Effect of Game-based Learning using Live Streaming on Learners' Interest, Immersion, Satisfaction, and Instructors' Perception

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Abstract

Many people have preconceived notions about games and distrust the effects of game-based learning and show negative attitudes. In fact, there are limitations and disadvantages of game-based learning, and it is difficult to overcome them. More than half of the inconveniences or problems of teachers who want to try game-based learning revealed by the 2009 survey have not been solved yet. Due to the sudden spread of COVID-19, the Ministry of Education has issued a policy to convert classes at schools and academies into non-face-to-face. Non-face-to-face classes have the characteristics that instructors and learners will be spatially separated, spatially simultaneous, interactive, and teaching and learning behavior will be mediated by the screen. And these features are common to live streaming. Taking advantage of this, this study aims to approach improving the perception of game-based learning as an advantage of "watching games" beyond "playing games" by using live streaming for game-based learning. This study conducted game-based learning and game streaming learning for 210 third-year middle school students, compared the effects of game-based learning on learning interest, immersion, and satisfaction with the results of previous studies to verify the design and prove the combined effect of live streaming and game-based learning. In addition, in-depth interviews with instructors who conducted game-based learning confirmed that awareness of the introduction, value, and finance of game-based learning improved.

Keywords: *game-based learning; live streaming; commercial game; non-face-to-face learning; improve awareness;*

1 Introduction

Various studies have demonstrated that game-based learning designed properly can be an alternative with better results in motivation, immersion, and learning effects than traditional method education. However, the disadvantages and perceptions of game-based learning, which was surveyed by the European Schoolnet (EUN), a network of education in 34 European countries in 2009, are still showing no significant improvement today[1,2].

Among the disadvantages of game-based learning that has been maintained so far are lack of financial resources and lack of infrastructure. Education at school should ensure equal learning rights for all students, so all students should be allowed to use computers that can play games for game-based learning [3].

As the recent spread of COVID-19 has reached a serious level and has been prolonged, the Korean Ministry of Education recommends non-face-to-face classes in 2020 and recommends several remote communication platforms that enable real-time interactive communication [4]. According to the Ministry of Education's guidelines, elementary, middle, and high schools nationwide enter full non-face-to-face classes. Non-face-to-face classes require terminals that can participate online in classes such as PCs and mobile devices, but equal learning rights cannot be guaranteed because there are cases where students cannot participate. Nevertheless, the situation was serious, and the government introduced a new educational environment. A fast Internet environment is required to enable real-time interactive communication. The Ministry of Education acknowledged that although not all students can prepare devices equally, the Internet or smartphones have been distributed enough to introduce non-face-to-face classes into public education.

Like non-face-to-face classes, "live streaming service" is a medium that communicates in real time with the person who conducts the broadcast. The person who broadcasts in live streaming is called a streamer, and provides audio and video in real time while communicating with viewers in real time [5]. Game-based learning is a method of educating learners by using the game itself or the characteristics of the game in the learning field. Attempts to move the learning site online are showing beneficial effects as they are attempted in a variety of ways, from Internet lectures to classes through video chat. Streaming media can also be interpreted in the same context as the movement of the learning field.

In this study, non-face-to-face game-based learning using game streaming is experimented. Since there is no limit to the number of people available for non-face-to-face lectures, it is possible for fewer teachers to accommodate many students, unlike attempts to introduce game-based learning by class at school. In other words, it is possible to solve the problem of teacher's lack of ICT (Information and Communication Technology) education, which is mentioned as a chronic barrier to game-based learning, through training professionals. The reason why the lack of financial resources and infrastructure are mentioned as barriers is that learners are not guaranteed equal learning rights due to the gap between the rich and the poor. However, since only viewing media at the same level as non-face-to-face classes recognized by the Ministry of Education are required, equal learning can be expected even if introduced into public education.

The contents of the thesis are composed as follows: Section 2 provides several backgrounds for the trends in which game-based learning has been studied and developed, and Section 3 introduces the composition of digital games, subjects, and experimental methods used in the experiment. Section 4 analyzes the results of the experiment and introduces the interviews of the participants, Section 5 summarizes and discusses the results derived in Section 4, and reports conclusions in Section 6 based on them.

2 Related work

2.1 Commercial games and serious games in game-based learning

When designing game-based learning, the target subject is determined like traditional educational methods, and the teaching method and scope are determined in consideration of the learner's age. The difference is that games are used instead of textbooks as learning materials, serious games made for educational purposes are used, or commercial digital games made for fun are also used.

Serious games are games that contain enough game elements and have special purposes other than fun elements [6], mainly refers to games that have educational effects, therapeutic effects, and training effects [7]. Since most of them are used in training or learning, serious games are sometimes confused as synonyms with game-based learning [8]. In the past, in particular, since serious games were mainly used as learning textbooks

for game-based learning, the distinction between game-based learning and serious games may have been meaningless. However, it is necessary to clarify the distinction now that the method of utilizing the fun and accessibility of commercial digital games has developed, mainly in Europe [2].

Game-based learning (GBL) is a concept that utilizes educational elements in games, and is learning in which learners reach their learning goals by using games that combine educational content and games without direct involvement of teachers [9]. And serious games are games with the aim of solving practical problems facing reality, not just pursuing entertainment elements [10]. Since serious games have this purpose, students' preference is lower than that of commercial digital games designed for fun only. When planning to educate using actual video games, it is also necessary to discuss "how many times to educate by teaching" starting with the installation of the game selected in the class, so even if the effectiveness of the serious game is academically proven, it is difficult to introduce it into the regular curriculum in school [11].

Developing a video game requires numerous resources, ranging from graphics to sound, and requires a lot of high-quality manpower that can be designed or coded depending on the size of the game. There is a limit to covering these costs without investment. In addition, since investment is centered on highly profitable areas, it is difficult to expect high returns in serious games for educational purposes, making it difficult to attract investment. Therefore, most serious games are made low-quality because they are made at low-power and low-cost compared to commercially made games. The quality of serious games is insufficient because today's students, who have been accustomed to high-quality games by accessing the Internet since childhood, have fun.

Accordingly, as Europe develops in the direction operated by the European Schoolnet, it proposes two methods instead of using serious games with low accessibility and low quality as a material for game-based learning. The first is a way to support teachers to develop their own games to use in class. Scratch, Univy, Godot, and Game Maker Studio were recommended as engines for easy game development, and introduced ways to easily produce games in the form of drag and drop. Second, games that can be used for education are introduced by dividing them into expected effects, genres, prices, and appropriate ages [2]. As shown in Table 1, more than half of the top nine items in the list of inconveniences experienced by teachers in game-based learning surveyed in the past were related to finding games to be used for education[1].

Table 1. *Inconveniences experienced by teachers who attempt game-based learning*

Rank	Reason
1	Cost and licensing
2	Timetable of the school
3	Finding suitable games
4	Attitudes of other teachers
5	Training and support
6	Inappropriate content
7	Worries about negative aspects
8	Insufficient evidence of value
9	Examinations

In addition, teachers who are not ICT majors will choose the direction of choosing among games that have already been created, even if they help someone make games easier. Recognizing this, EUN used a means to select games based on various conditions among commercial games, collect cases through pilot introduction, prove their

effectiveness, and present appropriate games. The conditions for EUN to select a game are as follows.

- Games should be accessible online, on mobile devices, and on the desktop.
- Games are evaluated scientifically as much as possible to understand their effects on learning, motivation, and emotions.
- Games should be suitable for elementary and secondary levels.

With these conditions, the EUN classified the learning field and recommended about 70 commercial games [2].

2.2 Prior Research

The factors that game-based learning studies mainly focus on can be classified as follows.

(1) Learning subject

Wi Jung-hyun has proven its effectiveness by combining games with various subjects such as math [12], English [13], economy [14], and politics [15]. Wi Jung-hyun's characteristic of game-based learning research is that he uses online games. Online games have positive aspects such as social efficacy and formation of a community culture in relationships in games [16, 17], but adults such as teachers and parents have strong negative perceptions of game addiction, school maladjustment, and increased aggression [18, 19]. Nevertheless, he mainly borrowed online games because he highly appreciated the effects of advantages such as solidarity, homogeneous consciousness, and satisfaction through communication of online games on learning.

The subject that is most studied as the central material for game-based learning is the field of information and computer [20]. The computing thinking skills required when playing games can lead to natural computing thinking learning [21]. The theoretical basis for improving computing thinking skills such as problem solving [22], algorithm building [23], and socialization [24] through various interpretations of game-based learning was studied.

(2) Game genre

It is the most studied simulation genre in previous studies, and research types can be classified into three types. First, there are types that studied the rationale for the suitability and applicability of simulation games as learning methods [25, 26], second, types that verify the effectiveness of simulation games [27, 28], and third, types that provide specific data or develop instructional models to apply simulation games to actual classes [29].

The types of research on game-based learning based on the MMORPG genre can be divided into those that improve the effectiveness by changing the composition of the game [30] and those that connect to the learning subject using the elements of the game [31].

Kim Young-cheon analyzed the educational effect and satisfaction of the management simulation genre called Tycoon, identified success factors, presented a development methodology [32], and studied cases of use in start-up education [33].

(3) Learners characteristics

In general, game-based learning research is conducted by designating a specific group, but similar results are obtained even when experimenting with another similar group. The learner's characteristic here refers to the subject of a study that becomes meaningless when the characteristics of the experimental group change. In particular, studies targeting infants [34], the elderly [35], and the disabled [36] are difficult to cite the results of the studies in other game-based learning studies due to the specificity of the subjects. In

addition, learning necessary for vocational training or special circumstances was also classified into this type.

(4) Proof effect

Researchers also focus on the dependent variables influenced by game-based learning. Among them, academic achievement [37], interest [38], immersion [39], efficacy [40], and learning motivation [41] can be cited as representative variables. Among them, this study proved its effectiveness by investigating interest, immersion, and academic satisfaction.

(5) Perception

This type of research investigates the perceptions of game-based learning such as prejudice, attitude, dissatisfaction, and acceptance intention. In most cases, teachers, students, and parents are surveyed, and there are types of asking if they are willing to try [42, 43], and there are types of asking why they are not trying [44, 45].

2.3 Perception of game-based learning

Game culture still tends to be perceived negatively, and some think that children are addicted to games and should be controlled. However, as generations change and the spread of the Internet and smartphones increases, games have become a universal leisure culture, and children are more likely to access games, so it is desirable to induce them to teach how to use them correctly rather than strict regulations.

Games are sometimes used in education, but they are only at the level of "Gamification" in which game elements such as competition and interest are added to general teaching methods, and classes using digital video games are rarely attempted. Even if the perception of games held by teachers and parents is strong in the negative aspects and some people view them positively, it is a difficult problem to persuade those who oppose them when using games in class.

Research on education using games can be subdivided into various fields such as "game-based learning," "educational games," and "game making activity," but terms are not systematized, software education in elementary schools since 2018 includes basic programming courses, which require students to program and produce games themselves, but there is still a lack of awareness and interest in game-making learning [43].

Park Hyung-sung and Park Sung-deok examined the perceptions of game-based learning by elementary school teachers by dividing the factors that need to be solved first into game-based learning and curriculum relevance, teacher preparation, teaching learning support, and administrative support [46]. First, it was found that it was difficult for most teachers to find educational games that were closely related to the curriculum, and it took some time to materialize them as teaching methods and use them properly in classes. Second, in the part of teachers' class preparation, teachers recognize that students' level of computer use does not have much effect on classes using games, but they feel difficult in selecting appropriate games suitable for learners' academic level. Teachers who do not usually encounter games recognized that they would feel a lot of pressure in using and preparing games for learning, and that they felt less difficult in terms of using games and other media in classroom classes than other media. As the existing teacher ICT utilization classes are gradually expanding to the educational field, instructional design using media is becoming more common in the use of facilities and instructional design, and games can also be seen as a tool and method for educational activities. In addition, the perception of the design and preparation of game-based learning is recognized as a new method different from the basic method, and there are not many guidance and information, so there will be considerable difficulties in designing classes. Third, with the perception of teaching-learning support, there was a great perception that information provision for game-based learning and appropriate guidance could not be provided, in detail, there is a

lack of instructional materials and instructional model guidance support for game-based learning design, it was recognized that detailed classification and information provision of educational game lists for each subject that can be used for instructional design were insufficient. It can be understood that due to the Korean situation, there is a need for an institution responsible for providing accurate and correct guidance on the educational game list and services on how to use it. As an early stage of movement for the development and spread of serious games developed for actual educational purposes, services for related information and guidance are insufficient [47]. Fourth, with the perception of administrative support, it is difficult to secure and support a stable budget for purchasing educational games, most of the contents were that the awareness of the facilities used, such as computer specifications and network speed, was not sufficient. Above all, it was investigated that it would not be easy to improve the manager's willingness and perception of the conditions of using games in class progress.

In Europe, research is continuing to incorporate cutting-edge technologies or creative concepts into education, centering on the EUN. According to a report published in 2009 by the EUN, No. 1, No. 3, and No. 6 among the top list of inconveniences experienced by teachers who attempt game-based learning are related to the selection of suitable game materials for education. In addition, it was interpreted that No. 2 and No. 9 were also indirectly related to game selection because there was room for improvement depending on the characteristics and content of the game [1]. And in the same report, as shown in Figure 1, the responses to open questions about why games are not used in education were grouped into 10 broad categories to analyze the ratio. Responses to questions were surveyed in the order of "difficulty integrating into curriculum," "lack of computer availability," "negative attitudes toward games," "lack of time," "lack of information and support," "technical problems," "cost and resources," "too many students in class," and "other obstacles."

Figure 1. *Reasons not to use games in education*

Similar problems are maintained in the perception of game-based learning surveyed in 2021. Polyxeni Kaimara surveyed students from 25 universities of education preparing for elementary and middle school teachers to identify five potential barriers that hinder game -based learning implementation [48].

Table 2. *Inconveniences experienced by teachers who attempt game-based learning*

Theme	Label	number of Responses
T1	Lack of financial resources	68
T2	Preference to traditional teaching methods and stereotypical perceptions about the value of digital games	65
T3	Lack of ICT training	63
T4	Lack of infrastructure	56
T5	Lack of policy and framework	24
	Total	276

The stereotype about the value of digital games here refers to distrust of educational ga me values and a lack of willingness to use irrational and modern teaching methods compa red to preferred teaching methods. Opinions such as negative policymakers' attitudes, curr iculum and education systems, stakeholders, education departments, curricula, education s ystems, and lack of time for teachers to include games in the course fall into the category of policy and framework shortage.

3 Research method

3.1 Research Participants Composition

In this study, the role of learners was played by a third-grade student attending a middle school in Gwanyang-dong, Anyang-si, Gyeonggi-do. The contents of the study were fully explained, 147 students who agreed to it were conveniently sampled, and the average grades of the middle and final exams of the history course learned in the second grade of middle school were investigated. After that, 147 people were divided into two groups, and the number of people was adjusted so that the average of the historical test results of each group was close, and it was divided into 74 experimental groups and 73 control groups(Levene isometric variance test F=.075 p=.785 t-test t=.074 p=.941). The experimental group experienced game-based learning in the form of watching game streaming, and the control group experienced game-based learning taught in the classroom according to the method of previous researchers.

The results of 112 people were finally analyzed, excluding 16 people who did not respond to some questions or responded insincerely in the learning interest, immersion, and satisfaction tests conducted before and after the experiment, and 5 people who expressed their intention not to attend. The final number of people distributed is as shown in Table 3.

Table 3. *Classification of learner groups*

Group	Number of Initial people	Number of analyze people	History test grade average	Class location
Experimental group	74	56	65.40	Streaming channel
control group	73	56	65.21	Classroom
Total	147	112		

Participants in the study, who will serve as instructors, recruited seven instructors to teach middle school history subjects with the support of an academy in Anyang, Gyeonggi-do, and an education company in Cheonan, Chungcheongnam-do. As for the recruitment conditions, it was required that the computer utilization ability to install and

execute the digital game on its own and that the game class be conducted for an hour every Saturday during the time when the learner can take the class. Only basic information on game streaming was delivered to instructors, and the instructor recommended to find and study the details on his own.

Table 4. *Information on study participants in the instructor role*

Classification name	Age	Career	Gender	Group in charge
A	34	9	F	Experimental group
B	33	5	M	Experimental group
C	27	4	F	Experimental group
D	29	4	M	control group
E	36	8	F	control group
F	34	3	M	control group

The personal information of the experiment participants is shown in Table 4, and the common points are that they teach middle school history subjects and that they have no personal broadcasting experience, but have enough computer literacy skills to carry out the researcher's instructions. As described in Chapter 2, game-based learning requires infrastructure such as teacher's ICT technology, computer equipment, and software. In addition, in this study, since streaming services are used, it was judged that research could not be conducted with the ability to utilize computers enough to require basic ICT education. Instructors' teaching skills can also be considered as dependent variables, but as in other game-based learning studies, the difference between instructors between groups was treated as a control variable, judging that increasing the sample amount of qualitative research would be more meaningful.

3.2 Game Selection

Among the methods that prove the effectiveness of game-based learning in previous studies, the methods mainly used include learning interest, immersion, efficacy, and academic achievement. Since learning interest and immersion are dependent variables that are greatly affected by the level of player knowledge, the smaller the difference in player knowledge among study participants, the simpler the variable analysis becomes [49]. Since the game-based learning to be studied here is premised on being available in public education, it is possible to link with what is learned in regular classes, and there should be no or minimized difference in knowledge due to private education among learners. In this regard, Korean, English, and math subjects show a large difference in level due to private education, but science, society, and history subjects, which are no less important than that and relatively non-private education, are expected to be the most suitable materials for the game, and among them, games based on history were selected as research tools.

In order to establish the basis for the game selection conditions, the game selection method of previous studies that studied game-based learning using commercial digital games was referenced. Sardone set the following criteria to select games to use in experiments to investigate the views of game-based learning held by teachers [50].

- Factors that involve players through the combination of fun and learning.
- Whether the contents of the game can be linked to the learning topic.
- Whether reasoning skills are needed
- Connection to the main curriculum standards
- Easy to access.

- Low cost($30~40)

Based on the basis of these preceding studies, the conditions of the game selected as the research topic in this study were defined as follows.

(1) The background of the times must be clear. Historical elements to be educated through games include characters, culture, and technology. Games with ambiguous game backgrounds are not suitable for history education because characters who do not survive at the same time appear at the same time, or because the backgrounds of the times do not match, and there is a risk of harming students' understanding.

(2) There should be no problem with historical testimony. As mentioned by Ki-duk Kim and Man-ki Moon, since the game is based on real history, there is a risk that learners may receive incorrect knowledge due to historical issues [51]. This is also true of historical distortions. Games that are expected to have fatal side effects when used in education were excluded from the study. The historical verification or distortion problem of the selected game was confirmed by referring to various Internet communities, developer interviews, and news articles.

(3) It should be possible to link with regular classes. In order to emphasize the necessity of learning and draw the learner's attention, it is advantageous that the subject matter of the game is related to the content learned in the textbook. Therefore, in the game to be used in this study, there must be an event or character to be linked among the contents covered in the history textbook.

(4) It should be easy to install over the web, and the price should be limited to $40 or less.

As a game that satisfies the above conditions, ‘Variant hearts: The great war’ was selected as the learning material.

Figure 2. *Game ‘Valiant hearts : The great war’ in-game screenshot*

The game ‘Variant hearts: The great war’ (Figure 2) is a game made with a scenario based on an anecdote that would have occurred between 1914 and 1918, when World War I took place. The protagonist of this game is not a war hero, but a peasant who was forcibly taken to the army due to the outbreak of war. The game tells the story of a conscripted soldier using the surrounding terrain to survive and escape from war. In the process, other surrounding comrades are killed by guns or shells, showing the tragedy of war.

The game begins with the assassination of Franz Ferdinand, just like in real history. The game begins with the history of Germany declaring war on Russia and the protagonist, an ordinary French farmer, conscripted into the military. Based on the historical facts that appeared in this process, it can draw interest in World War I, and induce the conscripted protagonist to sympathize with the suffering of war through his colleagues who were sacrificed while surviving the war. Since the protagonist is an

ordinary citizen, it is expected that students' empathy can be drawn more, and through this, re-enaction history learning will take place. The flow of the game begins with a story and circulates through a puzzle-action-story. This game is easy to purchase for about $15.

The contents of regular classes related to World War I can be found in Chapter 5, 'World War II and Social Changes' in textbooks for second graders in middle school. The prologue of the game begins by showing the beginning of World War I like a cartoon, and the textbook explains the contents as shown in Figure 3 on the first page of the learning unit.

Figure 3. *Comparison of game prologue and textbook content*

3.3 Live Streaming Platform Selection

Live streaming refers to an online broadcast in which an Internet personal broadcasting person provides personal broadcasting in real time and communicates with viewers through real-time chat [52]. A platform with this method is called a live streaming platform, and a person who broadcasts on the Internet on this platform is called a streamers. The content of live streaming crosses a variety of topics from daily life covered on social media such as Instagram and Facebook to online video games. Non-live media, such as YouTube video clips, can technically be called streaming, but it is not live streaming. Representative live streaming platforms include Instagram live and YouTube streaming, but in this study, Twitch was selected as a live streaming service to be used for game-based learning.

Unlike other streaming platforms, Twitch is a live streaming platform that mainly deals with game content. Several companies, including YouTube Gaming, Facebook Gaming, and Mixer, are trying to provide customized services aimed at the game market, but Twitch has an overwhelming share in the live game streaming sector within this competition. As a game streaming platform, Twitch provides an independent broadcast category for individual games. Regardless of the type of game, it is different from the existing live streaming platform that handled game broadcasts in one category. In this respect, it was judged to be the most suitable platform for experiments conducted using game content.

Broadcasting programs such as Twitch Studio and Xsplit are required to broadcast on Twitch. In this study, OBS was used. Among the study participants, Instructor who are

broadcasting are explained in detail how to start Twitch broadcasting for game streaming, and learners They explained how to access the Twitch channel.

The Twitch expansion program 'Quiz Kit' was used to induce learner participation during the broadcast and to smoothly proceed with feedback from instructors and learners. As shown in Figure 4, "Quiz Kit" is an extension program in which a quiz set by a streamer is overlaid on a broadcast screen, and viewers can solve the quiz by interacting with clicking the screen like a button. The quiz may be prepared in advance before the broadcast or may be modified during the broadcast.

Figure 4. *Twitch broadcast screen overlaid with quizzes from 'Quiz Kit'*

3.4 Learner Inspection Tool

In this study, in-depth interviews are conducted to survey learners on learning interest, immersion, and satisfaction, and to survey instructors' perceptions of game-based learning. The survey was produced using Google Forms and conducted online. The question format was cited on the Likert 5-point scale to respond to 5 if the response was 'very yes' and 1 if it was 'very no'.

(1) Learning interest test

Yoon Mi-sun and Kim Sung-il developed a curriculum interest measurement tool that classified cognitive and emotional interest groups according to Schiefele's interest theory [53, 54]. The cognitive interest group refers to interest in learning content, subject value, and effort, and the emotional interest group refers to interest in the subject's competence and preference for the teacher in charge. In this study, a measure of learning interest was produced by applying a subject interest measurement tool. The highest score of learning interest questions was 80 points with a total of 16 questions, and when the Cronbach's α coefficient was measured to confirm the reliability of the scale, it was good at .766.

(2) Learning Immersion Scale

Jackson and Marsh produced the Flow State Scale (FSS) according to Csikszentmihalyi's immersion theory that the more proportional the individual's ability and task level are, the more immersive they fall into. Killi's Flow state scale, which modified and supplemented this Flow state scale (FSS) to suit game-based learning, was used in this study[55-57]. The immersion state scale consists of a total of 36 questions, 4 per area, according to 9 areas of challenge and skill balance, integration of behavior and perception, clear goal, immediate feedback, concentration on task, loss of control, self-consciousness, distortion of time, and self-purpose experience. Killi proposed to

supplement the 'integration of behavior and perception' among the immersion state measures with 'game ease'. The scale used in this study consisted of a total of 9 questions by reorganizing the immersion scale according to Killi's proposal and simplifying it into one question for each area. The Cronbach's α coefficient on this scale was found to be good at .897.

(3) Learning satisfaction test

The tool used to measure learning satisfaction was modified to suit this study by translating the English class student satisfaction scale using games developed by Yu and fellow researchers [58]. The learning satisfaction measurement tool consisted of a total of 12 questions, and the Cronbach's α coefficient of the measurement tool was .811, which was good.

(4) Instructor's perception interview

Instructor's perception interview is a qualitative study that investigated the perceptions of game-based learning through in-depth interviews with participating professors. The questionnaire was prepared by referring from the inconveniences of teachers using game-based learning surveyed in 2009 [1] to teachers' experiences, attitudes, self-efficacy, and cognitive barriers surveyed in 2021 [49, 59].

This survey was conducted on learners twice before and after the game-based learning experiment, and the questions were finely different in consideration of the game-based learning experience generated by the experiment. Detailed questions are attached to the appendix.

3.5 Experimental Procedure

Before starting this experiment, a formative evaluation is conducted to review the composition of the experiment, and the instructor sets the learning goal for each week while checking the contents and scope to be linked with the textbook while practicing a pre-selected game, and considering time, the progress of the game was distributed.

Formative evaluation was divided into expert review and user review, and C, a research participating instructor to conduct classes, and one middle school history teacher in Guro-gu, Seoul, helped as an expert. Two of the study participating learners were arbitrarily designated as users, and experts and users played their respective roles, discussed experimental procedures designed through interviews, and revised and supplemented the goal setting steps.

Table 5. *Class scope and learning objectives by week*

Time	Progress of the game	Learning objectives
1 Week	Prologue ~ British Army's attack on Neuve Chapelle	From the prelude to World War I to the Battle of Neuve chapelle in 1915
2 Weeks	German forces spray Ypres poison gas ~ bombing of Reims Cathedral	From the poison gas used by the Germans at the Battle of Ypres in 1915 to the bombing of the Notre Dame Cathedral in Reims
3 Weeks	Taxi requisition in Paris ~ Treatment of wounded soldiers in Ypres	Description of the requisition of supplies using taxis during the war and various treatment methods during the war
4 Weeks	Battle of Verdun	Describes the beginning of the Battle of Verdun in 1916 and the capture of Fort Duomont
5 Weeks	Recapture the Duomont Fortress	Description of the process of retaking Fort Duomont occupied by German forces
6 Weeks	Construction of the Buqua Mine Base ~ Escape from the French POW camp	Tunnel development and underground warfare using the mines of the French village

		of Bucua and the structure of the French concentration camp explained
7 Weeks	Battle of Som ~ Battle of Vimy Ridge	From the Battle of the Somme in 1916 to the Battle of Bemy Ridge in 1917, and the participation of Canada and the United States in the war.
8 Weeks	Failed Nivelle Offensive ~ Ending	In the Second Battle of Yen in 1917, the French commander-in-chief Nivelle's operational failure caused the soldiers to revolt, and the soldiers who protested were executed

Game-based learning classes were conducted over a total of 8 weeks, and the contents and learning goals of each week were organized as shown in Table 5. The game-based learning class progress model was used by modifying the course of the game-based political class conducted by Wi Jung-hyun in elementary school according to the contents of this study [15].

The control group presented tasks according to the contents of the game played in the corresponding week by the instructor and explained the game based on historical facts. The learner was instructed to organize the contents learned that day while performing the suggested task and to write a report about the class. On the other hand, the experimental group explains what learning goals the instructor will play while playing the game himself. Since then, the role of the instructor is more important than the control group because it explains and communicates according to the content of the game.

In the experimental group, the learner summarized what he learned on that day by solving the 'Quiz Kit' problem set in advance by the instructor while watching the game played by the instructor. The quiz was conducted with 10 questions every week, and participation was induced by presenting a small amount of convenience store gift certificates to learners with the highest score every week. On the other hand, in the control group, this process was substituted by the instructor asking questions offline.

While the learners in the experimental group were taking streaming classes, those who did things that might interfere with other students' listening to classes, such as profanity or paperwork, were controlled by the second chat ban function after the first warning, and all other broadcast participation activities were left to be free.

Every week, about 10 minutes before the end of the class were spent checking whether the learning goals set for the week were achieved, and during that time, the instructor recommended giving feedback on all questions as much as possible, allowing learners to ask questions.

In the course of the experiment in this study, the experimental group and control group members were not disclosed what kind of experiment was conducted in each group, and the participants were instructed to keep the contents of the experiment a secret. The reason was to prevent the members of the experimental group from feeling deprived, who did not have the opportunity to directly play the game, considering that the learners participating in the study were young students.

4 *Effect of game streaming based learning on learners*

4.1 Survey data analysis procedure

Before comparing the experimental group and the control group, the results of previous studies were compared to determine whether the traditional face-to-face game-based learning experienced by the control group had a positive effect on the learner. It can be assumed that the game-based learning experience conducted in this study is also

successful if it reaches the level that previous researchers report as being successful as an experimental result.

In previous studies, a method to verify the effectiveness of game-based learning is to prove the effectiveness by using the pre-post variance of the dependent variable as an index and to compare the experimental group and the control group. In this study, to verify the effectiveness of the control group, it was verified whether game-based learning was designed to be effective by comparing the amount of change in learning interest, immersion, and satisfaction of learners before and after the experiment. Paired t-test was performed to compare the pre-post test results for each variable in the control group with the results of other previous studies.

Table 6. *Pre-post paired t-test of learning interest, immersion, and satisfaction of control group*

Time	Pre-inspection		Post-inspection		Error	t	p
	M	SD	M	SD			
Interest	2.34	.3925	2.67	.4488	.3326	-18.169	<.001
Immersion	3.46	.4163	3.92	.4453	.4623	-18.167	<.001
Satisfaction	2.40	.3665	3.39	.3814	.9911	-13.508	<.001

Jung-hyun Wi conducted economic learning using online games targeting 5th graders of elementary school and investigated efficacy and interest [15]. Among them, the interest in economic learning was surveyed as 3.37 in the pre-test, 3.67 in the post-test, and .30 in the difference(t=-4.80, p<.001), It showed a slight difference from the difference of .3326 in the pre-post learning interest test performed by the control group in this study.

Soo-in Kim conducted a game-based design class for first-year middle school students and measured pre-post learning immersion [60]. Kim Soo-in used Kim Hee-jung's learning immersion scale, which was written based on the immersion state scale suggested by Csikszentmihalyi, and used a total 29-item immersion scale in the investigation [61]. As a result of the investigation of she's study, the pre-test 3.035 and the post-test 3.750 showed a difference of .715(t=-5.782, p<.05). This difference shows a significantly higher score than the .4623 difference in the pre-post immersion test of the control group in this study.

Jonghwan Kim investigated the effects of game-based learning on copyright awareness and learning satisfaction among middle school 3rd graders [62]. Of these, the learning satisfaction survey used a scale with the same structure as in this study with 12 questions. Learning satisfaction test was conducted between the experimental group performing game-based learning and the comparison group performing traditional face-to-face learning, and the average of the comparison group was found to be 50.54, 11.94 points higher than the average of 38.6 points (t=21.57, p<.001). Learning satisfaction test was conducted between the experimental group performing game-based learning and the comparison group performing traditional face-to-face learning, and the average of the experimental group was found to be 50.54, 11.94 points higher than the comparison group average of 38.6 points.

Table 7. *Demonstrating the effectiveness of the control group*

Previous researcher	Research variable	Previous research score	Control group score of this study	Error	hypothesis
Jung-hyun Wi	Interest	.30	.3326	.0326	Accept
Soo-in Kim	Immersion	.715	.4623	-.2527	reject
Jonghwan Kim	Satisfaction	.995	.9911	-.0039	Accept

Of course, the research summarized in table 7 does not represent the effect of game-based learning, but these are studies that prove the effectiveness in each subject area and claim that previous researchers are successful. Regarding the hypothesis that the control group's game-based learning is effective, among the dependent variables, the interest and satisfaction variables showed satisfactory comparison results, but the immersion variable showed a large difference from the scores of previous studies, so it is difficult to say that it is valid. However, based on the fact that the difference between the pre-post survey results of the interest factors analyzed through the control group paired t-test in Table 6 was valid (t=-18.167, p<.001), it was assumed that there was a weak effect and caution was taken in the interpretation of the results.

For a reliable comparative analysis of the control group and the experimental group, it was confirmed through t-test whether both groups were homogeneous before the experiment. The Levene test for the identity of the error variance is interest = 9.837, p=.002; Immersion =.191, p=.663; Satisfaction =.852, p=.358, the t-test was conducted without assuming an equal variance for the interest test.

Table 8. *Control group-Experimental group pre-test items t-test*

Time	Control group		Experimental group		Error	t	p
	M	SD	M	SD			
Interest	2.34	.3925	2.46	.5316	-.1239	1.403	.164
Immersion	3.46	.4163	3.45	.4200	.0059	-.075	.940
Satisfaction	2.40	.3665	2.37	.3251	.0283	-.432	.667

As shown in Table 8, in all three factors, the significance probability p was higher than the significance level of .05, so both groups before the experiment were found to be homogeneous. Therefore, it can be proved that the difference between the experimental group and the control group appearing in the post-test after the experiment is due to the experimental treatment.

MANOVA was performed to prove that the difference was statistically invalid when the changes in the dependent variable of the two groups were compared in a complex manner after the experiment. To review the basic assumptions for MANOVA analysis, Pearson's bivariate correlation coefficient was first analyzed. As a result of checking the correlation coefficient between dependent variables, the correlation coefficient between interest and immersion was .690, and satisfaction was .005 with interest and correlation coefficient with immersion -.110, which was analyzed to be irrelevant to the two dependent variables. Accordingly, it was confirmed that it is appropriate to use MANOVA as an interest-immersion variable.

The identity test of the covariance matrix for each group and interest and immersion variables was conducted (Box's M=2.007, F=.656, p=.579), Levene test was conducted to confirm that the error variance of individual dependent variables was homogeneous for each group (Interest F=.095, p=.758; Immersion F=.036, p=.850). By satisfying the above assumptions, it was proved that there was no problem with the MANOVA analysis results.

Table 9. *Control group-experimental group post-test MANOVA results*

Dependent variable	Sum of squares	df	F	p	partial η2
Interest	2.34	.3925	2.46	.5316	-.1239
Immersion	3.46	.4163	3.45	.4200	.0059
Wilks' · λ = .989 F=.619 p=.541					

As a result of multivariate analysis of variance between the control group and the experimental group, excluding the satisfaction of the correlation among the variables examined after the experiment, as shown in Table 9, Wilks' λ= .989, F=.619, p=.541 the null hypothesis could not be rejected and the difference between the two groups was invalid. This means that game streaming-based learning, which is taught non-face-to-face, is as effective as game-based learning in previous studies conducted in class.

4.2 In-depth interviews with Instructor participating in the experiment

In this study, six participants experienced game-based learning by playing the role of instructors, three instructors conducted face-to-face classes in the class according to the game-based learning composition of previous researchers, and three instructors conducted non-face-to-face streaming classes. Although it is a small sample, we tried to gain persuasion about the possibility of development of this study topic by in-depth interviews with the instructors who participated in the study according to the composition of the experiment. Interviews were conducted using phone calls, video calls, and ZOOM, and the questions asked in the in-depth interview are shown in Table 10.

Table 10. *Teacher perception in-depth interview questionnaire on game-based learning after experiment*

Type	Question content
Stereotypes	What do you think about the game?
	What do you think about teaching with games?
Value distrust	What do you think game-based learning is better than traditional teaching methods?
	What side effects do you think game-based learning will have?
Lack of support	Do you think ICT education is necessary to do game-based learning?
	How much money do you think you need to do game-based learning?
	What help do you need for game-based learning?

4.2.1 Interview with the instructor of the experimental group

Instructor A had the idea that the teacher's quickness and creativity would be necessary when attempting game-based learning, but said that it could be easily led by using Internet search, one of the advantages of non-face-to-face classes in experiments. The positive evaluation was given in that it provided material for communication with students, and the fact that parents were free to observe was difficult for the teacher, but thought that it would help to improve the perception of the game. She said that it was necessary to help teachers because real-time broadcasting was included in the experimental process, and mentioned broadcasting computer support as the amount necessary to introduce game-based learning. Instructor A had a positive perception of games from the beginning and felt vague fear because game-based learning was an unknown area that had not been attempted, but after the experiment, he felt easier and more beneficial than previously thought, so he actively encouraged the introduction of various subjects.

Instructor B thought that games could not replace the contents of textbooks, but after the experiment, he partially favored the introduction of game-based learning, saying that it would be good if the contents of textbooks were further explained or game-based learning for liberal arts classes was good. At the beginning of the experiment, he was concerned about not controlling students' chat, but as the second half of the experiment progressed, he saw a positive part of the chat, it was said that the more students adapted to the class, the more they used chat to participate in the class. It was said that education was necessary because of the large individual difference in ICT skills between teachers, and that smooth game-based learning could be attempted by investing only about $50 per student.

Instructor C said he had a preconceived notion about game addiction and did not intend to try game-based classes, but after the experiment, he felt that he was sufficiently educational and improved in favor of the introduction. Instructor C also mentioned the advantages of chatting. Chatting is easy to understand each other because records remain over time, and both questioners and respondents have time to organize their thoughts once. In addition, he answered that the cost of purchasing a computer or laptop was about $ 1,000 as the amount required to introduce game-based learning. She also mentioned the advantage that it is easy to share know-how because it is free to observe other classes, and he said that the teaching skills of teachers will improve quickly.

4.2.2 Interview with the instructor of the control group

Instructor D approved the introduction of game-based learning as he had experience using quizzes or competitions in class like a game, but expressed concern that students would focus more on the game itself than in class. In addition, it is expected that support for the computer room infrastructure at the class site will be needed, and the amount required for this would be more than $ 30,000.

Instructor E maintained a negative position, saying that the existing perception of the game was not good and that she saw more adverse effects in the experimental results. Learners seemed to be more focused than usual, but when she asked learners to play games with longer running times, she has confused about how to control them. About $ 10,000 was expected as the amount needed for the introduction, but it was said that help was needed to control learners or learn how to teach.

Instructor F said that the keyword that the perception of the game before the experiment was violent was dominant, but that it could be used in class if it was an educational game after the experiment. However, he felt difficult to manage a short class time, and since most games were not educational, he was worried about the side effects of game selection failure and opposed the introduction of game-based learning. Therefore, he wished that there would be more educational games, and expected that the cost of introducing game-based learning would be about the same as the development cost of educational games.

5 Discussion

This study was started to check whether game-based learning was as effective as the game-based learning designed by previous researchers when it was performed using a live streaming service and had an effect on improving the perception of game-based learning. The game to be used for the experiment was selected as a commercial game based on history, and instructors who would broadcast the game using a live streaming service and learners who would watch their game streaming class were recruited. Instructors qualitatively studied the perception of game-based learning after the experiment through in-depth non-face-to-face interviews, and learners investigated and compared learning

interest, immersion, and satisfaction before and after the experiment, and discuss the results as follows.

First, game-based learning conducted by the control group was as effective as previous studies. To prove this, the difference was confirmed by investigating the learner's learning interest, immersion, and satisfaction before and after the experiment, and whether the difference was significant compared to the game-based learning effect of previous studies. It was confirmed that the effect of game-based learning in this study was effective at the level of learning interest and satisfaction at the level of previous studies, and immersion showed significant differences through experiments, but fell short of the level of previous studies. Two of the three dependent variables were satisfied, the results of the immersion variable that was not satisfied with the conditions were also reported as valid for the control group's game-based learning because there was a significant increase in the score when comparing the results of the pre-post experiment survey.

Second, streaming game-based learning performed by the experimental group was as effective as game-based learning performed by the control group. When comparing the difference in the change in the dependent variable between the control group and the experimental group with MANOVA, the difference in the score change between the two groups was analyzed to be statistically invalid.

Third, it was analyzed that there is a correlation between interest and immersion among learning interest, immersion, and satisfaction investigated as an effect of game-based learning, but there is no correlation between interest and satisfaction, and immersion and satisfaction have no correlation with high probability. Both groups investigated showed that the difference in pre-post satisfaction level increased by 10 or more based on descriptive statistics, but the distribution of satisfaction among the individual dependent variables of each group did not form a linearity and did not show equal variance between interest and immersion variables. Considering the reliability of the analysis, satisfaction was not included in MANOVA, but from subjective interpretation, the difference in the amount of change in satisfaction between groups is clear. The difference between pre-post satisfaction of the experimental group was 13.49, indicating that the satisfaction level increased to a higher level than the difference between the control group 11.19. It is estimated that the cause of this difference is the relationship between the viewing experience of game streaming and game preference, and furthermore, the relationship between game preference, academic achievement, and satisfaction.

Next, the in-depth interview of the instructor was examined, and the change in perception of the changed game-based learning was investigated. The universal perception and preconceived notions of game-based learning surveyed by previous researchers are covered in section 2.3, and the participants of this study also had perceptions that did not deviate from the universal preconceived notions.

Table 11. *Organize the perceptions of the instructors on game-based learning confirmed through interviews*

Instructor	Pre-experimental perception	Introduction of regular classes	Acknowledge the value	Necessary finances
A	Positive	agreement	O	About $ 2,000
B	neutrality	Partial agreement	O	$50 per student
C	Negative	agreement	O	$ 1,000 over
D	Positive	agreement	O	$ 30,000 under
E	Negative	Opposition	X	About $ 1,0000
F	neutrality	Opposition	O	game production cost

Considering the interviews, the initial perceptions of each instructor and the perceptions they have after the experiment can be summarized as shown in Table 11. In this study, ICT ability was required to the extent that it was possible to participate in the experiment as a condition for recruiting instructors, although instructors have an opinion

that ICT education is necessary because the ages of instructors are distributed from their late 20s to mid 30s, it can be expected that it is not necessary for the research participating instructors themselves and is limited to the teachers around them.

In the interviews, instructors B and C had negative preconceptions about game or game-based learning, but their perceptions improved enough to approve the introduction of game-based learning into regular classes. And instructor E maintained a negative position, and instructors A and D maintained a positive position. Instructor F conducted the experiment with a preconceived notion that the game was violent, and confirmed the effects of learners' immersion and achievement during the experiment, but showed opposition to introducing game-based learning to regular classes, fearing that it would have more disadvantages than advantages.

The most notable thing in the interview was that the experimental group ranged from $1,000 to $2,000 in the topic of finance needed to introduce game-based learning, but the control group ranged from $10,000 to $30,000 or more. The reason for such a large difference in the amount of money is that Instructor who have already conducted non-face-to-face classes due to COVID-19 believe that the experimental group method can be introduced even with a similar level of communication medium, whereas the computer lab in schools This is because it is perceived that it is unrealistic to introduce game-based learning performed by the control group because there is a large difference in facilities between schools even if there is a computer lab.

In addition to necessary financial issues, the advantages of streaming classes that can be seen through interviews with instructors can be summarized as follows. First, when questions between instructors and learners come and go, it is possible to secure enough time to think before questions and answers due to the existence of the chat window. Second, since the Internet is always available, information that the instructor does not have is also available for education. Third, the way learners play games themselves is that when learners focus on games, they cannot focus on classes, whereas the more they focus on games, the better they participate in the class.

6 Conclusions

This study conducted game-based learning for middle school students using commercial history games to confirm the effect of game streaming-based learning on learners' learning interest, immersion, satisfaction, and instructor's perception. From the results of the study, it was found that game streaming-based learning had a positive effect on learning interest, immersion, and satisfaction, and a positive effect on the instructor's perception of introduction, value, and finance.

In the United States and Europe, research on game-based learning is led at the government level in the name of research and development of creative education. Creative education refers to teaching those who learn with new technologies and new ideas away from traditional face-to-face teaching methods. In terms of new technologies, we think the combination of gaming and live streaming is a very good subject for research and we argue should be actively studied. As a result of this study, if game-based learning is conducted non-face-to-face, the entry barrier will be lower in cost compared to the existing game-based learning composition, and since the number of learners that can be accommodated by one instructor is not limited, a plan in which a small number of instructors are dedicated to game-based learning becomes possible. Based on this, development into a way to cultivate game-based learning experts can also be considered.

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Appendix

Table 12. *Pre-post learning interest scale (linear magnification, 1-5)*

	Question
1	I like the way the history teacher teaches.
2	I think I should get good grades in history.
3	This history teacher's class is easy to understand.
4	I read a lot of other books about history, not textbooks or reference books.
5	History teachers and friends recognize my historical knowledge.
6	I am confident that I will know history well if I try.
7	I am confident in the history subject.
8	I think history education is essential.
9	I like this history teacher.
10	I am happy to increase my knowledge of history by studying history.
11	When I study history, I can concentrate well.
12	I spend a lot of time studying history.
13	If I become a teacher, I want to be like this history teacher.
14	I have a lot of questions about history.
15	I want to learn a little more difficult history.
16	In addition to what I learned in history class, I have a lot of knowledge I learned from books, broadcasts, and museums.

Table 13. *Pre-learning immersion scale (linear magnification, 1-5)*

	Question
1	I find the contents of the history class too difficult or not easy and appropriate.
2	I clearly understand what goals should be learned in history learning.
3	History classes provide adequate feedback on my learning behavior.
4	You can easily find the necessary content and information in history textbooks.
5	I feel that studying history is helpful to me.
6	I want to study history more.
7	I was able to concentrate completely on studying history.
8	While studying, I erased other people from my thoughts and didn't care.
9	Time seems to have passed faster than usual while studying history.

Table 14. *Post-learning immersion scale (linear magnification, 1-5)*

	Question
1	I found the content from the history game too difficult or not easy and appropriate.
2	I clearly understood what the goals should be achieved in the history game.
3	History games provided adequate feedback on my learning behavior.
4	It was easy to find and use the necessary functions and information in historical games.
5	I felt that historical games were helpful to me.
6	I want to play more history games.
7	I was able to concentrate completely on the game.
8	While playing the game, I erased other people from my thoughts and didn't care.
9	Time seems to have passed faster than usual while watching historical games.

Table 15. *Pre-learning satisfaction scale (linear magnification, 1-5)*

	Question
1	I enjoy taking history classes.
2	I like textbook-oriented classes.
3	Learning from textbooks is effective.
4	The learning problems in textbooks are satisfactory.

5	I hate studying history.
6	I fully understand the historical content in the textbook.
7	I like to study using textbooks.
8	I am satisfied with the teaching method of most subjects that are taught with textbooks.
9	I don't need a new study method other than textbooks.
10	Classes using textbooks suit me well.
11	I am satisfied with what I have learned in my usual class.
12	Usual class is not very helpful to me.

Table 16. *Post-learning satisfaction scale (linear magnification, 1-5)*

	Question
1	I was happy to participate in game learning.
2	I like classes using games like this.
3	Learning using games is effective.
4	I was satisfied with the mission in the game.
5	I hate this kind of game activity.
6	I fully understood the historical events in game learning.
7	I like to study using games.
8	I think all subjects should be taught using games.
9	I was happy to try out how to study using games.
10	Classes using games suit me well.
11	I am satisfied with what I learned in this class.
12	Classes using games are not very helpful to me.