Engaging Students with Flipped Classes using 3D Video Collaboration Technology

Full Paper

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Abstract
The objective of this paper is to demonstrate the potential of 3D video collaboration technologies to engage students with the learning materials prior flipped classes. The study uses iSee designed for 3D video collaborative classes and compared it with online learning management systems. An experiment has been reported on 273 students in an undergraduate Information System course. It was revealed that the correlation between either the students’ engagement on the online quizzes or their engagement on iSee discussions with their learning outcomes were high. However, our statistical analysis showed that the relationship between iSee engagement and students’ learning outcomes was stronger. The qualitative observations during this experiment are also discussed. The results have been discussed in the lens of Theory of Peer Learning and the future research have been suggested. This study motivates teaching practitioners in Information Systems to use 3D video collaboration technologies in flipped classes.

Keywords
Flipped Learning, Students' Engagement, 3D Video Collaboration Technology.

Introduction
In the past few years, research in higher education has paid a great deal of attention to flipped learning. A flipped classroom is a student-centered learning approach that encourages students to spend most of their time in the classroom on discussions and task-oriented exercises while they have already learned the materials before they come to the class (Li, Lou, Tseng, & Huang, 2013). Flipped learning has the potential to address the needs of today’s students and complexity of the industry in Information System where graduates find jobs based on their practical skills (Davies, Dean, & Ball, 2013).

One of the challenges in implementing flipped classes is the strong motivation that is required of students, to have them prepare the work prior to class time as compared with lectures where minimal effort is required beforehand (Elliott, 2014a). It has been reported that students participating in flipped classes may get dissatisfied (Missildine, Fountain, Summers, & Gosselin, 2013) and struggle with the amount of the work required prior to attending flipped classes (Betihavas, Bridgman, Kornhaber, & Cross, 2016). Missildine et al (2013), leading to lower engagement with the materials, and accordingly, decreased learning outcomes (Simpson & Richards, 2015).

Topping (2005) notes that peer support can occur through a tutoring process or through goal-oriented collaborative learning in a group. In the theory of peer learning, Topping (2001) defines the peer learning constructs as the interaction of five constructs; namely organizational or structural features, cognitive conflicts, error management, communication and affective components. Peer tutoring has been found to
Peer Learning through 3D Video Collaboration for Flipped Classes

be effective in improving students’ engagement (Ashwin, 2003; Kuh, 2009). For example, Bishop & Verleger (2013) implement an online discussion forum and highlight the role of collaborative tools in facilitating peer tutoring and engaging students with flipped learning materials.

Video collaboration has been long used to connect with students and to engage them in online learning practices. Thompson & Lee (2012) report a successful experiment that uses screencasts to engage students with learning materials outside of the classroom. Screencasts are screens of a computer with voiceover that can be used to connect teachers and students. While the usual settings of online courses may lack peer-learning features, thus resulting in lower learning outcomes for students, conducting group tasks in online courses using video collaboration facilities can improve peer learning Yang (2006). Further, the use of 3D immersive environments has been found to improve the social context in education, leading to improved peer-learning (Hew & Cheung, 2010). Adding social context into the preparation in flipped classes has also been found to improve the students’ engagement (Talaei-Khoei & Daniel, 2016).

As discussed above, there is a rich body of research supporting the use of video collaboration and 3D video collaboration to empower the social context of online learning and to improve the peer learning. The role of social context to engage students with flipped classes has been also demonstrated. However, the use of 3D video collaboration to improve the peer-learning through a social context and engage students with flipped classes has not yet been investigated. The objective of this research is to address this gap in the literature by demonstrating through a classroom experiment.

There has been a body of literature in the support of collaborative tools to improve the students’ engagement with the flipped class materials (Bishop & Verleger, 2013). Although discussion boards in the online learning management systems are powerful tools to handle content-related collaborative interactions, they lack a comprehensive social engagement in real-time simulation of face-to-face communication among students that required for an effective peer tutoring environment (Hrastinski, 2008).

Video conferencing and collaboration technologies such as Skype connect people in geographically distributed places. However, they lack the social context highlighted by Computer Supported Cooperative Work literature as required for engagement (Hertel, Geister, & Konradt, 2005). In response to this issue, technologists suggest 3D video collaboration technologies that provide a 3D virtual environment, for example a virtual classroom, where the parties can collaborate through their online video. We propose that 3D video collaboration facilitated peer learning and providing a social context to the flipped class will improve students’ engagement with the materials provided prior to class and will accordingly improve their learning outcomes. To do so, we adopt iSee, a 3D video collaboration technology specially designed for online learning, and examine the correlation between online discussions by students on iSee, (about the lecture topic before joining a flipped class,) and their learning outcomes. iSee is an immersive video collaboration technology, that enables a large number of students to gather together in a 3D virtual classroom. iSee uses real time video and audio of the participants to create a sense of immersion in the presence of others.

This research reports an experiment in a second-year undergraduate course in Information Systems major, in which the students were asked to participate in four flipped learning classes. Prior to these classes, the students were provided content material, as well as discussion questions. In two of these classes the discussion questions were provided through the online learning management system as individual voluntary quizzes. However, in the other two classes, the discussion questions were provided on iSee, to be discussed between student groups, in a virtual classroom environment. The correlation between students’ engagement and their learning outcomes were compared in these two interventions. As discussed above, the following hypothesis is proposed:

H: In flipped classes, the correlation between the students’ engagement on the iSee discussions and their learning outcomes is significantly stronger than the correlation between students’ engagement with the online quizzes.

The rest of this paper is organized as follows. The Methods section presents details about the course, the design of the experiment, data collection and analysis. The Results section presents the results of the analysis. Finally, the last section discusses the findings, limitations, and future research. It also compares the results of this research with a prior study on the use of Facebook to provide a social context and improve students’ engagement in flipped classes (Talaei-Khoei & Daniel, 2016).
Method

Context
About 300 students in a second-year undergraduate Information Systems course were invited to participate in the study. Of these, 19 students did not participate, and a couple of students did not complete the experiments, which left the experiment with 273 students (range 19 – 42 years; Mean = 22.8; SD = 2.7; 167 males and 106 females). The topic of the course was enterprise resource planning (ERP) from management perspective, but with some technical flavor such as introducing the technologies that can be used in ERPs. The course did not involve any hands-on experience by students but focused more on managing an ERP system in an organization. The course duration was twelve weeks, and met twice a week for 90 minutes each, one day per week for lecture, and the other day for a tutorial/workshop session. The lectures were given by the instructor and the tutorials were managed by teaching assistants, in classes of 24-28 students.

Design
The course offered four flipped class sessions during the course of a 12 week semester, paced as demonstrated in Table 1.

<table>
<thead>
<tr>
<th>First flipped class</th>
<th>Second flipped class</th>
<th>Third flipped class</th>
<th>Fourth flipped class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 3</td>
<td>Week 5</td>
<td>Week 8</td>
<td>Week 10</td>
</tr>
<tr>
<td>Lecture Material made available to students through LMS</td>
<td>Lecture Material made available to students through LMS</td>
<td>Lecture Material made available to students through LMS</td>
<td>Lecture Material made available to students through LMS</td>
</tr>
<tr>
<td>Additional videos provided</td>
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<td>Additional videos provided</td>
</tr>
<tr>
<td>Online Voluntary Quiz, including 5 discussion questions</td>
<td>iSee Voluntary discussion</td>
<td>iSee Voluntary discussion</td>
<td>Online Voluntary Quiz, including 5 discussion questions</td>
</tr>
</tbody>
</table>

Table 1 Flipped Classes Schedule
For the online iSee discussions, students were not allocated to any group, but were asked to arrange a meeting with some of their classmates to discuss the questions on iSee. To participate in the iSee meeting, they had to login and virtually gather around a desk to discuss the questions. The students could use a virtual board to present to the group using power point slides, word documents, or by writing on the board. (See Figure 1). The students could gather while other groups may gather around another desk. The closer they were to the group, the more they could hear. This simulated the real classroom environment in a virtual class online. The students were asked to record their iSee meetings which is possible in iSee environment. Then, in all these four flipped classes in weeks 3, 5, 8 and 10, the students when physically participating in the class were given five similar but not the same questions about the topic of the week in hardcopy. Their performance was recorded.

Analysis
The quantitative analysis phase in this experiment was involved the study of correlations among three different constructs; namely (1) students’ engagement in the online quizzes prior to the class, (2) students’ engagement in the iSee discussions before the class and (3) students’ learning outcomes. For this to happen, we took the following three steps:

• **Step 1 - Measurement:** The following three measures were defined for each of the above-mentioned constructs and calculated for each participant:

![](image-url)
Engagement with the Flipped Online Quizzes: the students on the first and fourth experiments were given five online discussion questions that each could be graded to the maximum of one mark (five marks in total). These marks were given by the teacher and based on the answers entered.

iSee Engagement: Instead of online quizzes, in the second and the third experiments, the students were asked to discuss five discussion questions on iSee. The students’ engagement on the iSee discussions in a particular experiment on week 5 or 8 for each student was calculated by average time staying active in discussions. Active time is defined as the number of minutes that the participants were contributing in the discussion. It was observed that in some groups there were more than one session for each experiment on week 5 and 8. In that case, we add the active time for each participants and averaged it between two experiments. This was measured for each student in the second and the third experiments separately.

Learning Outcome: The students’ learning outcome was calculated by their answers to the five discussion questions given to them in the physical class in all four experiments.

• Step 2 – Calculating the Correlation Efficient: In each experiment, the correlation between the data sets of the students’ Engagement with either the Flipped Online Quizzes or iSee discussions and the Learning Outcome was calculated. In order to do so, the Bivariate Correlation Analysis was conducted in SPSS to calculate correlation coefficients ($r$). The significant level of these correlations was measured by $p$-value. One may say that the correlations between students’ Engagement with the Flipped Online Quizzes or iSee discussions and Learning Outcome are because of the natural correlation between Flipped Online Quizzes and iSee discussions. For example, a possibility is that one may participate in iSee just because he/she was very active and as such she/he became interested in the topic. However, this cannot be the case, as these experiments were conducted separately and on different weeks.

• Step 3 – Comparing the Correlations: In this step, the calculated correlation in the first and the second experiments as well as the third and the fourth ones would be compared. It would help us to see our comparison provides us similar results at the beginning and at the end of the semester. Using the Fisher $r$-to-$z$ transformation (Weaver & Wuensch, 2013), we calculate a value of $z$ that can be applied to assess the significance of the difference between two correlation coefficients, found in two independent samples of the correlations between the students’ Engagement in Online Flipped Quizzes and their engagement on iSee discussions with the learning outcomes. We repeat the comparison for comparing samples of the first experiment with the second experiment as well as the third experiment with the fourth one. The comparison of correlations can only meaningful if they are significantly different.

Having done the above three steps, the null hypothesis explaining the significance of the difference between the correlation of the students’ Engagement in the flipped online quizzes with the learning outcome and iSee Engagement with the learning outcomes would be retained or rejected. The results can be double checked across the beginning and the end of the semester. The correlations in all above calculations were considered as 2-tailed.

In order to analyze the qualitative notes, the teaching team including the lecturer and the teaching assistants were meeting after each flipped learning week and discussed their observations. At the end of the semester, the notes and the observation findings were concluded in a workshop of 8 academics who were involved in teaching similar courses.

Results

Quantitative Results

Comparison of the First and Second experiments: Following the guidelines of Evans (1996), the correlation coefficient 0.6 to 0.79 is called high and the correlation coefficient between 0.8 to 1.0 is called significantly high. The results indicated that the correlation between the students’ engagement in the flipped quizzes and their learning outcome in the first experiment was high but not significantly high ($r=0.621$, $p<0.001$). It was found that the correlation between the students’ engagement with iSee discussions and their learning outcomes was high but not significantly high in the second experiment ($r=0.734$, $p<0.001$).

The difference between these correlations was highly significant, $z=2.45$, $p<0.014$. Therefore the Null Hypothesis implying the no significant difference between these two correlations was rejected. It was revealed that the correlation between the students’ iSee engagements with their learning outcomes was
significantly stronger than the correlation between their engagement in the flipped quizzes and their learning outcome. One may say this can be influenced by the natural correlation between the students' engagement on iSee with their engagement in the flipped quizzes. However, The Evans (1996) guidelines indicated that the correlation between the students’ engagement with the flipped quizzes and their iSee Engagement was weak ($r = 0.231$, $p < 0.001$). Therefore the risk is not the case.

**Comparison of the Third and Fourth experiments:** The results found in the beginning of the semester were confirmed by the comparison of the correlations at the end of the semester. It was found that the correlation between the students’ engagement in the flipped quizzes and their learning outcome in the fourth experiment was high but not significantly high ($r = 0.712$, $p < 0.001$). However, it was found that the correlation between the students’ engagement with iSee discussions and their learning outcomes was significantly high in the third experiment ($r = 0.821$, $p < 0.001$).

The difference between these correlations was highly significant, $z = 3.121$, $p < 0.002$. Therefore the rejection of Null Hypothesis implying the no significant difference between these two correlations was confirmed. The result of the comparison of the first and the second experiment was acknowledged by comparing the third and the fourth experiments. The correlation between the students’ engagement on iSee with their engagement in the flipped quizzes was found insignificant. The Evans (1996) guidelines indicated that the correlation between the students’ engagement with the flipped quizzes and their iSee Engagement was weak ($r = 0.119$, $p < 0.001$), which rejects any natural effects caused by correlation of the students engagements with flipped quizzes and iSee discussions.

All in all, it was found that the correlation between the students’ iSee engagements with their learning outcomes was significantly stronger than the correlation between their engagement in flipped quizzes and their learning outcome in the course.

**Qualitative Observational Results: Lessons learned to improve students’ engagement with Flipped Learning Materials using 3D Video Collaboration**

**3D Video Environments increase students’ motivation to engage with the flipped learning materials prior to the class.**

iSee could motivate students to study the materials before sitting in the flipped classes, in two different ways; namely prior and after the iSee discussion sessions. It was found that students were motivated for the iSee discussions and as such tried to be prepared before participating in them. Interestingly, it was also found that the students went through the materials once more after the iSee session to reflect on what have been discussed in the iSee discussions.

One student indicated in an informal chat with the teaching team that his disagreement with the discussion could simply motivate him to go through materials and find out the correct answer. This self-learning component that was motivated by the discussions on iSee is the main objective of the flipped learning practices. While the students’ engagement to the self-learning of materials has been reported as a problematic issue in Flipped classes by Elliott (2014) as well as DeSantis, Van Curen, Putsch, & Metzger (2015), 3D video environments seem to be effective to engage students.

**3D environments cultivate a collaborative environment and improves learning.**

It was observed and discussed by students that the 3D feature of iSee and the classroom settings in virtual environment made it possible for students to have a more realistic perception about the discussions with their peers. The students believed that they enjoyed their discussions on iSee and they preferred them to environments such as Skype or Google hangout. There was a student that she was so much impressed with the interactive nature of the discussions and she related them to the settings provided by iSee. The students were generally very impressed by the board and its features to write on it or put power point slides and word documents. The students believed that the discussions occurred in iSee among their peers contributed in their learning. They indicated that in comparison to the online quizzes, the discussions on iSee because of its collaborative settings and the interactive nature were more interesting. They believed that they have learned from iSee more than they learned from the online quizzes.
Sense of community could not be motivated among students in 3D collaboration environment.

Surprisingly, the teaching team could not observe the development of sense of community in the iSee discussions. In many occasions, the students have changed their discussion group when realized that there is another group discussing the materials in a deeper or richer fashion. There was no attempt observed that students were motivated to teach the materials to their peers. They were more interested to learn from the discussions and make sure that they learned the materials.

This findings are in disagreement with the finding of (Abedin, Daneshgar, & D’Ambra, 2010) about sense of community in online learning. The teaching team found that the students did not build and hold any sense of community around the materials, but they were enjoying casual discussions with their peers about the materials.

Students did not show any privacy concerns.

It was found that the students expressed their satisfaction about their privacy when using iSee. Although the students were given an option to use a fake name and disable their camera, there was no student that actually used such an account. The students also were asked in an informal conversation after the second flipped class if they are concerned, none showed any. It was interesting to see that the students could see this is not about getting into their privacy but it is about them getting encouraged to engage with the materials.

Advantages, disadvantages and recommendations for the use of iSee as an online collaborative tool for flipped learning

Overall, the students informally expressed their general satisfaction with the use of iSee. They believe 3D video collaboration technology provides ease of use and ubiquitous access. They think it is much easier to discuss the materials on iSee provided its interactive features, compared to logging into the online management system. iSee provides more user friendly environment. The students pointed out that iSee supports the interactive communication and collaboration among the peers. The advantage of iSee in comparison of other 3D video collaborative environments is that it is specifically designed for education. Therefore, the settings provided in the virtual class environment (e.g. desks and boards,) helped the students during their discussions.

However, students think that the learning curve involved in understanding the environment can impact on their motivation. This is similar to the results of Li et al. (2013). The students also indicated in larger groups it became very difficult to manage the discussions as the virtual communication could be a barrier. They actually preferred smaller group discussions or meeting in person for larger groups.

The students recommended that the use of polls in iSee can improve engagement and also recommended that the questions for discussion on iSee can be implemented in a poll. They also indicated that the desks should be placed with more distance from each other. Therefore, students wouldn’t hear other groups. It was also suggested that there a maximum number of students should be allocated to each discussion. An auto allocation feature to discussions would help when a student does not know to join which group.

Discussion & Conclusion

In this paper, an experiment has been reported on 273 second year Information System students for an ERP undergraduate course. The experiment was a longitudinal correlational study in four flipped classes on weeks 3, 5, 8 and 10. In these four classes, the students were given the materials prior to the class on the learning management system. While the first and the last class required students to participate in online quizzes including five discussion questions in advance to the physical presence in the class, the second and the third classes needed the students to participate in a 3D video collaboration environment called iSee and discuss five questions. The choice of time and whom they are discussing the question with, was by students.

It was revealed that in both cases, the correlation between either the students’ engagement on the online quizzes or their engagement on iSee discussions with their learning outcomes were high. However, our
statistical analysis showed that the relationship between iSee engagement and students’ learning outcomes was significantly stronger than the correlation between online quizzes and learning outcomes.

Our results is in agreement with Edirisingha et al. (2009) that social engagement among learners can be boosted by 3D video collaboration technology, such as iSee in this study - resulting in achieving higher learning outcomes.

Although the present study does not look at the causal relationships between these constructs and only investigated the correlations, it suggests the potentials for such learning practices that use 3D video collaboration technology. Such a delivery model has potentials to improve students’ engagement and learning outcomes by implementing online peer tutoring in flipped classes. Since the iSee environment requires students meet together at a particular date and time to carry on the discussion, it might be useful to explore if this was problematic or not for the students. A number of students in the online class environments may preferred that this type of requirement is not included in the class as the benefit to the online environment is the flexibility of being able to work on the class when it is convenient for them and not having to schedule a particular time to meet. This opens an avenue for future research.

**iSee: Place Presence, Social Presence, Co-Presence and Students Engagement**

Our findings are supported by the Bulu (2012) theoretical framework. The conceptual model suggests that the immersive tendency provided by 3D video collaboration technologies provides stimulation of physical place and participants. This results in social interactions and accordingly engagement. In the present study, iSee was deployed as a 3D video collaboration technology to engage students with the flipped learning materials prior to the class. As the theoretical framework suggests the place presence is a construct to create social context. In this study, not only does iSee provide immersive capabilities, but also the virtual environment in iSee has been designed for classroom settings. The place presence includes a fully functional classroom environment with desks that students can gather and also boards that students can write on or put presentation slides or even text documents. In addition to the classroom features that the immersive environment in iSee provides, it also promotes a collaborative setting that stimulates the physical presence of participants, i.e. co-presence.

In regular practices for flipped classes, the lack place presence and co-presence leads to poor engagement of students with the materials outside of the class. However, according to Bulu (2012) theoretical framework, iSee by providing such settings that include classroom and classmates improves the social context and therefore engages students in their discussions.

**Theory of Peer Learning: Research for Quantitative Results**

In this section, the applications of these constructs in the use of iSee as an intervention to improve students’ engagement with flipped classes are going to be discussed. One of the main organizational advantages of using iSee discussions comparing to the online quizzes to implement flipped learning is the social context that this setting creates. The concept is built on a social notation that the engaging students with the learning materials prior to the flipped classes does not occur only because of the quality of materials but also because of a social context that iSee creates; See section above. Our statistical analysis on the difference of the coloration between students’ engagement with online quizzes and their learning outcomes shows that the engagement with iSee discussions has a significantly higher correlation with the learning outcomes (for the first and second flipped classes: \( z = 2.45, p < 0.014 \) and for the third and the fourth flipped classes: \( z = 3.121, p < 0.002 \)). Although the limitation of the analysis does not suggest any causal relationship but provides us with a possible potential. The importance of social context to improve students’ engagement is supported by online learning literature (Edirisingha et al., 2009; Kreijns, Kirschner, & Jochems, 2003) and justified by the Bulu’s (2012) theoretical framework discussed in the above section.

Another organizational advantage of using iSee discussions comparing with other technologies that provide social contexts such as Facebook classes is related to individualization of learning occurred in small groups. This is in supported by the concept of individualization of learning in small groups introduced in the Topping’s model of peer learning (K. J. E. S. W. Topping, 2001). However, it is in stark contrast with the findings of Talaei-Khoei & Daniel (2016) that believe the power of crowd provided can
improve students’ engagement with online materials in flipped classes. They work was based on prior research by Talaei Khoei & Talaei-Khoei (2015a) marrying the theories of social learning (Parke, 2014) and peer learning (K. J. E. S. W. Topping, 2001). Our findings from the qualitative analysis of the observations show that students believe that managing large-group discussions is difficult. They prefer smaller size groups gathering together in iSee. Therefore, further research in this area is required to investigate the actual individualization of learning that occurs during small group discussions during iSee sessions in comparison of larger groups of Facebook in the context of flipped learning.

Cognitively, peer learning requires challenging as well as supporting the learners’ opinions. iSee providing the immediacy of discussions and interactions can empower the peer tutoring required to engage students with the flipped materials. Bishop & Verleger (2013) believe that the implementation of peer tutoring can improve the students’ engagements with the flipped materials.

Error management is a monitoring mechanism that has been introduced in peer learning model of Topping (2001). In some informal conversations, students expressed their worry that in flipped classes there is a risk of misunderstanding of the materials. However, it was shown that the discussions on iSee can help students to correct their misunderstandings.

One of the drawbacks for the flipped learning is that the same comprehension cannot be assumed from the written and visual materials given to the students prior to the class compared to teaching the materials to students. Beside the variety and the differences of communication skills among students, not to say that we also have international students that may require extended time in understanding written and visual materials. This would be hard in the context of flipped learning when the comprehension is only relying on a one-way written or visual channel. The iSee discussions give all students this opportunity to relax from the pressures of the one-way communication channels. However, this may create a risk where students with less communication skills may be less active and therefore get disadvantaged. This needs further investigation by empirical results from the students’ perspective.

From affective components there are few considerations that are required to be taken into account. For example in practicing flipped learning on iSee comparing to the online quizzes, Lockyer and Patterson (2008) believe that learning in informal settings is not considered a highly conscious activity. However, the results of this work are in stark contrast with the Lockyer and Patterson’s statement (2008).

**Insights from Qualitative Results**

Most students believe that iSee enables a collaborative environment in flipped learning as it stimulates classmates in online discussion wherein they learn from different perspectives. They also feel that iSee provides convenience of use as it is flexible to use from anywhere and at any time. However, given that they are not familiar with iSee user interface, there is a learning curve involved in employing it for flipped classes. For students, it is an interactive and engaging tool; it stimulates self-learning and improves their understanding of the subject.

Despite the positive features, the students experienced some of issues and limitations in using iSee for their Flipped Learning activities. Mainly, they feel that iSee discussions can end quickly thus they felt that there was a need for more open-ended questions. The platform also caused some issues such as students getting distracted by other groups of students discussing. It is recommended that desks in the virtual environment should be set up with some distance. It was notable though that there were no statements on issues for the privacy concerns. This shows students realized that the iSee discussions of the flipped learning class is not to intervene with their privacy, but to provide an effective channel of discussion for flipped materials.

It also appears that conventional online learning environments such as Blackboard and Moodle have definite limitations when compared to 3D video collaboration technologies such as iSee. The immersive environment provided by iSee promotes the presence of class and classmates. In comparison with conventional online learning environments, the stimulation of place presence and co-presence, theorized by Bulu (2012), improves the social contexts of discussions and engages students to prepare themselves before flipped classes.
Comparison of the Current Work with Related Studies

Talaei Khoei & Talaei-Khoei (2015) demonstrated the use of Facebook in improving the peer tutoring practice in the class that resulted in improving the students’ learning outcomes. Another study examined the application of Facebook in improving learning outcomes for flipped class, and found that Facebook lacked the interactive features that help students to carry out the discussions (Talaei-Khoei & Daniel, 2016). Results from prior literature suggest that students find the lack of interactive features makes the discussions dull after a while. In an attempt to address this challenge, this research combines the peer learning theory (K. J. E. S. W. Topping, 2001) and the framework presented by Bulu (2012). This research has added place presence and co-presence to improve social interactivity and finds that students’ engagement was achieved.

Our results show that the social interactions during discussions were improved, which resulted in higher learning outcomes. Our findings show that the use of 3D video collaboration technologies such as iSee compared to Facebook, does not involve any privacy issue from the students’ perspective. However, in terms of building sense of community among students, iSee was a less successful intervention. The sense of community has also been shown to be an effective element in improving learning outcomes (Abedin et al., 2010). Compared to Facebook, another disadvantage of iSee is the lack of push notifications. Push notifications of discussion posts on Facebook have received a mixed response. While it can help constantly engage students with the materials; particularly if these notifications were sent to their smartphones; however, many students also reported being distracted by too many notifications (Talaei-Khoei & Daniel, 2016). iSee does not support push notifications.

There has been a body of literature highlighting the role of 3D immersive environments for online learning (Boulos, Hetherington, & Wheeler, 2007; Dickey, 2005; Hew & Cheung, 2010). These studies are in agreement that interactive features of 3D immersive environments can improve students’ engagement resulted in improving learning outcomes. Although these articles are in support with the idea of using 3D immersion technologies such as iSee to engage students’ engagement with online materials in flipped practices, there has been no experiment reported in this area. The present study suggests the potential for these technologies in flipped learning.

This research has examined the relationship of the students’ engagement in online quizzes and iSee-based discussions, with their learning outcomes in flipped classes. The statistical procedure used in this research, (correlation analysis) does not evaluate possible causal relationships between these constructs. Therefore, due to the different objective of this work, it cannot be concluded that deploying the iSee discussions is more effective for flipped learning compared to online quizzes. However, it opens an opportunity for future studies to investigate the causalities among these constructs. Another area for future study is to conduct a finely tuned analysis of students’ individual personality differences on the outcomes of engagement.

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