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Implementing Mobile-Phone-Based Student Response System in a Large Undergraduate Course

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Abstract

This study investigates students' perspectives on a student response system (SRS), Socrative in a large university-level course. The purpose of utilizing Socrative was to enhance participation and promote collaboration among students when they interact with one another to discuss their knowledge and critical thinking of the content of the course. Participants of the study were 82 students enrolled in an American Culture and Society course at a university in Korea. Web-based questionnaires and classroom observations were employed to examine students' perceptions of Socrative use and their engagement of the related PBL activities. Overall, the students' evaluation of the effectiveness of Socrative in a large enrollment class was more positive than negative. The students believed that the use of Socrative increased their interests and engagement, improved critical thinking skills, and conceptual understanding of the course contents, promoted interactivity and participation, and allowed them to get motivated. The results of the statistical analysis showed little gender difference for all the items except for interactivity. In addition, student participation and motivations were significantly different depending on individual learning styles, but not different in relation to other items. The results also revealed no significant differences among three different disciplines concerning all the items.

Keywords: student response system, student perception, Socrative, PBL, mobile learning

Introduction

Large classes at the tertiary level are not a new phenomenon and, in many countries, classes of between 100 and 300 can be found (Biggs, 2011). In many countries, whereas there is pressure to maintain small class sizes at primary or secondary schools, large classes are common in tertiary level educational institutions (Mulryan-Kyne, 2010). Often large enrollment courses in higher education have been the barrier to active learning pedagogy. In this learning environment, the traditional lecture seems to be ideal, yet the most engaging lecture is rather limited in how much it can support and facilitate widespread learner involvement and interaction (Trees & Jackson, 2007).

Moreover, traditional lectures are not always effective in facilitating learning because students were not given opportunities to process and integrate previous and new knowledge during the lecture. For example, Caldwell (2007) noted that even if learners

are motivated and eager to participate, certain educational settings, such as large classes, can hinder learners from actively volunteering for the fear of making mistakes. Geske (1992) also stated seating arrangements, impersonal atmosphere, and a sheer number of students in large classes constrain student involvement.

Active learning strategies may be a promising solution to encourage students' participation, concept understanding, and thus ultimately improved academic outcomes. One such active learning strategy is incorporating student response systems (SRSs) such as clickers. SRSs have been employed in classrooms for different objectives – that is, to promote and monitor attendance, to test students' performance, to provide immediate formative feedback, and to increase interaction in the classroom. Using SRSs has been associated with positive educational outcomes, by increasing students' participation and by fostering student engagement.

Despite all the positive attributes that SRS technology has to offer both in and out of the classrooms, many instructors in Korean universities are reluctant to use SRSs in their classrooms. More often than not, they tend to ask students to put their phones away in the classroom. To address this gap, this study attempts to extend the current knowledge base by providing an overview of how Korean university students experience a mobile-phone-based student response system, Socrative, in a large enrolment course. To conceptualize the investigation and define its scope, the following section will review the related SRS studies thereby acknowledging the aims and significance of the study.

Literature Review

Student response systems in higher education

In recent years, student response systems have become increasingly popular across the world (Hoekstra, 2008). Students use clickers to respond to the teacher's questions and can view an anonymous summary of the class's responses in real-time. Teachers can later view individual student responses to assess an individual student's performance or attendance (Chien, Chang, & Chang, 2016; Lantz, 2010). The technology is utilized in a variety of ways: for taking attendance, giving informal and formal quizzes, polling student opinions, providing immediate feedback, and promoting team-building among students in large classes. Interactive electronic response systems, also termed student or personal response systems, classroom or audience response systems are software technology increasingly used in primary and higher education.

In addition, a paradigm shift towards an individualized and constructivist approach to learning has driven a lot of research on the use of students' response systems in classroom settings (Han, 2014). SRSs have been widely used in the area of education (Kay & LeSage, 2009) and have shown a lot of advantages that address directions in pedagogical practice. Previous research has reported that students are more focused on the use of SRSs, and attention is more sustained (Bergstrom, 2006; Burnstein & Lederman, 2001).

Studies in the field of educational psychology reveal that deep level rather than surface-level processing facilitates learning (Craik & Lockhart, 1972; van Rossum, & Schenk, 1984). Cohen (1991) also states that class participation is important in the interaction between teacher and student, leading to the current focus on student-centered

learning, student involvement, and active class participation. From this view, integrating an SRS with traditional lecture may be beneficial for higher-order cognitive skills, particularly when encouraging independent thinking. This study thus relies on previous studies in allowing students to have independent thinking during class hours with the use of a student response system.

Much of the research to date has been based on the use of traditional clickers (Blasco-Arcas, Buil, Hernández-Ortega, & Sese, 2013). The teacher usually creates a question and shows it on the projector, whereas students use clickers to show one of the answers they chose. This process needs expensive devices to record student responses. With traditional clickers, it is usually institutions that decide whether or not to adopt the technology. In recent years, SRSs have been brought to the virtual cloud, eliminating the need for special and expensive clicking devices. Socrative, a new cloud-based response system, is free. Unlike clickers, Socrative needs general resources such as the Internet and smartphone (Matthew, 2012). Socrative exploits this ubiquitous access to the internet based on Bring Your Own Device (BYOD), which describes the circumstance in which users make their devices available for company use. This BYOD approach avoids the need for clickers with dedicated hardware and associated costs. An online version allows individual teachers the autonomy to take on the technology without requiring the institution to provide any special equipment. What is needed is individual access to laptops, smartphones, or tablets, and Internet access, wireless.

Linking SRS technology with the problem-based learning (PBL) approach

Although student response systems using clickers have been around since the 1960s, only more recently they have been given attention as tools to promote learning, especially focusing on the active learning approach. Grounded in active learning, constructive pedagogy claims that students learn more successfully when they are expected to build their understandings of course concepts actively (Anderson, 1987). It is thus teachers' responsibility that creates learning environments where students can practice applying and discussing course concepts during class hours.

Moreover, SRS is viewed as a form of mobile technology particularly suited to enhancing problem-based learning (PBL) in large courses (Hoekstra, 2008). PBL has historical origins in medical education but has been used in a variety of discipline-related academic studies, including architecture, business, engineering, law, and science in universities (Savery, 2015). PBL is defined as an instructional approach that is intended to facilitate prior knowledge activation, critical analysis of arguments, and promoting a deep understanding of the scientific perspective (Hmelo-Silver, 2004; Loyens, Kirschner, & Paas, 2012). PBL is based on learning the principles of constructivism and emphasizes learner's active participation in the learning process (Savery, & Duffy, 1995). In this vein, the PBL pedagogy shares some common features with those emphasized by utilizing SRSs in the classroom.

Unlike traditional lecture-style classes, this approach motivates students to learn through involvement in a real problem. Research and theory in psychology suggest that by having students learn through the experience of solving problems, they can acquire content and thinking skills (Hmelo-Silver, 2004). Particularly, the PBL approach stresses that social interaction is essential to knowledge construction, acquisition, and application (Evensen & Hmelo, 2000). The social negotiation of meaning lies in the core of the

knowledge construction process. PBL proponents suggest that instructional designers should create learning environments in which the teacher provides guidance and support, and the learner's knowledge construction is facilitated (Hmelo-Silver, 2004; Tseng, Chang, & Lou, 2012).

Thus, the effectiveness of content learning can be maximized when learners are actively engaged in social interaction, such as group activities and interpersonal communication. Hoekstra (2008) emphasizes that the PBL approach stimulates active student involvement during the learning process by placing students into small groups where they work to apply course concepts. Numerous studies have demonstrated that group discussions encourage students to explore specific topics, process material more deeply, and create meaning of the material (Kirschner, Paas, & Kirschner, 2009; Prince, 2004).

At the same time, the very aspects of PBL that allow for a productive learning experience make it more challenging to be implemented in the large classroom. The common concerns that discourage instructors from implementing at the undergraduate level include the nontraditional teacher role, the atypical student role, and potentially challenging group interactions (Aarnio, Lindblom-Ylänne, Nieminen, & Pyörälä, 2014). Students may feel uncomfortable when transitioning from passive roles in the traditional-lecture classroom to the leaders of their self-directed learning experiences. Students may struggle while attempting to think critically to solve group-worthy problems. Students may also have trouble working in groups if their prior academic experiences were individual and not so collaborative. These concerns over PBL may be highly alleviated by relying on SRS technology, Socrative, which has been shown to create a comfortable environment that provides an opportunity for all students to participate anonymously (Benson, Szucs, & Taylor, 2016; Stowell, Oldham, & Bennett, 2010)

Informed by previous research, this study utilized SRS technology to allow PBL to be implemented as a supplement to regular, didactic coursework. Accordingly, the purpose of this study was to incorporate SRS technology into a content undergraduate course to engage students in constructivist learning activities. Particularly, how Socrative affects students' learning process in a large-enrollment course, and potential differences between genders, individual learning styles, and academic disciplines were among the issues investigated in the present research.

Aims and significance of the study

Even though the use of SRS technology has already been explored in the existing literature, there has been a paucity in the literature concerning the investigation of Socrative that is associated with the variables that account for some of the differences in how students learn – that is, gender, learning styles and academic disciplines. Despite general support for adopting this simple technology in large classes, the gender effects of students' engagement and interaction as prompted by this technology are not well known. Previous research suggests that women feel uncomfortable using technology and that it may have a negative effect on female students' learning outcomes (Cooper & Weaver, 2003). In contrast, other researchers suggest that the gender gap associated with using technology in educational settings has diminished (Losh, 2004; Price, 2006).

Also learning styles have been explored as the primary source of individual characteristics (Reid, 1987). As Keefe (1979) stated, learning styles are widely viewed

as “cognitive, affective, and physiological traits that are relatively stable indicators of how learners perceive, interact with, and respond to the learning environment” (p. 3). It is reasonable to assume that learning styles make the same teaching method wonderful for some students and terrible for other students (Dunn & Griggs, 1988). These individual characteristics may result in differences in their experiences in the use of SRSs.

In this vein, this study makes contributions by investigating students’ perceptions of the use of Socrative in the PBL enacted classroom environment. By doing so, this study attempts to make a significant bridge between SRS technology and the PBL approach. Very few studies in higher education contexts attempted to explore SRS technology that is connected with PBL enactment. The significance of the present study is that it expands on the scope of some notable work carried out previously that has focused on SRS technology. As such, the research described here was driven by the following research questions:

First, how do male and female participants differ in benefitting from the Socrative use? Second, how do students’ perspectives on Socrative use differ in terms of their learning styles?

Third, how do students’ perspectives on Socrative use differ in terms of their academic disciplines?

After a closer look at the participant profile and the course in which the intervention was implemented, the intervention itself, the measures used, and the analyses on which the researcher relied are briefly introduced. Thereafter, the survey results will be analyzed focusing on the research questions. Discussions of the findings and pedagogical issues relating to the results conclude the paper.

Methodology

Participants

This study is part of a larger study that investigated an alternative pedagogical approach to large classes using Socrative. At the beginning of the 2019 academic year starting in March, the cloud-based student response system called Socrative (*www.socrative.com*) was adopted for American Culture and Modern Society class in a university in Korea. Of the 82 students who enrolled in the course, 71 took the survey and responded completely.

Therefore, 11 missing values that occurred were not considered in this study. The participants’ majors were varied, and their majors were put into 3 categories of Arts & Design (42 students, 59.2%), Language & Literature (20 students 28.2%), and science & engineering (9 students, 12.7%) as shown in Table 1. Among them, 35 (49.3%) were male students and 36 (50.7%) were female students.

Table 1

Participant overview

	Gender			Majors			
	Male	Female	Total	Art& Design	Language& Literature	Science& Engineering	Total
n	35	36	71	42	20	9	71
%	49.3	50.7	100	59.2	28.2	12.7	100

Table 2 illustrates the participants' learning style preferences. Based on student background survey that was administered at the beginning of the semester, 53 students strongly preferred individual learning styles, while 18 students showed a positive preference for group learning.

Table 2
Participants' learning style classification

Style	Individual learning	Group learning	Total
	Prefer traditional lectures; Study individually	Prefer group activities; Enjoy student discussions	
n	53	18	71
%	74.6	25.4	100

Implementation Process

During the spring semester of 2019, Socrative-mediated PBL was implemented in American Culture and Modern Society class offered by the Department of Language and Literature. The undergraduate content course was an elective introductory course of which the target audience was not limited to the Department of Language and Literature. Students typically did not have accounts to use online systems; when the teacher was logged into the system, they simply entered the teacher's online classroom with her code. When students provide answers on Socrative through their smartphones, the answers are instantly uploaded on the teacher's screen on PC. The screen is shared through the overhead projector to the whole class as the students engage in the activity so everyone can check the whole class progress.

Figure 1
Class schedule for activities

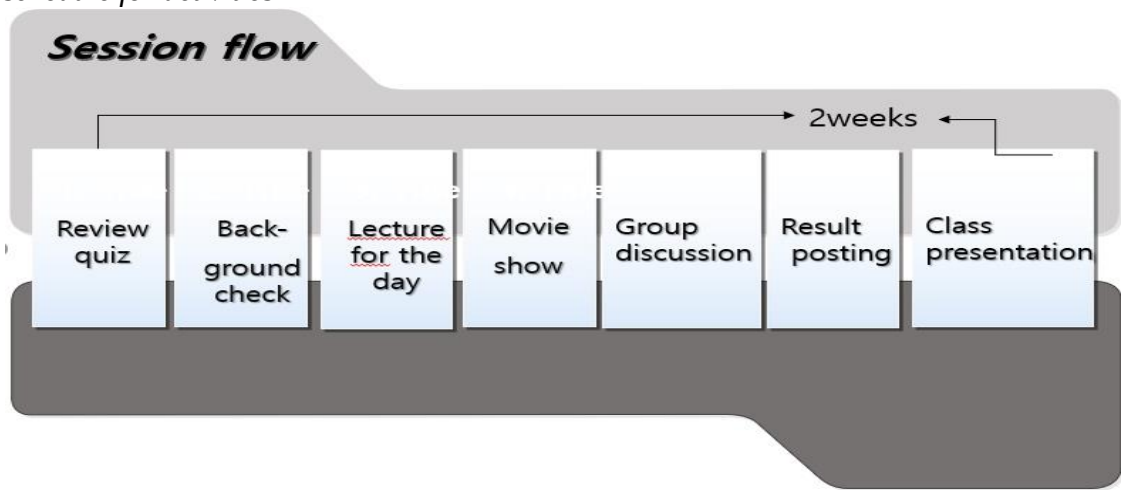

Figure 1 illustrates how the lectures were usually delivered in the class. Relying on the PBL approach, this class includes a small group discussion which is followed by a topic-related movie watching. It is well known that learning starts initially from prior knowledge, and then from the presented materials (Carr & Thompson, 1996), implying

that learning is influenced by student's existing knowledge about what is taught. Therefore, the first 15 minutes was spent to connect previous and present learning experiences by providing questions relating to what had been done in the classroom during the previous week.

Socrative was used as a formative assessment tool to review content through pre-made quizzes. Students were requested to choose the preferred answers by using Socrative. Before dealing with the main topic for the day, review quizzes were given first. During the next 10 minutes, a background check of the main topic for the day was provided. And the actual lecture for the day was presented, which was followed by the related movie watching. After the movie watching, topic-related issues were given for student discussions. Students were given 5 minutes to think over the issues individually and participated in group discussions for 15 minutes. Students were expected to post the common results of discussions on a Socrative platform. Each Group's responses were shared in Excel on the data projector screen for a whole class discussion. The class discussion was allotted 15 minutes and during the discussion, equal participation was encouraged by the instructor. The instructor spent the remaining time to provide feedback and finished the lecture by summarizing the important points.

The main menu of Socrative includes a Quick Question section that has Multiple Choice (MC), True/False (TF) and Short Answer (SA) options. As for this study, TF and MCs were used for content review and background knowledge checks. One of the greatest benefits of using MC and TF was that it could demonstrate students' responses in percentage forms. Students were able to catch up on whether their responses were correct or incorrect in real-time. SAs were mainly used for group discussions after watching a movie. Regarding SA questions, it was helpful to show the discussion result on a big screen when group participants were presenting their opinions on the discussion topic. Reading other groups' opinions could help students reflect on their responses and an instructor could get different kinds of responses from all groups.

Data Collection and Analysis

Data-Gathering Instruments

To obtain appropriate data for the study, both quantitative and qualitative data were collected. A mixed-method design was used, combining background information survey, end-of-semester questionnaires, with classroom observation.

At the beginning of the semester, a web-based background survey was administered. The main purpose of the background information survey was to find out the students' level of education, their major, gender, learning style preferences, and their previous experiences with any other course having an SRS component.

Regarding learning style preferences, Reid (1998)'s self-reporting questionnaire was used with modifications. Reid (1984, 1998)'s perceptual learning styles include visual, auditory, kinesthetic, tactile, individual, and group learning. According to his categories, the students who have visual learning preference learn better from seeing words and remember information by reading texts. Auditory students better remember information by hearing words and reading texts aloud while Kinesthetic students enjoy being involved physically in learning experiences and actively participate in learning

activities. Tactile students learn best when they are given hands-on experiences such as handling and building models or touching and working with learning materials.

According to Reid's classification, the students who show group learning style learn more easily when they study with others and complete learning tasks through group interactions. In contrast, the students who have individual learning preference learn best when they work alone and make better progress in self-study. Given that these two learning styles show clear contrasts in the learning process – group interaction vs. self-study and that the use of Socrative in this study is highly associated with group discussions, these two learning styles were selected as important individual difference variables. Similarly, Kolb and Kolb (2005) stated that students tend to learn in different ways through their learning styles.

At the end of the semester, the online survey that was created in Google Docs was distributed to quantitatively investigate the students' perspectives on the classroom activities conducted through Socrative and on preferences in using Socrative. The survey questions were drawn and appropriately adapted from previous studies (Cardoso, 2011; Dervan, 2014; Guarascio, Nemecek, & Zimmerman, 2017). The researcher extracted relevant items from the earlier studies and modified the items considering the study context. After a repeated process of item extraction, three open-ended questions and twenty close-ended items were finalized.

It consisted of 20 questions with 5 Likert-type scale for the questions on learner perspective on the use of Socrative and 3 open-ended items of the strengths and weaknesses of using Socrative, and suggestions for a future class. As for the close-ended statements, all the items were organized using the 5-point Likert-type scoring matrix (5=strongly agree, 4=agree, 3=neutral, 2=disagree, 1=strongly disagree). The reliability check was conducted through the data collected from the sample of this study. The Cronbach Alpha value of the scale was calculated as 0.87 for this study.

Data Analysis

The Statistical Package for the Social Science (SPSS) 17 was used to carry out t-test and Analysis of Variance (ANOVA). The alpha level for all statistical analyses was set at 0.05. To compare the mean scores between the female group and the male group, an independent samples t-test was performed. An independent samples t-test was also used to measure differences between the group of the individual learning style and the group of group learning styles concerning the items of interests, critical thinking, engagement, conceptual understanding, interactivity, participation, and motivation. A one-way ANOVA was carried out to analyze mean differences among three disciplines regarding the use of Socrative in the large class. Finally, open-ended responses were analyzed qualitatively by the researcher.

Results and Discussions

How do male and female participants differ in benefitting from the Socrative use?

Regarding a research question of gender difference in the use of Socrative, an independent sample t-test was carried out. Consistent with previous studies' findings, the

use of Socrative seems to enhance classroom interaction by engaging students in small group discussions (Duncan 2005, Hoekstra 2008). The mean scores of the groups on the questionnaires are presented in Table 3. Overall, the mean values of female students were higher than those of male students. As Table 3 shows, the P-values from t-tests provide little evidence that gender is directly related to the overall student perceptions of using Socrative except for the item of interactivity.

Interestingly, a significant difference was found in terms of the item of interactivity with peers and a teacher, indicating a p-value of .006. Regarding interactivity, female students responded more positively with the mean value of 4.00 than male students with the value of 3.6. It appears that Socrative creates learning environments that are particularly conducive to female students' interaction, that is, interpersonal communication. This may be because women, on average, are more relational than men (Lundeberg & Mohan, 2007). Also, the personalized invitation of 'getting into the talk' through using Socrative may be more appealing to female students. Accordingly, the results revealed that the use of Socrative provides richer opportunities for female students to be interactively engaged in their process of learning.

Table 3

Gender differences in the perspectives on Socrative use

Items	Male group (*m*)	Female group (*m*)	df	f	Sig.
Interests	3.94	4.14	69	.426	.516
Critical thinking	3.77	3.78	69	.020	.889
Engagement	3.49	3.61	69	.940	.336
Conceptual understanding	3.63	3.86	69	3.076	.0844
Interactivity	3.60	4.00	69	7.931	.006*
Active Participation	3.77	3.81	69	.683	.412
Get myself motivated	3.51	3.44	69	1.016	.317

How do students' attitudes to Socrative use differ in terms of their learning styles?

To understand whether students' responses had any significant difference between individual learning and group learning styles, an independent sample t-test was carried out. As shown in Table 4, students with group-learning preference gained higher mean values than individual learning- style group. The analysis showed that there is no statistically significant difference between the two learning styles regarding the items of interests, critical thinking, engagement, conceptual understanding, and interactivity.

However, it is interesting to note that significant differences between the two learning styles were found regarding the items of participation and learner motivation ($f=1.473$, $p <.05$; $f=2.055$, $p<.05$). Regarding the items of active participation, students of the group learning style achieved a mean value of 4.33 while students of individual learning styles achieved a mean value of 3.60. This difference may indicate that

Socrative-mediated student discussions are preferred from group-learning style students. Concerning the item of learner motivation, students of the group learning style achieved a mean value of 4.00 while a group of individual learning styles achieved a mean value of 3.33. This difference reflects that learning styles are one of the considerable indicators of how students perceive and respond to the learning environment.

Table 4

Learning style differences in the perspectives on Socrative use

Items	Individual learning style	Group learning style	df	f	Sig.
Interests	3.96	4.28	69	.605	.433
Critical thinking	3.55	4.44	69	1.658	.202
Engagement	3.43	3.89	69	.000	.991
Conceptual understanding	3.68	3.94	69	.907	.344
Interactivity	3.75	3.94	69	.285	.595
Active Participation	3.60	4.33	69	1.473	.006*
Get myself motivated	3.33	4.0	69	2.055	.012*

How do students' perspectives on Socrative use differ in terms of their academic disciplines?

To investigate whether students' survey results had any significant difference among the three different disciplines, a one-way ANOVA was conducted. The results of a one-way ANOVA analysis revealed that there is no statistically significant difference among the three groups for all the items. Overall the students' perspectives on Socrative were found to be highly positive across the disciplinary boundaries.

As for the items of interests, conceptual understanding, and interactivity, language & literature group obtained the highest score (m=4.30, m=3.95, m=3.95), followed by science & engineering group (m=4.22, m=3.89, m=3.89) and art & design group (m=3.88, m=3.62, m=3.71). Regarding the item of critical thinking, the science and engineering group showed the most positive response (m=4.0), and the language & literature group showed the lowest values (m=3.50).

Table 5

Disciplinary differences in the perspectives of Socrative use

Items	Art&Design	Language& Literature	Science & Engineering	df	f	Sig.
Interests	3.88	4.30	4.22	2	1.438	.245
Critical thinking	3.90	3.50	4.00	2	1.046	.357
Engagement	3.43	3.60	3.61	2	1.020	.336

Conceptual understanding	3.62	3.95	3.89	2	.760	.472
Interactivity	3.71	3.95	3.89	2	.467	.629
Active Participation	3.71	3.90	3.89	2	.288	.750
Get myself motivated	3.40	3.60	3.56	2	.268	.766

Perspectives on the strengths and weaknesses of Socrative

Participants were expected to respond to three open-ended questions: strengths, limitations, and suggestions for a future class. As for the first question in the open-ended questionnaire, students were asked to address the advantages of using Socrative in the content-based course for large classes. Their responses are demonstrated in Table 6.

Table 6

Strengths of Socrative-mediated class compared with traditional lecture class

Frequency of Responses	n
It was useful to share other peers' opinions.	50
I was able to express my opinions freely.	37
It increased class engagement and participation.	22
It allows immediate teacher feedback.	10
It was convenient to use Socrative.	7
It allowed for repetitive learning as I reviewed previous content through Socrative quizzes.	7
The use of Socrative made class time-saving.	7
Socrative-mediated discussions allowed for the knowledge building process.	2
It was easier to summarize key points of learning in Socrative-mediated class.	2
I didn't enjoy anything.	2

Opinion sharing was found to have the highest numbers of 50, followed by 'Express individual opinions freely (n=37)', 'Increased class engagement and participation', (n=22) 'Immediate teacher feedback' (n=10), 'Convenient use of Socrative (n=7), 'Repetitive learning' (n=7), and so forth. Based on their experience, the most common response was that utilizing Socrative enabled students to share different opinions. It seems that the students appreciated the opportunities to read other students' answers which is normally unavailable for sharing in the traditional lecture.

For example, students wrote, 'helps me understand what others think', and 'it was interesting to read others' opinions'. In a traditional lecture class, students do not usually have the opportunities to see what other peers in the classroom express. In contrast, the use of Socrative allowed students to read and check individual students' answers on the large widescreen. In addition, as expected based on previous research (Shaffer & Collura, 2009; Stowell, J. R., Oldham, T., & Bennett, D. 2010), students liked the anonymous nature of Socrative questions. Because of its anonymity, they were able to express their opinions confidently. Out of 37, 20 students responded that they enjoyed expressing their opinions without speaking anxieties. Using Socrative has allowed them to make

contributions to the class even when they were not sure of the correct answer. Also, students felt to be more involved in lectures integrated with the use of Socrative, and the possibility of immediate teacher feedback was perceived as one of the important features.

The student responses for the open-ended questions on the weakness of Socrative were grouped into 4 different categories. Compared to the strengths of Socrative, negative responses, such as technological inconvenience and increased opportunities for off-task behaviors, have a relatively lower prevalence as shown in Table 7.

Table 7

Weaknesses of Socrative-mediated class compared with traditional lecture class

Frequency of Responses	n
It was difficult to use with limited cellular data	27
The school Wi-Fi was not strong	17
Students didn't focus. They played with their smartphones.	10
It took too much time. We had to wait for all of us to finish.	8

The most frequently mentioned weakness was not having enough cellular data via their cell phone provider, which is followed by the school's Wi-Fi being too weak. It seems that most of the weaknesses were associated with technological problems related to Wi-Fi access. Although the school's wi-fi was available free of charge, it was slow and Wi-Fi strength, and the range was less than acceptable for large classroom use. At the beginning of the study, the students were told to tell the instructor technological problems immediately when those problems occur, and solutions such as borrowing classmate's phones or lending them an external battery pack were suggested.

Next, 10 students indicated that some students didn't focus and instead they played with their smartphones. To avoid making these comments, a teacher may incorporate points for Socrative questions into the course grade. The delayed procedure was one of the disadvantages they mentioned. 8 students stated that "It took too much time. We had to wait for all of us to finish."

Conclusion and Implications

This study examined how differently students perceived the use of Socrative in terms of gender, learning styles, and disciplinary boundaries. To some extent, this study provides concrete support for the role of Socrative as a facilitator of problem-based learning in a large class.

In general, the findings reported here are in line with previous studies on the pedagogical use of SRSs. When Socrative was introduced and used for a class discussion, students actively communicated with one another as confirmed in related studies (Green, 2016; Kaya & Balta, 2016; Shaban, 2017; Wash, 2014). They also developed an active learning environment that enhanced students' motivation (Agbatogun, 2014; Dakka, 2015; Hung, 2017). The main findings of the study are as follows.

First, altering classroom dynamics by enhancing students' participation and discussions with Socraive use plays certain roles in male and female students' learning. Regarding a research question of gender difference in the use of Socrative, both male and

female students felt positively as for the items of interests, critical thinking, engagement, interactivity, conceptual understanding, active participation, and motivation. The p-values from the t-test provided little evidence of the gender gap associated with using SRS technology in terms of interests, critical thinking, engagement, and conceptual understanding. As for interactivity between peers and a teacher, interestingly there was a significant difference between female and male students. Whereas the PPT lectures systematically presented information about American culture but in a neutral and impersonalized manner, the short questions from Socrative situated the cultural knowledge of American society in a specific personalized context.

In the Socrative use on American values and beliefs, for example, after the history of American macho hero is introduced, the students are presented with the following short question, 'Describe a desired hero in the current Korean society and compare the Korean hero with American heroes by more than two ways.' Students should post their thoughts on Socrative and the result is presented on the screen immediately. By doing so, this open-ended question provides the opportunity for students in the large classroom to relate the topic to their own culture, and to share it with their peers by responding to the Socrative question.

Also, students were asked to discuss the Socrative questions in small groups. During group discussion of the topic that does not involve the right answer, students talked about their experiences and personal knowledge with their peers in small groups. The result is consistent with previous reports that students perceived the use of Socraitve made the large classroom less passive and impersonal (Hoeskstra, 2008).

Second, statistical analysis showed that there was little difference between students of individual learning styles and students of group learning style in terms of interests, critical thinking, engagement, conceptual understanding, and interactivity. As for the items of participation and learner motivation, in contrast, the mean of student perception was higher in students of group learning style ($M=4.33$, $M=4.0$) and significantly different between groups ($F=1.473$, $p<.05$; $F=2.055$, $p<.05$). This implies that the use of Socrative goes better with students who show a preference for group learning to keep them motivated and increase the degree of participation. It is, therefore, reasonable to raise the instructor's awareness of different learning styles of class members in advance. Indeed, it is the teacher's responsibility to optimize learning opportunities offered to students. Moreover, increasing knowledge about student learning styles is seen as important when considering the success and drop-out rates along with students' academic achievement (Cavanagh, Hogan, & Ramgopal, 1995).

Third, the results of a one-way ANOVA showed that there were no significant differences in the mean values of three different disciplines at .05 level. Overall the students from three different disciplines showed positive responses. When asked whether they would recommend further use of Socrative in future classes, they also responded positively.

Finally, the main strengths that the students mentioned are related to shared opinions and thoughts and thus co-constructed knowledge grounded in intersubjectivity. The findings show that the students considered the ability to share the opinion with the whole class to be the strongest aspect of using Socrative in a big classroom. For most students, using Socrative had the effect of making the learning environment feel more cooperative in a lecture class. Through Socrative-mediated group discussions, students helped each other by evaluating each other's reasoning and catching each other's way of

thoughts. Using Socrative, students seemed to discover how much they know by speaking it out. Over the semester, working with the same peers time and again affirmed the cooperative nature of the group. The noisy, cooperative atmosphere fostered by Socrative-mediated PBL may help to alleviate the occasional boredom that accompanies in a large class.

As for the weaknesses, the majority of them were associated with technical difficulties, not classroom usage. With students being so accustomed to online applications, there were few comments in a survey related to software usage difficulties. This was perceived to be a stark contrast to the contexts of previous research. Just a few years ago many students were not familiar with using educational technology, and software was not so user friendly as the likes of Socrative. Having limited cellular data was the most frequently mentioned weakness, followed by a lack of school Wi-Fi strength and delayed class procedure. Wi-Fi access in the classroom was weak and sporadic occasionally.

An additional worry may be that a student's socio-economic status could embarrassingly come to light if the instructor were to insist that students use personal devices. Moreover, complexity arises because students are not only accustomed to the traditional lecture and their minor responsibilities therein, they may prefer the lecture for the way it fits with their learning style.

Based on the findings, the following suggestions are made for the use of Socrative in a large content-based class. First, in using Socrative, teachers should provide students opportunities to explore and internalize learning content and related issues by their views and thoughts. At the same time, it is important to keep in mind that students are interested in sharing peer responses.

Second, educators and practitioners must utilize appropriate pedagogical approaches incorporated with Socrative use. A well-designed pedagogical strategy, including a sense of one's learning goals and how to achieve these goals utilizing Socrative use, is of great importance. Clark (1983, p. 453), for example, states that "it is not media that influences students' learning directly, it is the methods associated with that technology employed by teachers that do." Certainly, Socrative alone cannot be a panacea to solve all of the challenges that large-class learning environments present.

Third, using Socrative brings up new problems and challenges to be considered – that is, how to deal with student resistance to increased learner accountability and how to connect Socrative activities with student grades. Accordingly, it is a pivotal responsibility of the instructor to make sure that students keep on the right track of Socrative-mediated activities. Despite these challenges, increased student engagement, interactivity, and critical thinking are great benefits to give this SRS a try in a large class.

This study has several limitations. First, the online survey was given only at the end of the semester. It would be highly recommendable to track the learning environment throughout the semester and to examine student perceptions at least in the middle and at the end of the course.

Second, open-ended comments on collected surveys suggested some questions that should have been included as items, such as questions concerning students' preference for the increase of smart classrooms with the mobile technology and questions relating to interactive pedagogy itself.

Third, this study is limited by the institutional and cultural contexts in which it was conducted. Although meaningful for pedagogical implications, findings of the study may

not be extrapolated to students worldwide. Further research is needed to investigate whether students' experiences with Socrative in implementing PBL differ across different institutional and cultural contexts. In addition, future research should continue to examine ways in which Socrative can be integrated with other active learning pedagogies such as PBL used in this study. The relationships between SRS technology, learning style preferences, and learning processes also need to be studied on a longitudinal basis.

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