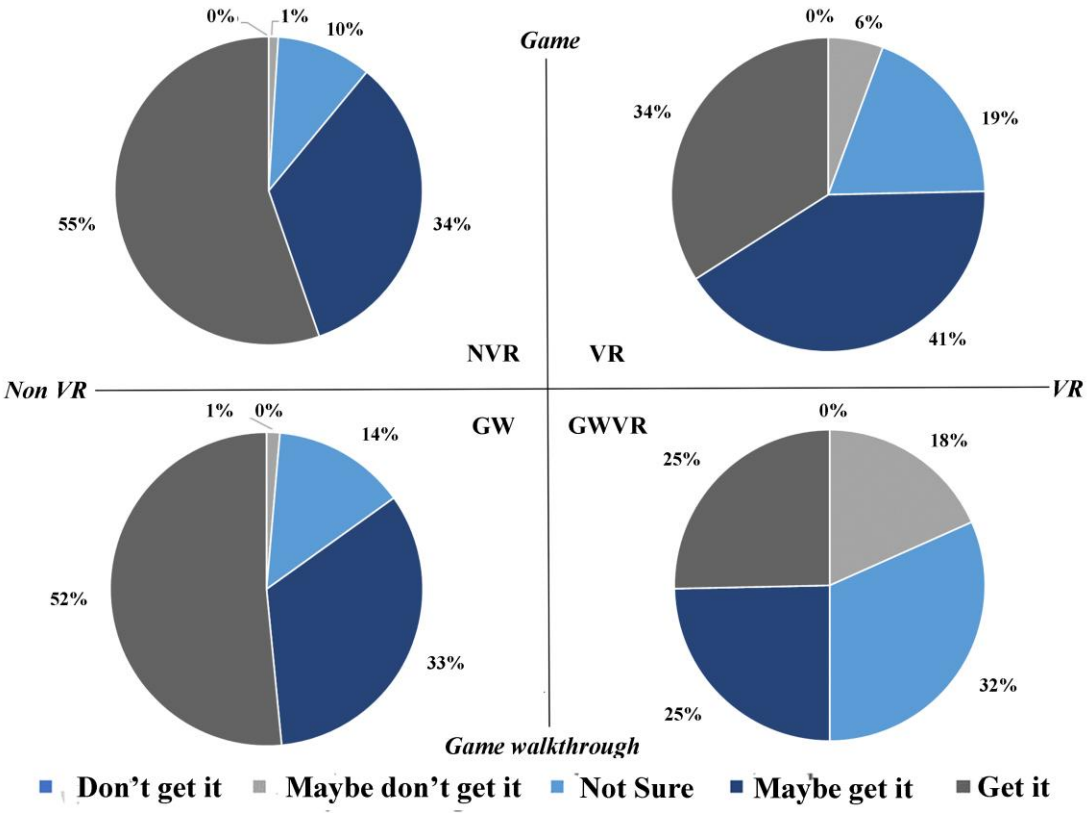


Figure 3. The percentage of times each option was selected in each group

3.3. Correctness Check

The same question is used for the recognition check and the correctness check. There are five levels of correctness depending on the subject's answer. The score for each level is: "More than correct": 5, "Correct": 4, "Mostly correct": 3, "Somewhat correct": 2, and "Incorrect": 1. The total score is 1500.

As Figure 4 shows, the total score of each group is Group NVR: 1153 points, Group GW: 1141 points, Group VR: 1248 points, Group GWVR: 1060 points. The scores are, in order from highest to lowest, VR>NVR>GW>GWVR.

It is clear that the overall score of the game sample is higher than the game walkthrough, but contrary to expectations, the difference in scores between group NVR and group GW is only 2 points. The highest and lowest scores were significantly different from those of adjacent groups, with a difference of 95 points between group VR and group NVR, and 81 points between group GW and group GWVR.

Taken together with the recognition check in the previous section, this indicates that Group NVR and Group GW are not only similar in their tendency to select for memory recognition, but also have very similar levels of the actual memory component.

The score ranking for the subjective questions again matches the overall score ranking: VR>NVR>GW>GWVR. Higher scores on subjective questions require more empathy from the subjects. If the genre is one that stimulates empathy, it may be better to have people play the game directly rather than deliver it using a game walkthrough to achieve the goal. Therefore, if subjective feedback from viewers is needed, the VR sample can provide the most feedback among the four groups. Next is NVR games. In terms of Ownership rate of VR and pc devices, NVR may be a more suitable medium. On the other hand, Game walkthroughs did not provide comparable subjective responses, especially for VR games.

In other words, if the subject matter requires empathy, it may be better to have the audience play the game directly rather than deliver it through a game walkthrough to achieve the goal.

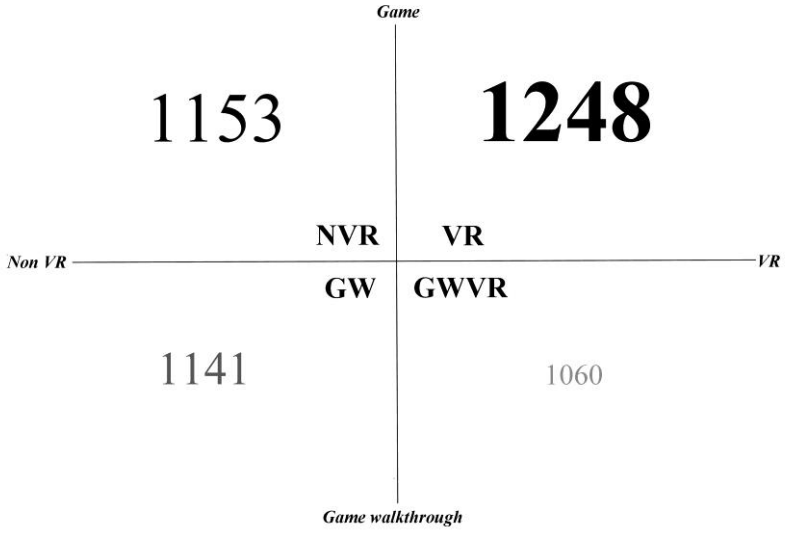
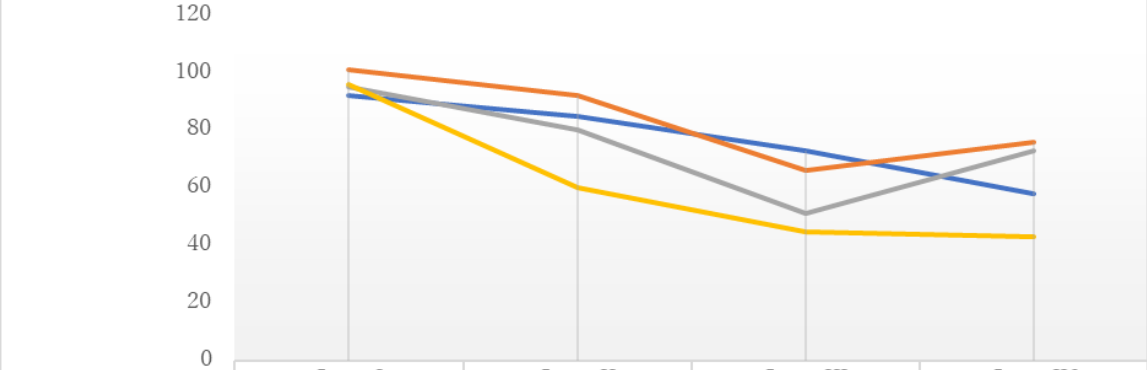


Figure 4. The total score a for each group

3.4. Empathy Check

As shown in Figure 5, overall, group NVR tends to start high and end low. Group VR and Group GW have very similar fluctuating trends, both starting high and ending low until stage 3, but increasing in empathy until stage 4. Group GWVR shows a steep decrease from stage 1 to stage 2, and a slower decrease in the other stages. The scores for NVR and VR do not change so much, whereas the scores for GW and GWVR are more variable.

With the exception of stage 3, group VR consistently led the other three groups in empathy, followed by group NVR, then group GW, and finally group GWVR. This is the same ranking as for the correctness check. The ranking of the overall score for the empathy survey is VR>NVR>GW>GWVR.



	Stage I	Stage II	Stage III	Stage IV
NVR	92	85	73	58
VR	101	92	66	76
GW	95	80	51	73
GWVR	96	60	45	43

Figure 5. Empathy for each stage

4. LIMITATIONS AND CONCLUSION

The self-report of the four groups in the recognition check was NVR>GW>VR>GWVR in order from highest to lowest. In the correctness check, the total score ranking of the four groups was: VR>NVR>GW>GWVR. The ranking for the empathy check was the same as the correctness check: VR>NVR>GW>GWVR. Negative emotional keywords such as "scary" appear frequently in the recordings. A number of studies have confirmed that empathy plays a role in the construction of our memories [24, 25]. Coupled with the fact that it is an experimental result, it further proves that empathy is positively correlated with memory correctness.

In other words, Group VR, which ranked first in both the empathy and correctness surveys, and the VR serious game with a storyline are the means by which recipients can remember the most information.

Group NVR's sample narrative VR serious game is also a good medium for environments where VR conditions are not feasible or where VR device Ownership rate is a consideration. Although

slightly inferior to Group NVR, the Group GW data was very close to Group NVR in all surveys and the selection trends were similar. If the recipients want to memorize a single message or multiple messages, or if they value the convenience of game walkthroughs, GW is considered more suitable than NVR. However, group GW scored lower in questions that required subjective thinking, if the receiver is required to think subjectively, GW is less suitable.

Finally, GWVR, which is also a game walkthrough sample, does not perform well. In particular, compared to the similarity between group NVR and group GW, group GWVR and group VR have large differences in each survey. According to additional interviews with subjects in this group, the major reason for this is that the shaking lens distracts the subjects' attention and the subjects are not used to the walkthrough of VR game. Therefore, the walkthrough of VR game is not a suitable medium to make the receiver memorize the information.

In the case of game media, it is known from previous studies that empathy is positively correlated with memory correctness[26]. Based on the above data, this rule is not completely true for game walkthrough media. Although the group GW game walkthroughs can empathize to some extent with the game walkthrough players about their gaming experiences, they are limited compared to actual game plays, especially when it comes to the questions they have to think about.

Researchers believe that this is because the quality of empathy that the receiver feels differs from the empathy that is guided by the game walkthrough players. Game walkthroughs often allow the receiver to experience the game by empathizing with the medium of the game walkthrough players. A game walkthrough, on the other hand, allows the viewer to empathize directly with the game's protagonist; in a game walkthrough, the player is constantly verbalizing his or her feelings as the game progresses, thus reducing the need for the GW viewer to perceive his or her own feelings. Therefore, group GW is inferior to group NVR in terms of the need to think and construct their own words, which has lost its empathic mediation.

There are also limitations to this study. One is that the data reads that while the percentage of correct answers for GW group is not bad, it is slightly lower than NVR group. This is most likely due to the fact that as a Video medium, games walkthroughs are still less interactive than game media. If the comments were used to increase the participation and interaction of the recipients, a higher percentage of correct answers might be obtained. At the same time, however, some of the comments undermine the convenience of the game walkthrough, as recipients who are eating have to put down their cutlery and use both hands to control the game. Therefore, the viewers of the game walkthrough are not able to empathize in a positive way through the game walkthrough players, or the accuracy and precision of the game content is not guaranteed due to the lack of interactivity of the visual media. In order to increase interactivity, the game walkthrough needs to sacrifice convenience. There may be ways to increase interactivity while maintaining the convenience of the game walkthrough, such as voice input of comments. However, it is difficult to guarantee the interactivity and convenience of the game walkthrough in the current mainstream way. Second, the sample in this study is narrative oriented and has a weak gaming aspect in comparison. Different samples may yield different results, and subsequently, a sample that focuses more on gaming than narrative will be the next research topic.

The results of this study indicate that serious games walkthrough is a viable educational option outside the classroom, especially given the prevalence and convenience. With the rapid development of technology, students' interests are constantly changing, According to self-determination theory, education can be constantly updated to stimulate students' interest in learning. On the other hand, game walkthrough, a byproduct of educational gamification, give students more options. Students will be able to experience educational games in class, and also learn outside the classroom by watching game walkthrough anytime, anywhere.

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