Luo, J. & Li, Z.(2022). A study of the verification of the effectiveness of multiple endings in learning novel games. *Journal of Educational Technology Development and Exchange*, *15*(2), 45-59

A Study of the Verification of the Effectiveness of Multiple Endings in Learning Novel Games

Jiejin Luo
Osaka University, Japan
jiejin@hus-et.net

Zhe Li
Osaka University, Japan

Abstract: *Today, digital games that incorporate multi-ending scenarios are not uncommon in the entertainment field. However, there is no such application of multiple endings to learning games and educational situations. Therefore, there are no studies that have examined the learning effects of multiple endings in learning games. The purpose of this study was to examine the effects of a multiple-ending learning game on learners' motivation and learning effectiveness. To test the effectiveness of multiple endings, a multiple-ending learning novel game was designed in the experiment. The results of the experiment showed that the learners of the group with multiple endings practiced more often. In addition, the multi-group performed better. And the results also showed that the learners in the multi-group had a higher sense of achievement and self-determination than those in the single group. Based on these experiments, this study clarified that multiple endings can improve the learning effect.*

Keywords: digital game-learning, gamification design, multiple endings, self-determination theory, intrinsic motivation

INTRODUCTION

Attempts to adopt games into educational situations are gathering more and more attention. Many studies are currently being conducted on the use of games as educational media. According to a summary by Fujimoto (2015), compared to paper-based learning materials, learning games motivate learners more and have a higher learning effect. However, not all learning games by any means motivate learners and have a high learning effect. This is because the learning effects of learning games are significantly influenced by the game design (Fujimoto, 2015).

When designing digital games for entertainment situations, one of the most commonly used methods of design is the multiple-ending scenario. The multiple-ending scenario is "a method of story expression often used in games with strong story elements," in which parts of the game change according to the choices made by the game player. It is a scenario in which players can choose their own options and experience different endings (Lenz et al., 2013, p. 181).

Today, digital games that incorporate multiple-ending scenarios are not uncommon in the entertainment field. However, learning games in a multiple-ending design are not known to the author. Therefore, there are no studies that have examined the learning effects. No studies have been found related to the effects on the players' side when using games that include multiple-ending scenarios, as well as for educational use. The authors developed a game with multiple endings for educational purpose, and the purpose of this research is to investigate the effectiveness of incorporating multiple-ending scenarios in learning games and to fill this gap in the literature by examining the effectiveness based on the designed game.

PREVIOUS RESEARCH

Based on the research problem and research purpose, the following reviews relevant previous studies.

The Design of Learning Games

As mentioned in the research problem statement, digital games have been introduced into many educational situations. This is because games have several educational advantages.

Fujimoto (2007, pp. 6-7) mentions five main advantages of using games in education: "arousing and maintaining motivation," "understanding the big picture and the activity process," "learning experience in a safe environment," "emphasizing important learning items," and "learning through action and failure."

However, not all games have these advantages, and whether they can be used in educational situations depends on how well the game is designed. Fujimoto (2007, p. 86) also identifies five common characteristics of badly designed games. These are: "the screen structure and operation methods are difficult to understand and detract from the playing feeling," "the explanation of game operation methods is redundant and separated from the game play," "the learning elements are separated from the game play," "there are many settings and unnecessary gimmicks unrelated to the learning content," and "there are no tricks to make the player want to play the game over and over again."

In contrast to these five characteristics, Fujimoto (2007, p.87) summarized the features of games of excellent designed games as "easy to understand screen structure and operation methods, allowing stress-free play," "easy to understand game operation methods

while playing," "well-balanced arrangement of learning elements in the game," "settings and effects that match the target user and learning content," and "mechanisms that make the player want to play the game over and over again without getting bored the first time."

Multiple endings, which are the focus of this study, are expected to promote round-playing (a game term that refers to playing a game once completed and then playing it again) because there are multiple endings. In other words, it is a "mechanism that makes the player want to play the game again and again without getting bored after the first play, (Fujimoto, 2007, p.87)" which is considered an excellent design. This feature is expected to demonstrate the advantage of "learning through actions and failures, (Fujimoto, 2007, p.87)" which is mentioned as one of the advantages of games.

Many studies have focused on designing and testing the effectiveness of an educational-purpose game. Mayer (2014, p. 130) proposes a value-added approach to explore the impact of various design elements in games on game learning effects. The value-added approach is defined as comparing "the learning outcome performance of students who learned by playing a game versus students who were assigned to play the same game with one instructional feature added (Mayer, 2014)". With this approach, it can be understood which elements of the game impact the learning effect of the video game, so that the game can be better designed to improve the learning effectiveness according to the learning content and the learner profile.

One such study by Kikuchi et al. (2015) is discussed here to provide a reference for verifying the effectiveness of serious games. They developed a serious game to teach evacuation behavior in a facility and tested its learning effectiveness. They identified the necessary characteristic elements for designing the game and used them to develop the game. They then tested the learning effects of the game through experiments. The study used pre- and post-tests to measure the experimental collaborators' knowledge before and after the game play, as well as a post-questionnaire to measure their motivation towards the game. The main methods used to test the learning effects include comparing the number of correct answers in the pre- and post-tests to determine if there was a significant learning effect. Additionally, the post-test questionnaire asked participants to rate the game's interest level. The results of the experimental group that learned through the game were compared to the control group that learned through a textbook. Based on these previous studies, this study would also like to add the multi-endings as an instructional feature and to examine the learning effectiveness of multiple endings for this study from two aspects: learning performance and learning motivation.

Multiple-ending Games

The next section describes the multiple-ending games that are the focus of this study. The multiple-ending is a game term that refers to games that have multiple endings within the game. During the game, the player is given several choices, and by choosing one of the choices, the player can reach different endings depending on the choice (King et al., 2010).

In general, the different endings can be categorized into three main types: good, normal, and bad. A good ending is one in which the protagonist achieves their goal or overcomes their conflict, and the outcome is positive. A normal ending is one in which the story is resolved, but the outcome is not necessarily positive or negative. A bad ending is one in which the outcome is negative or tragic for the protagonist or other characters.

In addition to these three main types of endings, some games also offer a true ending that can only be achieved by completing certain requirements, such as completing all the other endings, making specific choices, or finding hidden items. The true ending is often presented as a reward for players who invest more time and effort into the game (Ganzon, 2017).

However, many players do not like bad endings because bad endings can leave the player feeling unsatisfied or even upset. For this reason, many games have only good endings and normal endings. In the case of this study as well, only good endings and normal endings were used as the pattern of endings for the designed game, in order to avoid damaging the mood of the learners as much as possible.

Looking back at the history of multiple-ending digital games, the stories of early ADV games (adventure games) and Japanese-style RPG games (role-playing games) progressed along a single path. However, since then, multiple-ending games have gradually developed as story-centered. As the player progresses through the story, choices are made along the way. Depending on the player's choices, the main character's actions change, the story unfolds, and a different ending is reached (Onizuka, 1998).

However, a review of previous research shows that studies on multiple endings have developed mainly from the perspective of game providers, targeting games for entertainment purposes. Such research has primarily sought to support the creation and management of storylines. For example, Nakata et al. (2007), considering that "the storyline is limited to what the creator intended (Nakata et al., 2007, pp. 497-498)" in conventional multiple-ending games, proposed a "new story generation method that differs from conventional methods (Nakata et al., 2007, pp. 497-498)" in which the reader's taste is included as one element in the game and the probability of giving choices is changed according to it. The authors propose a "new story generation method that differs from conventional methods (Nakata et al., 2007, pp. 497-498)" that changes the probability of giving a choice.

As mentioned above, looking back at previous research on multiple endings, there is no research on the effects of multiple endings and their influence on players' motivation. Therefore, this study intends to investigate the effects of multiple endings.

The Effects of Multiple-ending Games on Learning Motivation and Learning Effectiveness

In this study, when examining the effects of multiple-ending games, the authors intend to examine it from two main aspects: the effect on learning performance and learning motivation. This section explains why the authors expect that multiple-ending games will have both of these effects.

First, the effect of grades on scores is discussed. In games with multiple endings, it is often assumed that the game is played around due to such characteristics. Round-playing refers to playing a game from the beginning again after completing it, in order to complete the achievements that were not achieved in the first round. In the case of novel games, each game has a different ending, so if the player wants to see more than one ending, it is assumed that the game will be played multiple times. In addition, in a game with multiple endings, the player may be required to fulfill certain conditions of occurrence in

order to see a certain ending. Applying this method, a learning game could make the completion of a specific learning task (e.g., some practice assignment) an occurrence condition. In other words, multiple endings can be a feature of good design, as described above, "a mechanism that makes the player want to play the game again and again without getting bored after the first play," and can encourage repeated practice by the learner. With repeated practice, it is believed that learners will become more proficient at the tasks and obtain higher scores.

Next, the effect on motivation to learn will be discussed. One important characteristic of games with multiple endings is that the player is given choices in the game and can choose the progression of the game story at his or her own will. In the study of motivation in psychology, the feeling of being able to determine one's own behavior by oneself is called self-determination, and is theorized as self-determination theory (Deci & Ryan, 1985, 2000). According to Sakurai (2012), self-determination theory is a fundamental theory related to motivation: the stronger the sense of self-determination in many activities, such as learning and working, the higher the performance of the activity. From the perspective of the multiple endings, the theory of self-determination can be reconsidered as mainly related to the "need for autonomy". The "need for autonomy" is the innate desire for self-determination. A more self-determined action, in which a person has the "desire to self-determine" before performing the action, allows the person to feel satisfied and achieve higher performance.

The following relationship between the desire to make choices and determine the development of a story through multiple endings and the feeling of self-determination is considered to exist. In Sakurai's (2008) research on the difference between occupational choice and sense of self-determination, it was suggested that there is a difference in the sense of self-determination between those who, when looking for something they want to do, have a psychological "want to find it" spontaneously and those who have a psychological "have to find it" due to environmental influences. Positive results, such as increased enjoyment and satisfaction, were found with a higher sense of self-determination.

The same can be considered when reading a game story and making a choice, as in the case of occupational choice. When a player becomes the main character in a story and participates in the story, there are two types of players: those who are given choices in the story and spontaneously want to advance the story or let the story unfold, and those who simply read the scenario designed by the game designer and feel that they have to press the screen to advance the story. It is believed that a difference in the sense of self-determination can also be observed between the two types of players. Therefore, it can be assumed that with the existence of multiple endings, players will have more fun playing the game and enjoy reading the story more, and they will practice more spontaneously in the game.

Another aspect of the impact of multiple endings on motivation to learn can be considered. In games with multiple endings, players often want to collect multiple endings (a game term referring to reaching a specific ending). The motivation to feel satisfied by collecting the endings is considered to be a sense of accomplishment in motivation theory. The sense of accomplishment felt by the learner is considered to be important in stimulating the learner's motivation to learn

and encouraging learning activities. One theory related to the sense of achievement is the theory of achievement motivation. Dweck (1992, pp. 165-167) defined achievement goals. An achievement goal "refers to the more general goal behind a person's desire for a certain outcome." Motivation regarding achievement goals is achievement motivation. There is a feeling of completing a game by collecting multiple endings. The desire to see all the stories in the game, to experience all the content, motivates the learner to collect all the endings. Also, in the process of collecting multiple endings, new stories can be read. The ability to read multiple stories further motivates achievement because it is thought that the game is more enjoyable to play.

The Hypothesis

Based on the above previous research, two hypotheses were developed.

Hypothesis 1: The presence of multiple endings can promote repeated practice. Repetition will increase learners' proficiency and performance scores.

Hypothesis 2: The presence of multiple endings will increase learning motivation. Specifically, it is expected that there will be some significant difference between the sense of self-determination and achievement of the multi-ending group and the single-ending group. It is also expected that the longer the learner reads the story about the assignment, the more interested he or she will be in the assignment.

METHODOLOGY

The Design of the Study Subject

Before creating the game, a learning subject was first determined. After considering various aspects, Japanese classical grammar was selected as the learning task.

There are two reasons for choosing classical grammar as the learning subject of the game. One reason is related to the purpose of this study. This study intends to examine the effects of multiple-ending games and also to measure students' motivation for the task. Therefore, by choosing assignments that are low in motivation to begin with, the study believes that the change in effectiveness can be made more pronounced and easier to analyze. Another reason for choosing classical grammar is its social significance. Despite the current situation where learners have low motivation for classical grammar, the importance of classical grammar is obvious. Studying classical grammar will increase one's chances of gaining admission to the university of one's choice, since one must choose the classics when taking the university entrance examination. Furthermore, from a cultural understanding perspective, when studying a language, it is important for both Japanese and foreign learners to understand the historical context of the language. Therefore, it would be socially significant to improve learners' motivation to study classical grammar by introducing games with multiple endings.

The following is an explanation of the specific study content and learning objectives addressed in this study with regard to classical grammar, which was set as the study subject. Based on a comparison of current junior high school Japanese textbooks and reference books for studying classical Japanese (Oda, 2007), it was decided that the study content would be historical kana usage, the most basic knowledge of classical Japanese. In the game, five rules for correcting historical kana usage into modern kana usage were introduced

as the study content. The learning goal is to memorize and master these five rules, and to apply them to perform grammatical transformations from ancient Japanese to modern Japanese on their own. First, it was explained that "i, u" should be replaced with "i, u" in the historical kana characters. Next, it was explained that "ha, hi, fu, he, ho" should be replaced with "wa, i, u, e, o" except at the beginning of a word. Next, it was explained that "au, ui, eu" should be replaced with "ou, yu, yo" when the vowels are superimposed. Then, it was explained that "tefu, kefu" is replaced by "chou, kyo" when the three rules explained before are combined. Finally, it was explained that "kuwa, guwa" should be replaced by "ka, ga". After introducing the rules, one example is given for each rule to check understanding. If they want to go over the rules again, they can return to the previous part of the explanation. The learning objectives of the game were set so that the learners would acquire knowledge of the five rules for historical kana usage and answer the drill questions as correctly as possible.

The Design of the Multiple-ending Novel Game

The game format was decided to be a multiple-ending novel game with a pattern in which the story changes according to the player's choices. A novel game belongs to the adventure game category and is a game format that combines several elements such as CG showing locations, standing pictures of characters, screen effects, sound and background music, and choices with the text displayed on the screen (Nanabe, 2006, p. 70).

The structure of the game is described next. The game consists of four main parts: a cover story, an introduction to the knowledge, a test of knowledge in the form of drills, and an ending story. In this study, for experimental purposes, two versions of the game are prepared, one with multiple endings and the other without multiple endings, but the cover story, the part introducing knowledge, and the drill part are common to both versions. The only differences are the choices after completing the drill section and the number of endings in the ending story section. The game operations are the same in the two versions.

In the game flow, the player first reads the cover story and learns that his/her role in the story is to study classical grammar. Next, the player is presented with knowledge about the learning task.

After studying the knowledge of the learning task, the player takes a drill test. The drill test consists of 10 questions. After completing the drill, the player can see his/her scores (number of questions answered correctly). The score of the drill test will be evaluated as the learner's performance in Hypothesis 1 in a later discussion. If the player does not get 60% or more of the questions correct, he or she will have to do the drill again. During the drill, each time players solve a question, they will know if they got it right or not, so if they drill more than once, they can go back and think about the questions they got wrong the last time they played and review the questions they got right one more time. After answering more than 60% of the drills correctly, each of the two versions of the game will unfold differently. For the sake of explanation, the game version with multiple endings will be referred to below as the multi-condition and the game version without multiple endings as the single condition. Figure 1 is an example of the system of answering drill questions in the game. The question in this figure shows a classical grammar kana usage of the word "tefutefu"

and requires the student to change it to the modern grammar kana usage according to the rules learned previously and to choose the correct option among the three choices. The translation of three options are “shoushou”, “kyoukyou” and “chouchou”.

The multi-condition is the version that includes multiple endings. After passing a drill test, a character in the game asks a single question. In response to that question, the player selects his or her own choice, after which the storyline branches off. When the player reaches one of the endings, the first play session ends. After the end of the play, the player can go back to the previous part of the drill if he/she wants to choose another option in the previous scene. In other words, if you test the drill again, you will be able to choose a different option. If you choose a different option, you can see the other endings. The single-condition is a version that does not include multiple endings. After passing the drill test, there are no questions from the character and only one continuing storyline. However, the drill can be performed again in order to achieve a higher grade. However, no matter how many times the drill is done or how many times the grade changes, the continuing storyline remains the same. Figure 2 shows an example of the re-selection page in the game flow, where the translation of the question asks the student “Do you want to replay the game again for the second round? If you choose to play a second round of the game you will see a different ending.” Students can choose “Yes” or “No”. Flowcharts displaying the flow of the game setup are in Figures 3 and 4. Figure 3 is the multi-condition and Figure 4 is the single-condition.

Figure 1

Drill screen of the game

Figure 2

Reselection screen of the game that appears after clearing the game for the first round

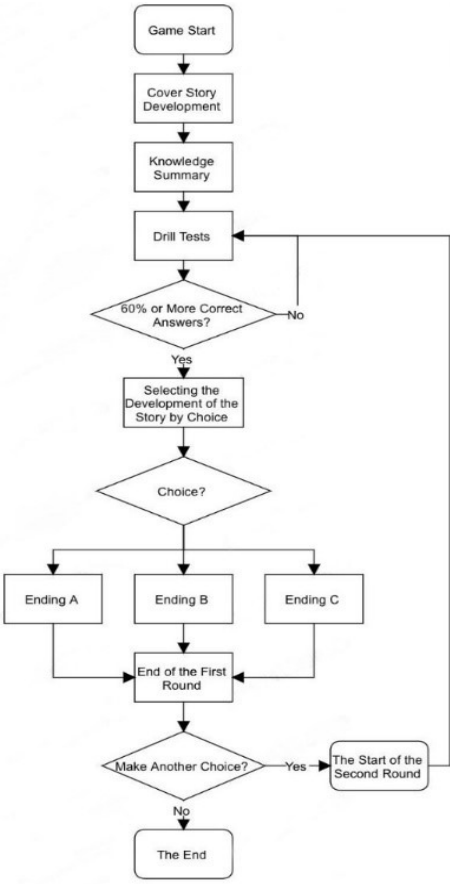

Figure 3

The flow of the game (Multi)

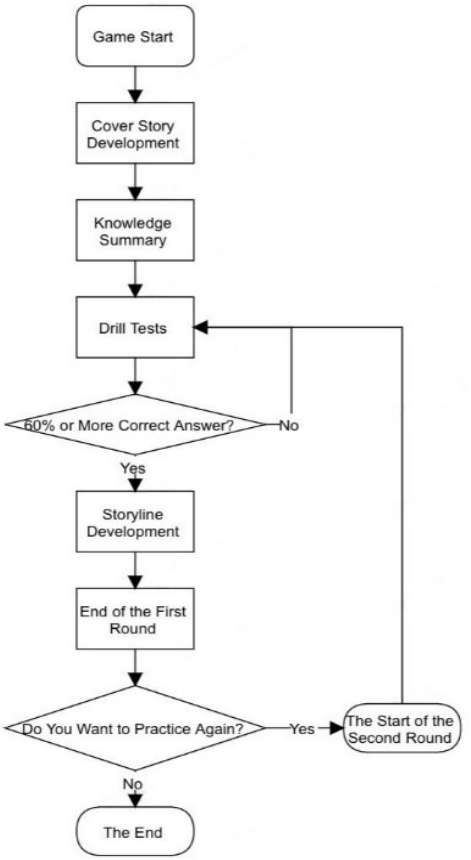

Figure 4

The flow of the game (Single)

The design of the experiment

The experiments conducted in this study are described in the next section. Based on their language background and lack of knowledge in classical Japanese grammar, thirty-six adult Japanese and Chinese participants who had little to no prior knowledge of classical Japanese grammar of all educational backgrounds and genders were selected. And they participated in the experiment online. All experimental collaborators had either never studied classical grammar or had studied classical grammar but had forgotten their basic knowledge because of the passage of time. Experimental collaborators were randomly assigned to two groups: a multi-group and a single group (multi-group: 14 Chinese and 4 Japanese; single group: 14 Chinese and 4 Japanese).

The process of the experiment is as follows.

First, 36 learners were randomly divided into two groups. The experimental group, the multi-group, was provided with a version of the multi-condition, and the single group, as the control group, was provided with a version of the single condition. Before starting the experiment, a preliminary explanation of the experiment, explaining precautions and other information, was presented to the experimenters.

Next, each player played the game for 10 minutes according to the in-game instructions. The 10 minutes were the expected time to complete the game, which could have been earlier or later than 10 minutes, depending on each player's personal circumstances.

A 5-minute break was then given. Five minutes was the estimated time to complete the game one more time.

Finally, a post-questionnaire was administered.

The post-questionnaire was divided into three parts and mainly asked the following questions. The first part of the post-questionnaire asked about the game played in this experiment. Based on Hypothesis 1, participants were asked about the number of times they practiced the drills and the change in their scores per practice in order to test the promotion effect of the multiple endings on repetition practice. Next, based on Hypothesis 2, to evaluate the effect of the multiple endings on learners' sense of self-determination, questions were asked about items such as "Did the story unfold the way I wanted it to?" with reference to a scale of sense of self-determination (Sakurai, 1993). Furthermore, based on Hypothesis 2, in order to evaluate whether multiple endings affect learners' sense of achievement, questions on items such as "Do you want to reach the ending" were asked with reference to a scale of sense of achievement (Horino, 1987). In addition, based on Hypothesis 2, to evaluate whether the multiple endings affect the learners' motivation for the task, questions were asked on items such as "Did the game make you more interested in the classic grammar?" The second part of the post-questionnaire asked about the cooperators' usual attitude toward the game in order to examine the effects of individual differences. The third part of the post-questionnaire was descriptive, asking about their impressions of the game and their opinions and comments. It also asked about their usual experience of using the game.

RESULTS AND DISCUSSION

Comparison of grade scores change and the number of practice times.

To test the effect of practice within Hypothesis 1, differences in the number of practices and scores per practice session between the multi and single groups will be compared. Table 1 shows the basic statistics of the data for the number of practices and scores after the experiment in the condition with and without multiple endings. The mean and standard deviation of the number of people, number of practices, and number of scores are shown.

Table 1 shows the number of participants who played the game multiple times. 11 participants in the multi-group played the game twice, and 4 participants played the game three times. In the single group, 1 person played the game twice and 0 persons played the game three times. This means that more than half of the multi-group played the game at least a second time, while in the single group, there was only one person who played the game a second time. In the multi-group,

20% of the collaborators played the game three times, i.e., collected all endings, while none of the single group practiced the game three times. From the above, as a result of the comparison of the number of times practiced, it can be said that the presence of multiple endings clearly promoted repeated practice among the experimental collaborators. Next, the results of the practice performance showed no significant difference, as the mean of the first practice performance was 7.50 for the multi-group and 7.17 for the single group. It is safe to assume that there is no significant difference between the learning ability of the two groups. However, for the experimental participants in the multi-group who did the game more than once, the scores after the second game are clearly higher than those of the first game. In the single group, very few people played the game up to multiple times, and no change in scores was observed. These results support hypothesis 1.

Table 1

The number of participants who played the game multiple times

	Multi-group Mean (standard deviation)	Single-group Mean (standard deviation)
The number of people who did the first round.	18	18
First-round score.	7.50 (1.20)	7.17 (0.92)
The number of people who did the second round.	11	1
The first-round score for those who did the second round.	7.36(1.03)	7.00(0.00)
The second-round score for those who did the second round.	8.45(0.69)	8.00(0.00)
The number of people who did the third round.	4	0
The first-round score for those who did the third round.	6.75(0,50)	0.00(0.00)
The third-round score for those who did the third round.	9.00(0.82)	0.00(0.00)

Comparison of motivation

To test hypothesis 2, the multiple and single groups are compared by means of an unpaired t-test on the items measuring motivation to learn. t-test results are displayed in Table 2.

It can be assumed that individual differences in preference for games and experience playing games will affect the motivation to play games. Therefore, in order to take into account the influence of individual differences, experimental collaborators were first asked about their attitudes toward games. Since the results in Table 2 shows no differences between the attitudes toward games, it can be assumed that preferences about whether or not they like playing games do not affect the differences between the two groups.

Next, other items will be discussed. Regarding the learners' sense of having gained knowledge, the item "acquired knowledge" was asked and evaluated. The results showed a significant difference between the two groups. It was verified that through the game, the multi-group had a sense of having acquired more knowledge. Regarding the motivation for the task, the item "Through the game, I became more interested in classical grammar" was asked and evaluated. The results showed that there was a significant difference between the two groups at the 1% level. Thus, it can be said that the multiple endings increased the learners' motivation for classical grammar. Regarding the sense of achievement, items such as "I want to play this game more" were asked and evaluated. The results showed that there was a significant difference between the two groups at the 1% level. This suggests that the multi-ending format enhanced the learners' sense of achievement. Regarding the sense of self-determination, both groups were evaluated by asking questions on items such as "The story unfolded the way I wanted it to". The results showed that there was a significant difference between the two groups at the 1% level. This suggests that there is a significant difference between the sense of self-determination of the learners in the multi-group and the learners in the single group.

In summary, differences were found between the learners' sense of having gained learning effects such as "acquired knowledge," their motivation for the task, their sense of achievement, and their sense of self-determination after the introduction of the multiple endings. These results may explain that the introduction of multiple endings increased learners' intrinsic motivation, such as the sense of achievement and self-determination, and increased their motivation to do the task. In other words, the results support hypothesis 2.

Table 2

The t-test results of the experiment

	Multi-group Mean (standard deviation)	Single-group Mean (standard deviation)	Effect amount d	t-value	df	p-value
Attitude toward games	7.56(2.18)	6.44(2.09)	0.51	1.56	33.9	.128
Sense of Learning Effectiveness	4.11 (0.68)	3.50 (0.99)	0.71	2.17	30.1	.038*
Motivation for the task	3.89(0.90)	2.94(0.87)	1.04	3.20	34.0	.003**
desire for achievement	12.56(1.89)	9.33(1.91)	1.66	5.09	34.0	.000**
Sense of self-determination	7.56(1.65)	5.78(1.93)	0.97	2.97	33.2	.005**

Analysis of the free-response question

Here the effects of multiple endings are analyzed mainly from comments on the free-response question portion of the questionnaire, and other findings are discussed.

Two free-response questions were asked in the questionnaire. One question asked about the respondents' impressions and opinions of the novel game designed for this study, and the other asked about their attitudes and opinions toward multiple endings based on their own game experiences.

In the responses of the multi-group, there were three comments on the ending of the game in this study. These were that they thought the ending was interesting because they could not predict how the story would continue when they saw the choices. In the single-group responses, there were four comments on the ending portion of the game in this study. These were comments that the ending was not what they expected, so they hoped for other developments, and that the ending was a bit short, so they felt it was not enough. In other words, it can be inferred that the multiple endings had the effect of increasing the players' general motivation, since the single group received fewer comments in the free-response questions, while the multi-group received many comments in the free-response questions.

Examination of individual differences and future challenges

The next section analyzes individual differences within the multi-group and discusses future challenges and prospects for multiple endings. Regarding the multi-group, there were 11 individuals who had done it twice, and 4 individuals who had done it three times. Compared to the single group, the multi-group as a whole was found to be more motivated, including a sense of accomplishment and self-determination, but differences in motivation within the multi-group were not examined. It is possible that within the multi-group, there may be some difference in motivation between those who made only one attempt and those who made multiple attempts. Although it was confirmed in this study that the multiple endings provide a higher learning effect, the extent to which this effect can be achieved is likely to be highly related to individual experience and preferences. Future work will be needed to control the effects of individual differences and to determine how to utilize the effects of the multiple endings even for those who have never experienced the game and those who do not like the game.

CONCLUSION

The purpose of this study was to examine the effects of a multiple-ending learning game on learners' motivation and learning effectiveness. Among the characteristics of well-designed games described in previous research on game design, the multiple endings are considered to be a mechanism that makes learners want to play the game over and over again. It was assumed that this mechanism could promote learners' repeated practice and enhance the learning effect.

In addition, the multiple endings allow the player to decide how the story unfolds, and this enhances the learner's sense of self-determination. Furthermore, it was expected that it would enhance their sense of achievement by motivating learners to want to experience all the endings, and by having them experience them all. In other words, it was believed that this would motivate the learners. To conduct an experiment to test this hypothesis, a multiple-ending learning novel game was designed.

36 participants were divided into two groups: one group that played the multiple-ending game (multi-group) and one group that experienced the non-multiple-ending game (single group). The experiment was conducted online. After the completion of the game, a post-questionnaire was administered asking about learning performance and motivation, as well as the usual game experience.

The results of the experiment showed that there was a difference in the number of practicing attempts between the multi and single groups in terms of learning

effectiveness, with the multi-group learners practicing more often. In addition, the multi-group performed better. Thus, the results support hypothesis 1.

Regarding the motivation to learn, the results showed that the learners in the multi-group had a higher sense of achievement and self-determination than those in the single group. Thus, hypothesis 2 was also supported.

In addition, results for the cooperating participants in the multi-group who did not attempt to play the game more than once, i.e., individual differences, were also examined. It was inferred that this was related to their gaming experience and other factors. Future work is needed to address such individual differences.

Based on these experiments, this study clarified what kind of learning effects can be expected when multiple endings are used as an expressive method for game design in educational situations. This study has also demonstrated the usefulness of adopting multi-ending games as teaching materials in educational situations.

As for future research, this research could shed light on whether the findings of this study are transferable to other subjects and age groups. And according to what was mentioned in the previous results analysis section, the effect of individual differences on learning performance could be examined more closely. Future studies could explore how prior gaming experience or other factors affect learning performance and motivation. And also, it would be interesting to investigate the long-term retention of the learned knowledge and skills. Follow-up studies could examine whether the effects of multi-ending games are sustained over time or if they are only effective in the short term. Finally, as technology continues to evolve, new methods of game design and implementation will emerge. It would be beneficial to explore how new technologies and game design elements can be incorporated into multi-ending games to enhance their educational effectiveness.

In conclusion, the findings of this study suggest that multi-ending games can be an effective method for promoting repetition practice and increasing learners' sense of self-determination and achievement. Further research in this area could contribute to the development of innovative and effective teaching materials that can improve educational performance.

Contact the Author

Jiejin Luo

Osaka University, Japan

Email: jiejin@hus-et.net

References

Dweck, C.S, (1992). The study of goals in human behavior. *Psychological Science, 3:* 165-167.

Deci, E. L, (1975). *Intrinsic motivation.* New York, NY: Plenum Press.

Daniel King, Paul Delfabbro, Mark Griffiths (2010). Video game structural characteristics: A New psychological taxonomy. *International Journal of Mental Health and Addiction. volume 8,* 90–106.

Fujimoto, T, (2007). Serious games: Transforming education and society through digital games. *Electronic bk.*

Fujimoto, T, (2015). New developments in game learning. *Studies of Broadcasting and Media*, 239-242.

Kikuchi, S. and Makanae, K.(2014) Development and evaluation of an action-based educational serious game about disaster evacuation, *Proceedings of the 14th International Conference on Construction Applications of Virtual Reality & Islamic Architecture,* 269-274.

Lenz, K. et al, (2013). Proposed story management method for multi-ending scenarios. *ITE technical report, 37*(17): 181-182. https://doi.org/10.11485/itetr.37.17.0_181.

Midori, H, (1987). Analysis and reconsideration of the concept of achievement motive. *Japanese Journal of Educational Psychology, 35*: 148-154. https://doi.org/10.5926/jjep1953.35.2_148.

Nakata, K., & Osawa, E. (2007). Dynamic automatic generation of stories based on user interaction. *Transactions of Information Processing Society of Japan, 4*, 497–498.

Oda, M, (2007), Classical Japanese grammar, *Oufu*.

Onizuka, K. (1998). The parallel world modeling of multiple-senario games. *IPSJ SIG technical reports,18*: 67-72.

Richard E. M. (2014). *Computer games for learning an evidence-based approach*. The MIT press, 130.

Ryan, R.M., Deci, E.L, (2000). Intrinsic and extrinsic motivations: Classic definitions and new directions, *Contemporary Educational Psychology, 25:* 54-67.

Sakurai, S, (2012). Let's live with dreams and goals! -Self-determination theory. Kage, Masaharu (ed.), *12 Theories of Motivation: An Introduction to the Psychology of Motivation from Zero!* Kongo Press, 45-72.

SC, Ganzon, (2017). Sweet solutions for female gamers: Cheritz, Korean otome games, and global otome game players. *Digital Love: Romance and Sexuality in Games.* 226-243.

.