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# Simulation Game-Based Learning for Middle School Students' Academic Emotions and Learning Achievement

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This study examined the effects of simulation game-based learning on academic emotions (positive, negative) and achievement (factual, conceptual, procedural knowledge acquisition). Sixty-three students from a high school located in South Korea were chosen for the study. The students were assigned to either an experimental group for simulation game-based learning or a comparison group for instructor-led lectures. The results demonstrated that there was a significant difference between the comparison and experimental groups in both positive and negative academic emotions. However, there was no significant difference in factual, conceptual and procedural knowledge acquisition. The results indicate that simulation game-based learning generates more positive emotions than instructor-led lectures.

*Keywords: Simulations, Game-based learning, Academic emotions*

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## Introduction

Technology has been widely employed in the educational field in an attempt to create a more effective, efficient, and engaging learning environment. However, there remains a gap between learning design and digitally native students who prefer a self-directed, enjoyable and socially connected experience (Prensky, 2001). That is, despite recent developments in technologies such as mobile, digital gaming and augmented reality, computers connected to projection screens often serve merely as replacements for blackboards in classrooms, presenting pictures or video clips. Consequently, students tend to listen passively to lectures (KERIS, 2012).

Simulation game-based learning as an alternative teaching method aims to close the aforementioned gap. In this study, simulation game-based learning is defined as a type of instructional method that utilizes critical elements of both simulation and game, such as goal-oriented and competitive activities and experiences for teaching and learning (Baek, 2006). According to Gredler (2004) and Sitzmann (2011), simulation game-based learning is a type of game-based learning, with game attributes such as fantasy, goals, rules, challenge, control, interaction and story. In contrast to other types of game-based learning, simulation taps into strategic decision-making based on simplified yet authentic conditions in a safe environment to achieve a goal. Simulation in this study refers to iterative simulations that enable learners to manipulate values and observe results (Alessi & Trollip, 2001).

Simulation game-based learning has great potential as a learning intervention for several reasons. First, it brings positive aspects of gaming into a learning context. Game-based learning has attractive and entertaining attributes (Anolli, Mantovani, Confalonieri, Ascolese, & Peveri, 2010; Garris, Ahlers, & Driskell, 2002). Especially, the emerging concept of serious game explores the possibility of combining games with education (Kim, 2012). A serious game is a computer-based game with learning as its primary objective (Michael & Chen, 2006). It also provides students with a pleasant and enjoyable experience, a critical issue in South Korea where students confront severe academic stress in highly competitive educational environments (KICE, 2012; Kim &Yang, 2011; Mullis, Martin, Foy & Arora, 2012). According to the 2012 PISA report, Korean students ranked the lowest on happiness in school, which precipitated recent concerns about the affective domain (PISA, 2014). Second, simulation game-based learning is rooted in the situated learning theory, which posits that learning is more meaningful when utilizing authentic tasks and real contexts (Choi & Hannafin, 1995; Howland, Jonassen, & Marra, 2012). In light of this theory, it is hypothesized that students using simulation game-based learning can actively construct their knowledge by manipulating data and making decisions to solve realistic problems. Therefore, the purpose of this study was to investigate the effectiveness of simulation game-based learning in terms of cognitive and affective learning outcomes.

## Theoretical Background and Hypotheses

In order to achieve the research purpose, academic emotion was selected as an affective outcome. Academic emotion is an emotional state triggered by a specific subject of stimulation and is comprised of enjoyment, pride, anger, anxiety and boredom (Kim, 2009). Unlike single dimensional variables such as motivation, interest or attitude, there is a benefit to understanding specific emotions that arise in classes. Further, studies report that academic emotions affect student motivation and the learning strategies they use to construct knowledge (Do, 2008; Pekrun, 2006; Yang & Kim, 2010). This study employed the theoretical framework on academic emotions suggested by Pekrun (2006), who designed a two-dimensional model for academic emotions: activating-deactivating emotions, and positive-negative emotions. Of 16 types of emotions, two positive (enjoyment, pride) and three negative (anger, anxiety, and boredom) emotions were selected, based on available theoretical and empirical evidence in simulation game-based learning contexts. For example, Astleitner and Leutner (2000) reported that game-based learning promoted enjoyment, while Anolli and colleagues (2010) claimed that simulation can facilitate self-efficacy, which can lead to lower anxiety. Pekrun, Goetz, Titz, and Perry (2002) reported that enjoyment, anger, anxiety and boredom are the most frequently observed emotions among learners in the course of learning.

Achievement, a key criterion for cognitive outcome, was also selected as a dependent variable. Achievement is defined as a degree of knowledge acquisition, and was categorized into factual, conceptual and procedural knowledge in this study, following Bloom's taxonomy (Krathwohl, 2002). Factual knowledge comprises basic elements that students must know to be acquainted with a discipline or solve problems in it, while conceptual knowledge embodies interrelationships between basic elements within a larger structure that enable the elements to function together. Procedural knowledge consists of how to do something, methods of inquiry, and criteria for using skills, algorithms, techniques and methods.

## The effects of simulation game-based learning on academic emotion

In the domain of game-based learning, previous studies have theoretically insisted that simulation games have a tendency to increase positive emotions such as enjoyment and pride, while reducing negative emotions such as anger, anxiety and boredom. For example, Anolli and colleagues (2010) provided the perspective that simulation games could reduce anxiety because simulation attributes incorporate various paths and answers. Simulation attributes also promote pride by employing game attributes, which encourage students to perceive failure as a process of challenge. Astleitner and Leutner (2000) suggested that a design strategy incorporating user-friendly interfaces and acceptance of mistakes could decrease the level of anger and fear associated with learning. Novak and Johnson (2012) reported that educational game elements such as feedback, challenge and storytelling cultivate the cognitive and affective aspects of students. Zhang and colleagues (2013) analyzed correlations between game attributes (concentration, clear goals, challenge, feedback, control, immersion) and academic emotions. Although theoretical and correlational relationships between educational games and academic emotions have been examined, an in-depth empirical investigation is required to determine cause-and-effect relationships.

## The effects of simulation game-based learning on achievement

Previous studies have reported that simulation game-based learning had significant effects on learners' achievements. Akinsola (2007) had positive results with an experiment in the domain of mathematics. Sowunmi and Aladejana (2013) evaluated three different instructional interventions, and the results showed that the simulation game and computer-assisted instruction groups had significantly higher achievement than the traditional instructional group. Sitzmann (2011) conducted a meta-analysis on 55 simulation game studies, which revealed that on average, the simulation game groups scored higher in the declarative knowledge domain (11%), procedural knowledge domain (14%) and retention domain (9%) than the comparison group. Based on interactive cognitive complexity theory, he concluded that simulation game-based learning simultaneously facilitated both emotional and cognitive processes, resulting in effective teaching. However, Sitzmann (2011) noted some exceptions according to the types of game and the instructional context. Van Eck and Dempsey (2002) raised the issue of the effect of competition in simulation game-based learning. In the experiment, participants in a noncompetitive situation had higher mathematics transfer scores when given access to contextualized advice (e.g., fix a house). Devlin-Scherer and Sardone (2010) interviewed teachers and students about their concerns regarding simulation game-based learning, and made note of phrases such as, 'Conveying inaccurate information through a game', 'Not funny', and 'Question about cognitive effectiveness of simulation game.' In sum, most studies reported that simulation game-based learning had a positive effect on achievement, but some exceptions and concerns persisted. Further investigations into various instructional situations are required to broaden the understanding of simulation game-based learning.

## Research questions and hypotheses

The purpose of this study was to examine the effects of simulation game-based learning on academic emotions and achievements. The significance of the study is two-fold: a) Student emotion is critical in the recent competitive learning environment, and results will provide insight on the use of attractive and entertaining game elements to facilitate learning in order to produce positive academic emotions. b) Investigations of achievements in terms of factual, conceptual and procedural knowledge can provide detailed suggestions for the use of simulation game-based learning in relation to learning goals. Eventually, the study results will provide practical implications for designing simulation game-based learning as well as theoretical justifications for the use of simulation games to create academic emotions. Research questions and hypotheses are as follows:

1) Are there any differences in academic emotions (positive, negative) between the simulation game-based learning group and the traditional lecture-oriented learning group?

HA 1)-1. There is a difference in positive academic emotion between the simulation game-based learning group and the traditional lecture-oriented learning group.

HA 1)-2. There is a difference in negative academic emotion between the simulation game-based learning group and the traditional lecture-oriented learning group.

2) Are there any differences in achievement (factual, conceptual, procedural knowledge) between the simulation game-based learning group and the traditional lecture-oriented learning group?

HA 2)-1. There is a difference in factual knowledge between the simulation game-based learning group and the traditional lecture-oriented learning group.

HA 2)-2. There is a difference in conceptual knowledge between the simulation game-based learning group and the traditional lecture-oriented learning group.

HA 2)-3. There is a difference in procedural knowledge between the simulation game-based learning group and the traditional lecture-oriented learning group.

# Method

## Research design

A quasi-experiment design was adopted to examine the effects of simulation game-based learning on academic emotions and achievements. Specifically, the independent variable was the use of simulation game-based learning (experimental group: simulation game-based; comparison group: lecture-oriented), and the dependent variables were academic emotion (positive, negative) and achievement (factual, conceptual, procedural knowledge). To ensure the internal validity of the experiment, researchers conducted the experiment in a relatively short period of 9 days. The homogeneity of the two groups was also confirmed in terms of entry-level academic emotions and prior knowledge. Preliminary analysis revealed that there were no significant differences between the experimental and comparison groups.

## Participants

Sixty-three students from a high school located in Seoul, a metropolitan city of

South Korea, were chosen by convenient sampling. Out of twelve second grade level classes, two classes were randomly selected and assigned for the treatment. In other words, the unit of random selection and assignment was class, not individual. Specifically, 32 students in a class were assigned to the experimental group with simulation game-based learning, and 31 in another class were assigned to the comparison group with traditional lecture-oriented learning (see Table 1).

The experiment was conducted in an economics class, as iterative simulation is well suited for learning economic concepts and principles, and the subject matter was ‘Finance and Economic Life’ (Park, Lim, Kim, Kim & Choi, 2012).

According to the pre-survey results, participants had no previous experience with the experimental intervention, which was a mock stock investment simulation game. All students in the experimental group were free to use computers at home and at school.

Table 1. Research participants

| | Treatments | *n* | Gender | |
|---|---|---|---|---|
| Experimental group | Simulation game-based learning | 32 | Male | 9 |
| | | | Female | 23 |
| Comparison group | Traditional lecture- oriented learning | 31 | Male | 8 |
| | | | Female | 23 |

## Materials

Content and instructor were identical for both groups. The only difference was the practice session, in which the experimental group used the simulation game, and the comparison group used paper-pencil-based exercises.

### Materials for simulation game-based learning group

Lectures and homework exercises for the experimental group were based on the simulation game called 'Mock stock investment simulation game' designed by the

Bank of Korea. This game was selected because it contains simulation game elements involving (a) reality, (b) choices and corresponding results, (c) non-linear structure, (d) trial and error, (e) goal-oriented activity, (f) rules, (g) competition, and (h) fun. Table 2 shows how specific simulation game elements were applied. The game contains learning content relevant to the module 'Finance and Economic Life', covering stock investment in a social study curriculum in Korea. The module includes key concepts related to stocks, a stock list, stock trading, an investment market, a distribution market and securities analysis, which are required for playing the simulation game.

Table 2. Simulation and game elements reflected in the simulation game

| | | Features of mock stock investment simulation game |
|---|---|---|
| Simulation elements | (a) Reality | Stock prices reflect the actual stock in the Korea stock trading market (KOSPI: Korea Composite Stock Price Index 200). |
| | (b) Choices and corresponding results | After company analysis, students can choose stocks and receive feedback in the form of return on investment (ROI). |
| | (c) Non-linear structure | Stock prices are dynamic and reflect the market situation, which exhibits iterative and non-linear progression. |
| | (d) Trial and error | Students can minimize investment loss risk because the purchase and sale of stocks is virtual. |
| Game elements | (e) Goal-oriented activity | Achieving the highest return on investment is the main goal in this game. |
| | (f) Rules | There are multiple rules such as "You can invest within your account balance", "All orders are calculated in sequence." |
| | (g) Competition | The top 15 students, ranked according to ROI, are announced every day at midnight. |
| | (h) Fun | The aim of the game is to learn finance (especially, the stock market) in a pleasant way. |


Figure 1. Screenshot of the simulation game website


Figure 2. Screenshot of the simulation game website for trading activity

The mock stock investment simulation game is an educational digital game developed for high school students (http://youth.bokeducation.or.kr/game/si/index2.do) that allows users to buy and sell virtual stocks for 40 companies. The stock prices reflect the real trading market, and the return on investment is calculated and announced at midnight every day. The instructor could control the amount of money students were allowed to invest in the game, and research participants were given a virtual wallet of $5,000 at the start of the simulation. Figure 1 is a screenshot of the mock stock investment simulation website, displaying an overview of the game and a brief description of key concepts for playing. Figure 2 is a screenshot of trading activity for the simulation game, providing information on return on investment for each stock, and the fluctuation of real stock prices. Users can also buy and sell virtual stocks using trading menus.

**Materials for traditional lecture-oriented group**

The comparison group received traditional lectures, although the scope of the contents and the instructor were identical to the experimental group. The comparison group was then assigned pencil-and-paper-based homework exercises, while the simulation game-based learning group participated in the simulation game. The scope of the contents in the pencil-and-paper exercises were similar to those in the simulation game and included information on stock trading. However, no simulation game components were provided to the comparison group at all. For example, students were asked to answer the question 'Which stocks do you want to invest in among the following companies?' or 'Let's analyze changes in the following company's stock price.'

## Measurement instruments

This study used three measurement instruments. First, academic emotions were measured using the Academic Emotion Questionnaire developed by Pekrun et al. (2011). Positive academic emotions were related to enjoyment and pride, while negative academic emotions were related to anger, anxiety and boredom. The Cronbach's alphas calculated using the study data were .95 for positive emotions, and .94 for negative emotions. A 6-point scale was used to avoid central tendency errors. Second, a prior knowledge test used to verify the homogeneity of the two groups was developed by two subject matter experts. Third, factual, conceptual and procedural knowledge acquisition was measured using instruments developed by the same two subject matter experts. Prior knowledge and achievement test items were validated by researchers and by an independent subject matter expert who is an economics teacher. Examples of the measurement instruments are illustrated in Table 3.

Table 3. Measurement instruments

| Variables | | Examples | Scale | # of items |
|---|---|---|---|---|
| Academic emotions | Positive | Enjoyment: I enjoy being in economics class.<br>Pride: I am proud of the contribution I have made in economics class. | 6 point Likert scale | 16 |
| | Negative | Anger: I feel anger welling up in me when learning economics.<br>Anxiety: I worry that others will understand more than I do in economics class.<br>Boredom: Because I get bored in economics class, my mind begins to wander. | | 24 |
| Achievement | Factual knowledge | What is the appropriate terminology for 'securities'? | Multiple -choice | 10 |
| | Conceptual knowledge | Which of the following statements about economic variables and the stock market is incorrect? | | 10 |
| | Procedural knowledge | What is the correct procedure for buying and selling stocks in the market? | | 5 |

## Procedure and analysis

First, researchers randomly assigned participants to experimental and comparison groups, then provided a 30-min orientation session for each educational method. Participants were asked to complete a pre-academic emotion questionnaire and prior knowledge test. Each group then participated in the intervention for 9 days. The experimental group received lectures and played the mock stock investment simulation game with the guidance of the instructor during two 80-min face-to-face sessions. They also played the game alone as homework. On the other hand, the comparison group received two 80-min face-to-face lectures given by the same instructor containing the same learning content, then completed pencil-and-paper-based homework alone during the experiment period. Finally, at the end of the experimental period, participants responded to the academic emotion questionnaire and the achievement test. Data were analyzed using an independent sample t-test and MANOVA. Details of the procedure are illustrated in Figure 3.

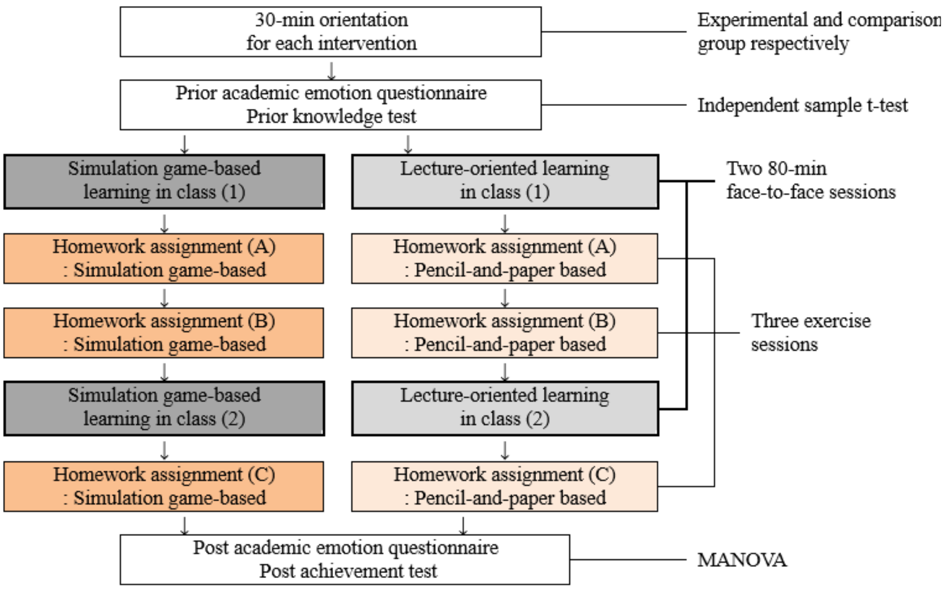


Figure 3. Research procedure

## Results

Table 4 illustrates descriptive statistics for pre-post academic emotion, and Table 5 contains the data for prior knowledge and achievement.

Table 4. Descriptive statistics for pre-post academic emotions

| Variables (Possible maximum) | | Group | | M | SD | Min | Max |
|---|---|---|---|---|---|---|---|
| Academic emotions | Positive (6) | Simulation game | Pre | 3.50 | 0.699 | 2.18 | 5.28 |
| | | | Post | 4.09 | 0.639 | 1.79 | 5.18 |
| | | Lecture | Pre | 3.51 | 0.755 | 2.33 | 5.83 |
| | | | Post | 3.48 | 0.862 | 1.94 | 5.51 |
| | Negative (6) | Simulation game | Pre | 2.78 | 0.709 | 1.00 | 4.86 |
| | | | Post | 2.27 | 0.624 | 1.00 | 3.49 |
| | | Lecture | Pre | 2.51 | 0.735 | 1.21 | 4.32 |
| | | | Post | 2.75 | 0.648 | 1.50 | 4.34 |

Table 5. Descriptive statistics for prior knowledge and achievement

| Variables (Possible maximum) | | Group | M | SD | Min | Max |
|---|---|---|---|---|---|---|
| Prior knowledge (10) | | Simulation game | 5.09 | 1.254 | 2 | 8 |
| | | Lecture | 4.52 | 1.387 | 1 | 7 |
| Achievement | Factual (10) | Simulation game | 7.22 | 1.773 | 4 | 10 |
| | | Lecture | 7.42 | 2.062 | 3 | 10 |
| | Conceptual (10) | Simulation game | 5.28 | 2.453 | 1 | 10 |
| | | Lecture | 5.10 | 2.286 | 0 | 9 |
| | Procedural (5) | Simulation game | 1.84 | 1.019 | 0 | 4 |
| | | Lecture | 2.06 | 1.263 | 0 | 5 |

Results from an independent sample t-test revealed that there were no differences between the two groups in pre-positive academic emotions ($t$ = .057, $p$ = .955), pre-negative academic emotion ($t$ = -1.481, $p$ = .144) and prior knowledge

($t$ = -1.735, $p$ = .088). To confirm the assumptions for MANOVA, correlations between positive and negative academic emotion, as well as correlations between factual, conceptual and procedural knowledge were examined. Also, the homogeneity of the groups and the normality of dependent variables were also analyzed. As the results indicated that Pearson's correlation coefficients were statistically significant yet lower than .90 (ranging from $r$ = .377 to $r$ = .572), the use of multivariate analysis is justified without concern for multicollinearity (Brace, Kemp & Snelgar, 2006). The equality of covariance matrices was tested using Box's M test, and the results showed that the assumption was met (Box's M for academic emotions = 2.957, $F$ = .951, $p$ = .224; Box's M for achievement = 2.883, $F$ = .456, $p$ = .842). The normality of dependent variables was examined using Q-Q plots, which showed a normal distribution of data.

## Effects on academic emotion

MANOVA on academic emotions revealed that there were significant differences between the experimental and comparison groups in both positive and negative academic emotions (Wilks' Lambda = .820, $p$ = .003). The eta square value ($\eta^2$) for the power of simulation game-based learning attributed 14.3% explanation power to positive emotions and 13.0% to negative emotions. Table 6 summarizes the results of the univariate test, followed by MANOVA. Results indicated that the hypotheses for the first research question were supported.

## Effects on achievement

MANOVA on achievement revealed no significant differences between the experimental and comparison groups with respect to factual, conceptual and procedural knowledge (Wilks' Lambda = .977, $p$ = .709). Table 7 summarizes the results of the univariate test, followed by MANOVA. Results indicated that the hypotheses for the second research question were rejected.

Table 6. Results on academic emotions (n = 63)

| Variable | | Treatment | *M* | *SD* | *F* | *p* | $\eta^2$ |
|---|---|---|---|---|---|---|---|
| Academic emotions | Positive | Simulation game | 4.09 | 0.639 | 10.162 | .002 | .143 |
| | | Lecture | 3.48 | 0.862 | | | |
| | Negative | Simulation game | 2.27 | 0.624 | 9.134 | .004 | .130 |
| | | Lecture | 2.75 | 0.648 | | | |

Table 7. Results on achievement (n = 63)

| Variable | | Treatment | *M* | *SD* | *F* | *p* | $\eta^2$ |
|---|---|---|---|---|---|---|---|
| Achievement | Factual | Simulation game | 7.22 | 1.773 | .172 | .680 | .003 |
| | | Lecture | 7.42 | 2.062 | | | |
| | Conceptual | Simulation game | 5.28 | 2.453 | .095 | .759 | .002 |
| | | Lecture | 5.10 | 2.286 | | | |
| | Procedural | Simulation game | 1.84 | 1.019 | .585 | .447 | .009 |
| | | Lecture | 2.06 | 1.263 | | | |

## Conclusion and Discussion

This study examined the effects of simulation game-based learning on academic emotions and achievements. The results indicate that simulation game-based learning creates more positive emotions and fewer negative emotions than instructor-led lectures. However, there was no significant effect on achievement.

### Simulation game-based learning and academic emotions

The results for academic emotions support previous studies (Anolli et al., 2010; Astleitner & Leutner, 2000; Novak & Johnson, 2012). Simulation game-based learning facilitates more positive (enjoyment, pride) and fewer negative (anxiety, anger, boredom) academic emotions in students. Especially, according to the eta square value ($\eta^2$), the teaching method's effect on increasing positive and negative emotions was 14.3% and 13.0%, respectively, indicating that simulation game-based learning can be a powerful tool that teachers can employ to develop the academic atmosphere.

These results have two possible explanations. First, as Zhang et al. reported (2012), academic emotions are similar to game elements (concentration, challenge, control, flow). Upon further investigation using an open-ended questionnaire, students reported that they were able to concentrate on learning when investing in mock stocks and challenging themselves to accomplish a better ROI, which promoted positive emotions. One participant said, "I enjoyed investing stocks by myself and seeing the results (rank, profits)," which shows that game elements (e.g. clear goals, rules, competition) can provide students with more pleasure during the learning process.

Second, in line with the Pekrun control-value theory (2006), simulation game-based learning tends to create more task values and a sense of control for students, which are relevant to positive emotions. In other words, it is possible that the mock stock simulation game increased learners' perceptions of task values because of its realistic design, and provided a sense of control because of the participant-oriented procedures involved (e.g. executing orders to sell and buy stocks). Another student in the experimental group mentioned that "Through the investment of mock stocks, I learned about KOSPI and KOSDAQ naturally. I felt like a real investor." Given these responses, simulation elements in particular (e.g. reality, decision making, choice and results) as well as game elements made learning more meaningful and impacted students positively. In contrast, students in the lecture group might have experienced fewer task values or a lower sense of control, which made them angry, anxious or bored. Students reported that they were anxious when they felt they were falling behind in class and they were also bored due to the passive learning method.

In conclusion, simulation and game elements facilitated greater enjoyment and pride, in addition to less anger, anxiety and boredom among students. Teachers can apply these elements to design a class with a more positive, productive and powerful environment where students experience clear goals and rules. Competitive attributes are somewhat controversial, as Ke (2008) reported that a cooperative environment is better than an individual or competitive environment for game-based learning, requiring further investigation on this topic. In addition, simulation game-based-learning generates more positive emotions when students have high task values and a sense of control. Therefore, teachers need to design lessons with real data and provide learners with the opportunity to make strategic decisions while learning.

## Simulation game-based learning and achievement

In terms of achievement, the results conflict with previous studies (Akinsola, 2007; Sowunmi & Aladejana, 2013). We found that simulation game-based learning had no significant effect on achievement. However, this observation still means that simulation game-based learning has an effect equal to lecture-oriented learning, with significant positive effects on emotion. This implies that there is sufficient justification to employ simulation game-based learning in Korea, where K-12 students suffer academic stress and psychological burnout in a highly competitive system.

There may be several reasons for the lack of significant impact on achievement. First, the type of simulation game might be important. For example, physical simulations, typically used in math and science, contain features that are different from iterative simulations used in social studies. In physical simulations, students can immediately confirm output after inputting data into a program, and hence naturally discover the exact laws and principles related to the subject. However, in iterative simulations, it is relatively difficult to understand the exact relationship between cause and effect, as real data in a social phenomenon affects the simulation program (e.g., changes in stock price). Therefore, participants in this study were able to infer the overall relationship between real data and the mock stock simulation. This feature likely influenced emotions but not cognition.

Second, students may have experienced cognitive overload due to the large amount of information required for stock investment (Sun & Choi, 2013). Although situated learning theory emphasizes 'abundant and complicated context' and 'teacher as assistant and facilitator' for meaningful learning, these factors place a large cognitive burden on students. In the context of mock stock investment, students may have experienced difficulty with understanding and analyzing all aspects of the stock market in a short time period. To generate meaningful learning experiences with a simulation game, teachers are expected to provide learners with more time for knowledge construction, appropriate scaffolding to assist with key concepts, and guidance to locate appropriate and supportive learning materials (Lindh, Hrastinski, Bruhn, & Mozgira, 2008; Sward, Richardson, Kendrick, & Maloney, 2008).

Third, though a simulation game typically reflects real-world characteristics, it is still artificial. In this study, the educational tool differed slightly from reality (e.g., Students could only invest in 40 companies; ROI was calculated at midnight), which may have contributed to misconceptions. Gredler (2004) and Devlin-Scherer and Sardone (2010) highlighted this issue. Therefore, teachers and instructional designers need to be aware of such limitations when implementing simulation game-based learning.

## Limitations and future research

Limitations of the study and implications for future research are as follows: First, participants were 63 high school students in Korea, which necessitates caution with generalizing results. Further study with students of diverse backgrounds and different subject areas would expand the research on simulation game-based learning. Second, academic emotions were categorized simply as positive or negative. A follow-up study would explore specific emotions, such as pleasure, pride, anxiety and boredom as separate dependent variables, providing more detailed information on academic emotions. Third, other key independent variables such as collaboration and self-regulation during simulation game-based learning must be considered to understand the mechanisms of cognitive processes for simulation game-based learning.

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