Effects of Networked Interactivity in Educational Games : Mediating Effects of Social Presence

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Abstract

Networked interactivity is one of the essential factors that differentiate recent online educational games from traditional stand-alone games. However, despite the growing popularity of online educational games, empirical studies about the effects of the networked interactivity are relatively rare. This study tests the effects of networked interactivity on game users' subjective evaluation of learning (sense of competition, satisfaction, and perceived efficiency) and objective test performance in an online educational game. In addition, since the games facilitate virtual social interactions, this study investigates the mediating effect of feelings of social presence between networked interactivity and the evaluation of learning in the game. Results show that networked interactivity enhances positive evaluation of learning, test performance, and social presence. Furthermore, social presence strongly mediates the effect of networked interactivity on the evaluation of learning.

1. Introduction

After the remarkable growth during the last two decades, computer games (including console-based video games, arcade games, online games, and stand-alone computer games) are being increasingly used for serious purposes such as education, exercise, health campaign, and even business training [16, 23]. Computer games have been making their way into education and training with two parallel foci—learning (education) and fun (entertainment)—paving the way for the term "educational games" [44, 48]. Education-focused educational games are developed mainly to maximize educational benefits by providing explicit educational contents. Educational effects of these games, therefore, are direct and overt. On the other hand, entertainment-focused educational games are created primarily for entertainment with educational benefits as side effects. In these games, educational effects are covert and are facilitated through the "stealth learning" [37] process, a learning process in which learners becomes so immersed in playing educational games that they do not actually realize that they are learning academic subjects while playing games.

Educational games have potentials of making radical changes in learning methods from brick-and-mortar classroom education to "digital game-based learning" [36]. It has been found that digital game-based learning can provide many educational benefits such as increased motivation [10, 29, 32, 35, 48], better memory retention [33, 34, 40], intensive mental engagement [14, 36], and enhanced visual-spatial perception ability [1, 11, 12, 27]. Consequently, educational games are increasingly used for both children and adult education. For example, games such as *Jump*Start*, *Achieve Now*, or *Thinking Games* are designed for helping children learn school curriculum, whereas games such as *Search for Justice*, *Strategy Co-Pilot*, or *Learning Solitaire* are designed for special education and training for adults.

With the almost ubiquitous existence of Internet connection and the wide diffusion of personal computers at home, educational games are increasingly designed to take advantages of almost ubiquitous "networked interactivity"—interactivity made possible by real-time network connection (see [39])—at home. These newly developed online educational games (see funbrain.com for a list of example) connect game users to other game users and let them either compete against or collaborate with each other to accomplish educational goals. Despite the growing popularity of online educational games and recent theoretical arguments for possible benefits of those games [7], empirical studies about the effects of online educational games are relatively rare. As a result, it is unclear how networked interactivity affects students' subjective evaluation of learning and objective test performance. Given that networked interactivity is one of the essential factors that differentiate recent educational online games from traditional off-line educational games or software, the role of networked interactivity in educational games should be carefully investigated. The current study tries to fill the missing link in the current literature by empirically testing the effects of networked interactivity in educational games on game users' subjective evaluation of learning and objective test performance.

In addition, the current study tests the mediating effect of feelings of social presence (see the later section for a detailed discussion on this concept) on the evaluation of learning in the educational games. The concept of social presence has been a key issue in the study of virtual social interaction

made possible by new communication and information technologies such as virtual reality systems, the Internet, mobile devices, and online games [2, 5, 28, 19, 47]. Given that online educational games have largely been designed to facilitate online social interaction between teachers and students or among students, the concept of social presence can be effectively applied to measure the effectiveness of online educational games. Following some recent findings on the mediating effects of social presence in virtual social interaction (see [21, 22, 24]), we test whether feelings of social presence during game playing mediate between networked interactivity and evaluation of learning.

2. Previous literature and hypotheses

2.1. Effects of networked interactivity in edu-games

The concept of interactivity has been explicated based on three major viewpoints—technology oriented, communication-setting oriented, and individual oriented views [20]. Among them, the current study adapts the technology-oriented view of interactivity, because this study technologically manipulates the existence of real-time network connection during game playing in order to test the effect of networked interactivity. Technology-oriented view of interactivity defines interactivity as a characteristic of new technologies that makes an individual's participation in a communication setting possible and efficient. For example, Steuer [46] argues that interactivity is a stimulus-driven variable which is determined by three technological structure of the medium—speed (the rate at which input can be assimilated into the mediated environment), range (the number of possibilities for action at any given time), and mapping (the ability of a system to map its controls to changes in the mediated environment in a natural and predictable manner). According to Steuer [46], interactivity is "the extent to which users can participate in modifying the form and content of a mediated environment in real time" (p. 84). As a subtype of general interactivity, networked interactivity in educational games can be defined as interactivity made possible by real-time continuous network connection between and among students and teachers.

Networked interactivity in educational games can significantly enhance learning for the following three reasons.

First, networked interactivity in educational games can create a strong sense of competition or collaboration (depending on game context) during game playing. Users of online educational games can vividly feel the existence of other users while they are playing games through real time network connection (see [7] for a similar argument). Instant updates on the performance (e.g., scores, level accomplishment, game item acquisition) of other game users can enhance the sense of competition among students. Students can also feel strong sense of collaboration, if the game they are playing requires them to collaborate with other users (including both teachers and other students) through various real time communication technologies (e.g., instant messaging, chatting, avatar-based communication, etc.).

Second, networked interactivity in educational games can enhance game users' general satisfaction and memory retention. Although not done in game contexts, previous studies on online instructional tools indicate that networked interactivity in online instruction can enhance students' satisfaction and retention [9, 45]. In addition, previous studies on educational games show that the delivery of educational content via the form of computer/video games can motivate students to be actively engaged in the learning process [41, 43]. Considering that students are increasingly becoming familiar with computer-mediated-communication (CMC) and online entertainment [7], online educational games enhanced by networked interactivity might lead to even better educational outcomes than off-line educational games by actively engaging students in the learning process [3].

Finally, networked interactivity in educational games can offer instant feedback and customized instruction on real time bases. Feedback in learning process is crucial in improving student's performance and motivation [25, 51]. While traditional classroom-based education settings can hardly provide instant feedback and customized instruction to each student, online educational games can provide instant feedback and customized instruction to each student based on his/her performance during game playing. Users of online educational games, thus, can have a better chance of efficiently mastering a subject matter by studying their customized instruction repeatedly while skipping instructions for materials that they already know [10]. Therefore, networked interactivity in educational games can provide an efficient learning mechanism to students.

Based on the claims and findings examined above, this study tests the effects of networked interactivity in educational games on various educational outcomes (e.g., sense of competition during learning, satisfaction with a learning method, perceived efficiency of a learning method, and memory retention [as measured by test scores after game playing]) by comparing three different learning methods—online educational game vs. off-line educational game vs. traditional classroom lecture (see the Method section for details on the manipulation of each condition). More specifically, the current study tests the following hypotheses:

Hypothesis 1: Students will have a stronger sense of competition, higher satisfaction, more perceived efficiency, and better test scores when they use an online educational game, than when they use an off-line educational game.

Hypothesis 2: Students will have a stronger sense of competition, higher satisfaction, more perceived efficiency, and better test scores when they use an online educational game, than when they passively participate in a traditional classroom lecture.

2.2. Social presence in educational games

The concept of presence, which is defined as "a psychological state in which virtual objects are experienced as actual objects in either sensory or non-sensory ways" ([19], p. 27), has great relevance to the design and evaluation of media products and computer interfaces, especially in entertainment (e.g., books, radio, movies, television, virtual reality systems), communications (e.g., telephone, video-conference, Internet, computer-supported-collaborative work), and education (e.g., simulation training, online education, virtual campus).

Among various types of presence (e.g., physical presence, social presence, and self presence), social presence is of particular importance in the context of online educational games, because online educational games try to maximize the social presence of other game users (including both teachers and other students) during game playing. Social presence can be defined as either "mental simulation of other intelligence" [5] or "a psychological state in which virtual (para-authentic or artificial) social actors are experienced as actual social actors in either sensory or non-sensory ways" [19]. In other words, social presence is the technology users' feeling that other (human or human-like) intelligences are interacting with or reacting to them while they are using technologies such as traditional media, computers, or telecommunication devices (see [5]). In the context of online educational games, social presence can be further defined as game users' feeling that other users are interacting with or reacting to them when they are playing online educational games.

Feelings of presence play an important role in mediating technology users' evaluation of and responses (cognitive, affective, and/or social) to the given technology (see [19], [28] for general reviews of the effects of presence). Previous studies provide compelling evidence for the mediating effect of presence in the context of e-commerce [18], speech user interfaces 21], human-robot interaction [22, 24], and entertainment games [20]. Especially in the context of entertainment games, Lee and his colleagues found that the enjoyment and evaluation of video games are mediated by feelings of presence (especially social presence) during game playing.

Based on the above studies, we set the following two hypotheses on social presence in the context of a comparison between the two game conditions—online educational game vs. off-line educational game. We do not set hypotheses involving the traditional classroom lecture condition, because social presence is about virtual experience, and does not concern real experience such as traditional classroom experience.

Hypothesis 3: Students will have stronger feelings of social presence when they use an online educational game, than when they use an off-line educational game.

Hypothesis 4: Students' feelings of social presence during game playing will mediate their game evaluations (e.g., sense of competition, satisfaction, and perceived efficiency).

3. Methods

3.1. Overview

The experiment was a one-way three group comparison (online educational quiz game vs. off-line educational quiz game vs. traditional classroom lecture) between subjects design. Participants in the "online educational quiz game" and "off-line educational quiz game" conditions played English quiz game developed by Toeicnet.com (www.toeicnet.com) for 45 minutes. The quiz game asked basic TOEIC (Test of English for International Communication) questions and provided a detailed explanation for each question if participants wanted.

The key difference between the conditions was that participants in the online condition were able to see the performance of the other three anonymous users on a real time basis, whereas participants in the offline condition played the quiz game alone without monitoring the performance of other users (see Figure 1 for a screenshot of the online game condition, and Figure 2 for a screenshot of the off-line game condition). Participants in the "traditional classroom lecture" were in a classroom in which a teacher provided a lecture on the same TOEIC questions that participants in the game conditions solved. The lecture was 45 minutes and explained 20 TOEIC questions. The teacher in the traditional classroom condition had more than three years of experience in teaching TOEIC.

Before the experiment, the teacher rehearsed her lecture multiple times to ensure that she explained 20 TOEIC questions in 45 minutes with the exactly same explanations provided in the game conditions. Therefore, the contents of explanations for all questions were exactly same across all three conditions. Since participants in the game conditions could answer all 20 questions in less than 45 minutes, an extra set of 20 questions which were slight variations of the original 20 questions were provided for the game conditions. The extra 20 questions were about the same English grammar issues that were covered by the original 20 questions. Therefore, the explanations for the extra 20 questions were exactly the same as the original 20 questions.

To sum up, the three conditions were differ in two ways from participants' viewpoints. First, participants in the two game conditions were able to focus on questions that they incorrectly answered while skipping explanations for questions that they correctly answered, whereas participants in the traditional lecture condition needed to hear all explanations for all 20 questions regardless of their performance. Second, participants in the online game condition were able to monitor the performance of other three game users on a real time bases (and at the same time,

they were aware of the fact that their performance was being monitored by other users), whereas participants in the offline game condition did not know the performance of other users. Other than that, participants in all conditions received the exactly same questions and explanations.

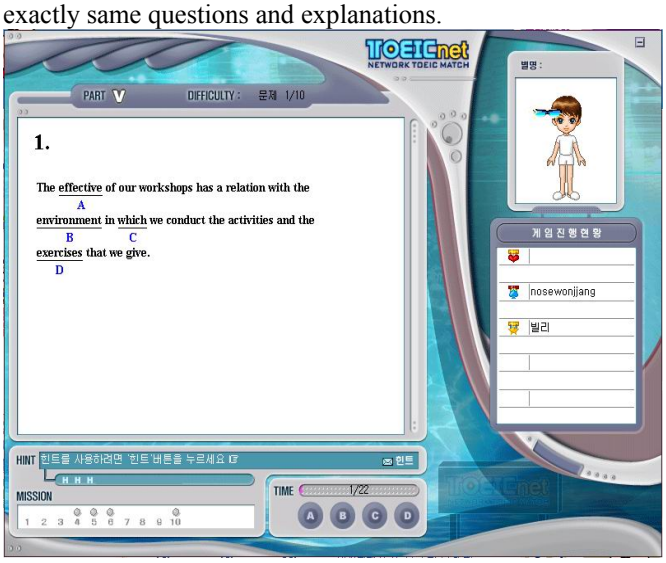

Figure 1 Screenshot of the online educational quiz game condition

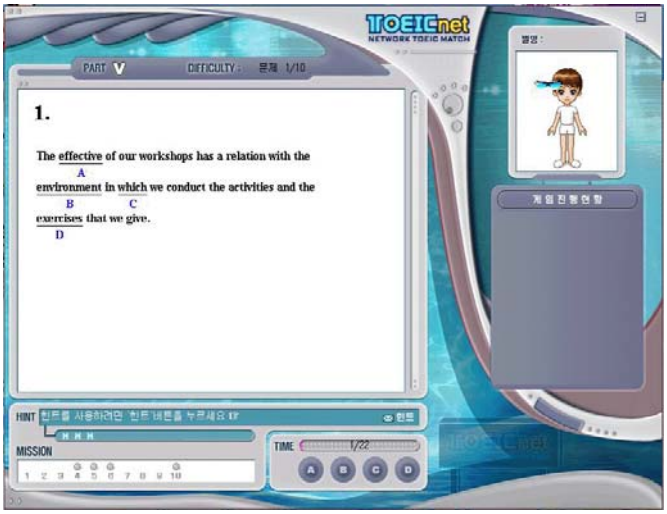

Figure 2 Screenshot of the off-line educational quiz game condition

3.2. Participants

Forty one participants (ages ranging from 19 to 26) were recruited from a major university in South Korea. Participants were in the study on a voluntary basis and they were randomly assigned to one of the three conditions—online quiz game (n = 14), offline quiz game (n = 14), and traditional classroom lecture (n = 13). In each condition, there were four male and nine or 10 female participants.

3.3. Procedure

All participants were asked to complete a pre-test questionnaire which was administered to ensure non-significant differences across the conditions with regard to general academic competitiveness, liking of English as an academic subject, perceived need for studying English, computer efficacy, positive attitude toward using computers for studying, and pre-test English test score.

A day after the pre-test, participants came to a computer lab or a classroom (depending on their conditions) and participated in the experiment for 45 minutes. After the experiment, participants filled out a posttest questionnaire measuring their general sense of competition during the experiment, satisfaction with and perceived efficiency of a particular learning method that they were assigned to, feelings of social presence, and post-test English test scores.

3.4. Measure

3.4.1. Pre-test

The following items were measured before the experiment as a pretest. All measures were highly reliable (see Cronbach's alpha for each measure).

General academic competitiveness was measured based on the level of agreement (1 = very strongly disagree, 10 = very strongly agree) with the following six statements: 1) In general, I feel inclined to compare my grade with other students; 2) In general, I frequently feel a sense of rivalry with other people; 3) In general, I am depressed when I feel I have less knowledge than other people; 4) In general, I enjoy competition with other people; 5) In general, I tend to concentrate more on my study when I see other people study hard; and 6) I would like to avoid competition with other people (reverse coded) (α = .74).

Liking of English as an academic subject was measured based on the level of agreement (1 = very strongly disagree, 10 = very strongly agree) with the following five statements: 1) It is interesting to study English; 2) I enjoy listening to lectures about English; 3) My favorite class is English; 4) I feel I have a talent for English; and 5) I am more confident in English than in other classes (α = .94).

Perceived need for studying English was measured based on the level of agreement (1 = very strongly disagree, 10 = very strongly agree) with the following five statements: 1) I think it is necessary to study English; 2) I think I need to be good at English; 3) I think I need to study English regularly; 4) I will study English harder; and 5) I will attend more English lectures (α = .88).

Computer efficacy was measured based on the level of agreement (1 = very strongly disagree, 10 = very strongly agree) with the following four statements: 1) I feel confident to use computers; 2) I feel confident to understand computer vocabularies; 3) I can easily learn new computer programs; and 4) I can easily deal with computer problems (α = .95).

Positive attitude toward using computers for studying was measured based on the level of agreement (1 = very strongly disagree, 10 = very strongly agree) with the following four statements: 1) I feel comfortable studying using a computer; 2) I am tired of studying using a computer (reverse coded); 3) I think it is efficient to study using a computer; 4) I enjoy studying using a computer (α = .86).

Pre-test English test score was measured based on the number of correct answers to 20 Basic TOEIC questions that were about the same grammar issues covered in the experimental conditions.

3.4.2. Post-test

The following items were measured after the experiment as a posttest. All measures were highly reliable (see Cronbach's alpha for each measure).

Sense of competition during the experiment was measured based on the level of agreement (1 = very strongly disagree, 10 = very strongly agree) on the following six statements: 1) I felt inclined to frequently compare my performance with other students while I was studying; 2) I felt a sense of rivalry while I was studying; 3) I was depressed when I felt I had less knowledge than other people while I was studying; 4) I enjoyed competing with other students while I was studying; 5) I became more concentrated on my study when I saw other students working hard while I was studying; and 6) I wanted to avoid competition with other students while I was studying (reverse coded) (α = .86).

General satisfaction with the learning method was measured based on the level of agreement (1 = very strongly disagree, 10 = very strongly agree) on the following ten statements about a particular learning method that participants were assigned to: 1) I was satisfied; 2) It was good; 3) It was easy to understand; 4) It gave me sufficient time to review; 5) It met my expectation; 6) I feel I learned something new; 7) It suited me well; 8) I was disappointed (reverse coded); 9) I will recommend it to someone else; and 10) It was useful (α = .93).

Perceived efficiency of learning method was measured based on the level of agreement (1 = very strongly disagree, 10 = very strongly agree) on the following five statements: 1) I think I benefited more from this learning method compared to other types of learning methods; 2) This learning method made me learn more in a short time compared to other types of learning methods; 3) This learning method was more efficient for me compared to other types of learning methods; 4) This learning method was more appropriate for me compared to other types of learning methods; and 5) I would like to study English using the method in the future (α = .97).

Social presence was measured based on the level of agreement (1 = very strongly disagree, 10 = very strongly agree) with the following seven statements: 1) I felt other students were close to me while I was studying; 2) I felt I was studying together with other students while I was studying; 3) I felt I was studying alone while I was studying; 4) I felt I was competing with other students while I was studying; 5) I felt other students were keeping track of my study and test results while I was studying; 6) I became interested in other students' performance while I was studying; and 7) I felt I was keeping track of other students' study and test results while I was studying (α = .84). Social presence questions were asked to participants in the two game conditions only.

English test score was measured using the number of correct answers to 20 English test questions.

4. Results

In order to check group equivalence, a series of one-way between-subjects ANOVA tests were conducted on the pre-test measures. In the pre-test, there was no significant difference between the three conditions with regard to general academic competitiveness, $F(2, 38) = .24$, $p = n.s.$, liking of English as an academic subject, $F(2, 38) = 1.73$, $p = n.s.$, perceived need for studying English, $F(2, 38) = 3.11$, $p = n.s.$, computer efficacy, $F(2, 38) = 1.07$, $p = n.s.$, positive attitude toward using computers for studying, $F(2, 38) = .32$, $p = n.s.$, and pre-test English test score, $F(2, 38) = 1.82$, $p = n.s.$ Thus, we can assume that group equivalence was maintained across the three groups.

In order to test H1 and H2, we conducted a series of one-way between-subjects ANOVAs with post hoc Tukey's tests. For H3, we used a simple two group comparison ANOVA. Finally, we conducted a path analysis to test H4.

Dependent variables	Means and standard deviations			F values and effect sizes
	Online	Offline	Lecture-based	
Sense of competition	7.06 (1.41)	4.84 (1.84)	3.82 (2.15)	11.35*** η2 = .37
Satisfaction with the learning method	7.29 (1.46)	5.50 (1.49)	5.33 (1.99)	5.96** η2 = .24
Perceived efficiency of learning method	6.83 (2.40)	4.69 (2.49)	4.90 (2.12)	3.52* η2 = .16
English test score	11.64 (2.56)	9.43 (2.28)	9.31 (2.02)	4.50* η2 = .19

Note. Standard deviations are in parentheses. $^{+}p < .10$, $*p < .05$, $**p < .01$, $***p < .001$.

Table 1 ANOVA Results

With regard to the sense of competition during the experiment variable, participants in the online game condition exhibited the highest sense of competition during the experiment ($M = 7.06$, $SD = 1.41$) compared to

participants in the non-interactive condition (M = 4.84, SD = 1.84) and participants in the lecture-based condition (M = 3.82, SD = 2.15), $F(2, 38) = 11.35$, $p < .001$, $\eta^2 = .37$. Follow-up post hoc comparisons using Tukey's test was conducted to evaluate pairwise differences with regard to sense of competition among the three conditions. There was a significant difference both between the online game condition and the off-line game condition and between the online game condition and the lecture-based condition in the 95% confidence interval. However, there was no significant difference between the off-line game condition and the lecture-based condition. We found the exactly same patterns—significant omnibus F test results followed by significant Tukey's tests results for the comparisons between the online game condition and the offline game condition and between the online game conditions and the traditional lecture condition—for the general satisfaction, the perceived efficiency, and post-test English test score variables (see Table 1 for details). Therefore, H1 and H2 were supported for all dependent variables.

With regard to feelings of social presence, there was a significant difference between the online game condition (M = 6.61, SD = 1.96) and the offline game condition (M = 3.77, SD = 1.69), $F(1, 26) = 16.79$, $p < .001$, $\eta^2 = .39$. Therefore, H3 was supported.

To test H4, a path analysis was conducted. In general, five criteria should be met in order to demonstrate mediation (Baron & Kenny, 1986, p.1177). The first criterion is that the independent variable should have a significant effect on the mediating variable. Secondly, the mediating variable should have a significant effect on the dependent variables. Third, the independent variable must have a significant effect on the dependent variables when the dependent variables are regressed on the independent variable without the mediating variable. Fourth, when the dependent variables are regressed on both the mediating variable and the independent variable, the effect of the mediating variable on the dependent variables should remain significant. Finally, the effect of the independent variable on the dependent variables should decline when the dependent variables are regressed on both the mediating variable and the independent variable.

In terms of the mediating effect of social presence in the comparison of the online game condition and the off-line game condition, the standardized β coefficient in the path diagram indicates that the independent variable—condition (we dummy coded this nominal level factor with "1" for the online game condition, and "0" for the off-line game condition)—significantly predicts the mediating variable—feeling of social presence ($\beta = .63$, $t = 4.10$, $p < .001$), thus satisfying the first criterion. The second condition could also be checked by looking at the significance of the standardized coefficient for each prediction. When the other dependent variables were regressed on the independent variable without the mediating variable, the group factor significantly predicted sense of competition ($\beta = .57$, $t = 3.57$, $p < .01$), satisfaction with the learning method ($\beta = .54$, $t = 3.23$, $p < .01$), and perceived efficiency of learning method ($\beta = .41$, $t = 2.32$, $p < .05$), meeting the third criterion. When the dependent variables were regressed on both the mediating variable and the independent variable, the effects of the mediator remained significant on all three dependent variables (sense of competition, $\beta = .76$, $p < .001$; satisfaction with the learning method, $\beta = .47$, $p < .05$; and perceived efficiency of learning method, $\beta = .38$, $p < .10$). Thus, the fourth criterion was also satisfied. The final support for mediation for the three dependent variables was obtained by demonstrating that the effects of the independent variable (group factor) on the dependent variables were significantly reduced (sense of competition, $\beta = .10$, $p > .10$; satisfaction with the learning method, $\beta = .24$, $p > .10$; and perceived efficiency of learning method, $\beta = .18$, $p > .10$). This indicated loss of their statistical significance after accounting for the effects of the hypothesized mediator (feeling of social presence). Therefore, the path model supports Hypothesis 4.

5. Conclusions

This study investigated the effects of networked interactive learning game on students' perception toward learning and test performance. To sum up, the results show that 1) networked interactivity between students in an educational game has positive effects on students' feeling of social presence, evaluation of learning (sense of competition, satisfaction, and perceived efficiency of learning method), and test performance; and 2) having a feeling of social presence during the game session mediates the effect of networked interactivity on the evaluation of learning. What follows is a discussion of the implications of the current study with respect to networked interactivity in educational games.

First, this study provides empirical evidence supporting the anticipated powerful effect of networked interactivity in educational games. More importantly, it was found that social interactions (i.e., competition) among students are important in enhancing positive evaluation toward learning and test performance: Students evaluated the learning more positively when they interact and compete with other people given the similar game interface in two conditions – online and offline gaming. It means that when the elements of game are employed, what spells the difference between the two conditions is whether or not there exists networked interactivity, which materialized social interaction and competition in the current study. Therefore, it can be said that the path analyses confirm that networked interactivity in educational games plays an essential role in enhancing students' positive evaluation of learning

Although the off-line game condition employed a similar game interface and provided instant feedback to students' performance, no social interaction and competition among students resulted in almost the same outcomes as the traditional lecture-based learning method. It means that non-interactive educational games can function only as a

complementary tool to the lecture-based learning, but not as a vehicle for radical transformations to enhance the effect of games in educational settings. This finding is contrary to Vogel, Greenwood-Ericksen, Cannon-Bowers, and Bowers' [49] finding that computer-assisted instruction without interactivity resulted in better outcomes (math scores) than a game-type instruction. However, in their study, interactivity meant just the interaction between the user and the intelligent program with gaming attributes such as feedback, score, and challenge without focusing on the interaction between students. Since the level of interactivity between the user and program determines the degree of involvement of the user in the activity [3], as Vogel and her colleagues [49] pointed out, careful tailoring of game design for higher interactivity is necessary to enhance gaming effects. Thus, practically, the developers of educational games need to focus on maximizing social interactions between students, which have not been fully utilized in computer-assisted instruction for decades.

Second, the current study shows that there are significant mediating effects of social presence between networked interactivity and evaluation of learning. Having social presence applies significantly to the variables of sense of competition and satisfaction with strongly mediating effects. Additionally, at the condition of networked interactivity, there was a marginally mediating effect of social presence on perceived efficiency.

Considering that networked interactivity in educational games takes an essential part in students' positive evaluation of learning, this result obviously shows that having a feeling of social presence helps students enhance evaluation of learning positively while playing an educational game. Additionally, the result explicates that social presence should be considered essentially in developing educational games with the networked interactivity.

Theoretically, the results of this study are in line with previous literature about the mediating effects model of presence in human-computer interaction studies such as e-commerce, speech user interfaces, human-robot interaction, and entertainment games [18, 20, 21, 22, 24]. Furthermore, the current study suggests that the mediating effects of social presence might apply not only to the domain of human-computer interaction, but also to other domains (educational games in this study) where technology-mediated virtual experience occurs. These findings, however, call for further investigation to elaborate the mediating effects of social presence in the context of educational games.

As a final remark, we would like to provide some suggestions for future studies. A limitation of the current study is that this was conducted in a Korean local university. In Korea, most students are eager to learn English to help ensure success in their future career, regardless of how they learn. This tendency might influence the effects of the game used in the current study. Future studies need to examine the effects of educational games tackling more diverse topics in other countries in order to validate and corroborate the present results. Another interesting extension of the current study would be to examine how much further the students' performance can be enhanced when their previous knowledge or test scores are in different levels. By showing the different degrees of improvement in students' performance, it would be possible to employ a customized educational game according to students' knowledge level or learning capacity.

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