The experience of three flipped classrooms in an urban university: an exploration of design principles

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1. Introduction

Over the past decades higher education standards have emphasized the potential value of student-centered learning environments in which students are actively engaged in higher-order tasks and taking charge of their own learning (Hannaﬁn, Hill, & Land, 1997; Means, 1994; Shea et al., 2012). Student-centered learning environments necessitate applying more active learning strategies to classroom teaching that, for example, involve student presentations, small group problem solving, self and peer evaluation, and group discussions (Zappe et al., 2009). Yet creating such environments remains a challenge. Teachers are not necessarily prepared to apply new pedagogies or to support the expanded roles and responsibilities associated with student-centered learning. This is evidenced by challenges encountered in designing and supporting student-centered learning (Brush & Saye, 2000; Hannaﬁn et al., 1997). For example, teachers often have difﬁculties managing their ﬁnite classroom time and limited number of face-to-face classroom meetings to achieve an effective balance between lectures and active learning strategies (Strayer, 2012). Instructors who are implementing student-centered learning would beneﬁt from a set of teaching strategies and tools to ease the tension among these activities.

Flipped classroom models have attempted to address these challenges by allocating more class time for active learning approaches and by leveraging accessibility to advanced technologies to support a blended learning approach. A typical flipped classroom approach provides students with access to online video lectures prior to in-class sessions so that students are prepared to participate in more interactive and higher-order activities such as problem solving, discussions, and debates. (Baker, 2000; Bergmann, Overmyer, & Wilie, 2012; Davies, Dean, & Ball, 2013; Foertsch, Moses, Strikwerda, & Litzkow, 2002; Fulton, 2012; Hughes, 2012; Lage, Platt, & Treglia, 2000; Talbert, 2012; Zappe et al., 2009). Students beneﬁt from the outside classroom events because they can allocate their time and pace their online learning to meet their individual levels of comprehension. In face-to-face classroom sessions, students have the opportunity to become more active and interactive through group activities rather than passively listening to lectures. Teachers in turn are able to commit more in-class time to monitoring student performance and providing adaptive and instant feedback to an individual or group of students (Fulton, 2012; Herreid & Schiller, 2013; Hughes, 2012).

Strayer (2012) posits that “the regular and systematic use of interactive technology” (p. 172) makes ﬂipped classroom models unique, countering a critique that ﬂipped classroom models are not new because teachers have always relied upon readings, and computer-assisted instructions to prepare students for in-class activities. We argue here that the ‘systematic use’ of technologies is inﬂuenced by the design of the ﬂipped classroom instance. The design limitations of previous ﬂipped classroom studies are listed below.

1.1. Limitations found in previous studies of the ﬂipped classroom approach

The design of ﬂipped classrooms has often been limited to the concept of replacing in-class instruction with videos and using class time for homework. In contrast, we deﬁne the ‘ﬂipped classroom’ as an

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open approach that facilitates interaction between students and teachers, and differentiated learning (Bergmann et al., 2012; Keefe, 2007; Lage et al., 2000; Tomlinson, 2003) by means of flipping conventional events both inside and outside of the classroom and supporting them with digital technologies (Hughes, 2012). A notable pioneer of the flipped approach, Lage et al. (2000), did not limit “flipping” to lectures and homework, stating:

Inverting the classroom means that events that have traditionally taken place inside the classroom now take place outside the classroom and vice versa. The use of learning technologies, particularly multimedia, provide new opportunities for students to learn, opportunities that are not possible with other media. (p. 32).

Research is needed on what aspects of flipped classroom implementations explicitly benefit teaching and learning. Zappe et al. (2009) experimented with a flipped undergraduate engineering class, concluding that students perceived the course as having a positive impact on their learning. Herreid and Schiller (2013) reported the benefits of flipped classrooms based on the results of a large-scale survey administered to STEM case study teachers who used flipping methods. However, these reports fall short of an explicit accounting of what features of the flipped classroom yielded benefits for learners and instructors. Another recently conducted experiment (Davies et al., 2013; Strayer, 2012) indicated that there was no significant difference in student performance between flipped classrooms and traditional classrooms. Strayer (2012) reported that students perceived a significantly lower level of structural support to facilitate student conduct during flipped events, warning that this perceived lack of support might lead to lower engagement. We posit here that this possibility (a perceived dearth of support prior to and during a flipped event) does not indicate that the flipped classroom approach is of low value to teaching and learning. Rather, we make the argument that it is necessary to explicitly define the values connected with flipped classroom models.

Few studies detail the design principles of the flipped classroom, and we found no scientific articles that detailed the flipped classroom design principles in our literature review. Many studies discussed what benefits can be expected from flipping the class (Davies et al., 2013; Foertsch et al., 2002; Fulton, 2012; Gannod, Burge, & Helmick, 2008), but fell short of defining and building design principles for the flipped classroom. Bergmann and Sams (2012) suggested a list of design considerations such as ‘time to learn new software’ and ‘support from administration.’ However, their guidance was limited to technological elements. Later, Bergmann et al. (2012) listed what characterized the flipped classroom (e.g., “a means to increase interaction and personalized contact time between students and teachers”) contrasting these elements to misleading manifestations of what are ‘Not Flipped Classrooms.’ Their proposal of what defines the flipped classroom suggests many potential discussions of what can be added to a list of design principles for the flipped classroom. This study aims to define design principles for the flipped classroom and those principles posited here build directly upon the first four design principles suggested by Brame (n.d.) at the Vanderbilt University’s Center for Teaching: Provide an opportunity for students to gain first exposure prior to class; provide an incentive for students to prepare for class; provide a mechanism to assess student understanding; and provide in-class activities that focus on higher-level cognitive activities.

1.2. Analytic framework: the revised community of inquiry (RCOI)

This study deploys the theory-driven analytic framework — Revised Community of Inquiry (RCOI) (Garrison, Anderson, & Archer, 1999; Shea & Bidjerano, 2010; Shea et al., 2012; Swan, Matthews, Bogle, Boles, & Day, 2012) — by first investigating the impact of the flipped classroom approach on three participating classrooms as a means of eliciting a model that is able to guide the elaboration of design principles. This framework posits that knowledge building results from the collaborative interaction between active students and teachers particularly in online/blended learning environments (Shea & Bidjerano, 2010; Shea et al., 2012). The RCOI framework theorizes four elements that contribute to a successful learning environment: Cognitive Presence, Social Presence, Teaching Presence, and Learner Presence (see Table 1). Fig. 1 illustrates that the four RCOI components are featured in the student-centered learning environment.

1.3. Goals and research questions of the current study

This study is based on a pilot project conducted at the University of Southern California (USC) located in urban Los Angeles, with three undergraduate flipped classroom instances. Each instance was explored in terms of the unique interpretation of “flipping a class” made by each instructor, their respective flipping strategies, and how the instructors used technologies to facilitate flipped classroom events according to their unique interpretations. Building on the RCOI framework, this study aimed to investigate participants’ perceived values of the flipped classrooms with respect to the RCOI components and to elaborate a design framework from which design principles for the flipped classrooms could be specified. The following research questions guided the study:

• How do the instructors interpret and apply ‘flipping’ to their classrooms?
• What are the students’ perceptions of the value of the flipped classroom?
• What are suggestions for the design of the flipped classrooms?

2. Research context: three flipped classrooms

USC is a large research institution with an enrollment of over 40,000 students. Since 2010 the university has transitioned from a commuter campus to a residential campus with extensive housing and corresponding facilities. Borne out of a desire to reconcile the needs of undergraduate residential learners who seek value in face-to-face classroom learning experiences with the convenience and efficiency of online instruction, the flipped classroom project was initiated in pursuit of providing better learning environments in which students can be more engaged, active, and responsible for their learning. Over the period of the fall 2012 semester, three classes, one each in engineering (ENG), social studies (SOC), and humanities (HUM) participated in the project. The project rendered useful data on discipline-specific flipped classroom applications including course events, feasible instructional technologies, and the internal support resource allocations required, which could give rise to design principles for the flipped classroom. Each participating class was carefully selected and a mentor-protégé relationship established amongst the participating instructors whereby seasoned ‘flipped classroom’ instructors were paired with the instructors who were newcomers to ‘flipping a class.’ In addition to mentorship, a learning technology service unit provided technology and instructional design support. Participating instructors had brief consultations with their respective support person(s), followed by nine project meetings as well as frequent email communications and some telephone support through the semester.

The three participating instructors designed their flipped classroom events in light of their individual contexts and purposes for flipping classrooms, which resulted in widely different forms of flipping across three disciplines. Table 2 describes the dimensions of the flipped classroom approach with accompanying details for each classroom implementation.
2.1. Engineering class (ENG): maintaining the essence of a flipped classroom

ENG was an undergraduate biomedical-engineering course with lectures and a weekly two-hour lab session for the application of concepts and principles that focused learning on the theme of ‘conservation of energy’ through problem-solving methodologies and activities. Students viewed videos outside of class on YouTube, discussing the course focus on ‘conservation of charge.’ Student learning of content in the video lectures was monitored through a combination of short quizzes (3–5 multiple choice questions) created on the Blackboard learning management system (LMS), and low-stakes points students received for participation on respective YouTube discussion boards. During class, the instructor presented a problem relating to, but not exclusive to, the video(s) viewed outside of class. Groups self-assembled among the 52 class members to solve problems during class while the instructor and two TAs provided facilitation. The instructor applied his prior experience with flipping a class whereby both the out-of-class and in-class experiences were improved by creating a clearly defined contextual link between the two. For example, the instructor used select student comments as a springboard for the next lecture and had students answer each other’s questions in groups, based on the questions they posted on YouTube.

2.2. Sociology class (SOC): building a project-based learning environment

For part of this course, the SOC instructor assigned students to group research projects as an out-of-class assignment and devoted some class time to making progress on those projects during a segment of the course. The flipped classroom events aimed to help students learn how to construct and refine a testable research question over the course of several weeks of discussion; how to collaborate with peers; and how to research across an array of data sources that address the testable research question. The instructor assigned the students to view a short video that described a specific set of activities designed to help students formulate a valid and measurable research question. Primary technologies used were the Blackboard LMS for discussion, with each group being required to post their key findings and remaining questions, and with at least one group member required to respond to another group; and YouTube for video postings. Students worked in groups to create an 8–10 minute presentation that they shared with the entire class, and that served as the content for a 5–7 page group paper. Students also used Google Docs for collaboration. All group members shared a project grade. Within each group, students individually evaluated their peers on the levels of their unique contributions to the effort.

2.3. Humanities class (HUM): experimenting radical student-directed learning

The HUM instructor taught 13 students in a seminar twice weekly. The instructor sought to create course continuity during three weeks when he was lecturing at other universities. For a period of three weeks, the students were given three different assignments designed to prepare three respective student groups for a set of student-directed in-class activities conducted without the instructor present. The instructor required students to record their discussions or a summary of their group discussions using some kind of video technology, and later viewed the groups’ self-reported in-class collaboration. The recording was expected to work as a tool that helped the instructor monitor student discussions remotely, while promoting student engagement in a meaningful, albeit non-instructor facilitated dialogue.

Discussion prompts were used to help facilitate discussion within each small group. Flipped events permitted students to (a) figure out how to lead the process in the instructor’s absence and who should

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**Table 1**

<table>
<thead>
<tr>
<th>Type of Presence</th>
<th>Definition</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive Presence</td>
<td>Knowledge building involving critical and creative thinking</td>
<td>Challenging tasks, the cyclical process of practical inquiry, and a multivariate measure of critical and creative thinking</td>
</tr>
<tr>
<td>Social Presence</td>
<td>Encouraging collegial settings</td>
<td>Discourses among students and instructor that promote positive affect, interaction, and cohesion</td>
</tr>
<tr>
<td>Teaching Presence</td>
<td>Instructional orchestration appropriate to the learning environments</td>
<td>Task sets such as organization, design, discourse facilitation, and direct instruction</td>
</tr>
<tr>
<td>Learner Presence</td>
<td>Self- and co-regulation of learning</td>
<td>Self- and co-regulatory strategies that marshal thoughts, emotions, motivations, behaviors and strategies</td>
</tr>
</tbody>
</table>

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**Fig. 1.** The RCOI framework applied in this study.
lead it and (b) edit spontaneous live discussion into an interstitial artifact: more edited than classroom conversation, less edited than a finished essay. Students created simple video-captures that they rendered in YouTube. Students were not expected to edit using software such as iMovie, motivated by the idea that developing video production skills was not a chief learning goal of this process. The YouTube platform enabled the conversation to be shared with the instructor.

The students conducted small group conversations off camera. The flipped element was to redact conversation for the camera in such a way that it would yield an edited artifact. The mentor and a supporting staff member, who was an instructional designer, supplied students with a variety of role-playing scenarios that would aid them in thinking about how to move the free-form conversation into an edited thought-piece.

However, in practice, students almost uniformly found the role play and redaction to be inauthentic and laborious. Students were leery of "performing" to the physically invasive camera, which due to its presence and the need to manage it, forced disruptions and interruptions during conversations. The goal of the HUM class was to have students develop an 'interpretive build' on a topic via their active in-class conversation. For students who already perceive the humanities classroom as student-centered, this flipped experience might be perceived as an authentic self-regulated conversation accompanied by the extra work of creating a video recording of inauthentic discussions.

3. Research methods

We conducted a mixed methods study to capitalize on the strengths of both quantitative and qualitative methods (Greene, 2007). The Revised Community of Inquiry (RCOI) framework was used as an underlying factor model to evaluate the levels of the implementation of three flipped classrooms for both quantitative and qualitative analysis. We first analyzed quantitative data to portray overall features of the flipped classrooms and then extracted design principles from multiple qualitative data sources.

3.1. Participants

Three instructors from different disciplines — engineering (ENG), social studies (SOC), and humanities (HUM) were selected on the basis of their commitment to the flipped classroom concept, their disciplinary focus in light of the other disciplines, and past experience using technology to support their online instruction. 115 students were enrolled in the three classes during the fall 2012 semester. A total of 41 students responded, with a response rate of 36%. Twice as many female students as male students participated in the study (see Table 3). The majority of the students in the ENG course were in their first year, while many students in SOC were in their third year or more. For the HUM, the response rate was 26%, but the number of responses was too small to analyze (only 4 students). With respect to prior courses taken, most students in the ENG had no previous experience with related courses, while over half of SOC students had taken course(s) similar to the SOC course.

3.2. Data collection

We collected data from diverse sources including surveys, interviews, instructor reflections, and documents (e.g., meeting minutes, course syllabi and student outcomes).

3.2.1. Student survey

The student survey consisted of four sections: (a) Teaching Orientation; (b) Revised Community of Inquiry (RCOI); (c) Technology Use; and (d) open-ended questions. The Teaching Orientation measure asked students whether the classroom culture is more teacher-oriented or student-oriented. The Revised Community of Inquiry (RCOI) measure consisted of four sub-scales: (a) The Teaching Presence, (b) Social Presence, (c) Cognitive Presence, and (d) Learner Presence. These measures were deemed to account for the specific features of the Teaching Orientation for the flipped classrooms. The Technology Use measure was also included to indicate the extent to which students felt easy and comfortable when using technologies, a key factor considering that the flipped classrooms employed a variety of online learning technologies. The total number of survey items was 50: seven items for orientation toward student-centered learning (Teaching Orientation); eight items for each of four RCOI subdomains; five items for the use of technology; and six open-ended questions. For 46 items, a four-level Likert scale was used, ranging from 'Strongly Disagree,' 'Disagree,' 'Agree,' to 'Strongly Agree.'

Seven items for Teaching Orientation were created on the basis of the Section IV of the Classroom Lesson Observation (CLO) survey of CITERA (Comprehensive Information Technology Education in Rural Appalachia, funded by the National Science Foundation; http://www.theedventuregroup.org/citerawv/). Section IV of the CLO questioned teachers about the impact of technology integration on classroom teaching in middle and high school contexts (Darrah & Blake, 2009). For this study two higher education professionals helped design the items for students within a higher education context.

We used a bipolar scale to rate the design and implementation of flipped classroom activities that ranged from teacher-centered (highly structured, directed learning) to student-centered (mostly unstructured, open-ended learning) (see Fig. 2). For example, given two polarized descriptions of the classroom (On the one end “Classroom activities focused on knowledge abstraction and acquisition,” and on the other end “Classroom activities focused on making real-world connections”), students selected the button nearest the classroom environment that most closely resembled their experiences. For seven items, the reliability score was 0.72 overall (see Table 5).

The second part of the survey was composed of the Revised Community of Inquiry (RCOI) measure. To measure the three sub-domains (Teaching, Social, and Cognitive Presence), we used items that were selected from the Community of Inquiry instrument (Shea & Bidjerano, 2010; Swan et al., 2012) according to the study context (i.e., flipped classrooms as a type of blended learning). Reliability scores were 0.87, 0.87, and 0.88 respectively (see Table 5). For the Learner Presence, previous studies introduced the concept of learner presence and developed a coding scheme for the use of content analysis, but did not develop questions for the construct (Shea et al., 2012). For measures of the

Table 2

<table>
<thead>
<tr>
<th>Three flipped classrooms.</th>
<th>Engineering (ENG)</th>
<th>Social Studies (SOC)</th>
<th>Humanities (HUM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pedagogy</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Flipping Approach</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>In-Class Activities</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Pedagogy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flipping in-class lectures and quiz</td>
<td>Problem solving in small groups</td>
<td>Discussion of group projects for assigned time in classroom</td>
<td>Flipping the role of Instructor and Students</td>
</tr>
<tr>
<td>Out-of-Class Activities</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technology Used</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engineering (ENG)</td>
<td>In-class Problem Solving</td>
<td>Project-Based Learning</td>
<td>Self-/Co-regulated Discussion</td>
</tr>
<tr>
<td>Social Studies (SOC)</td>
<td>Flipping in-class lectures and quiz</td>
<td>Flipping in-class lectures and extended collaboration</td>
<td>Flipping the role of Instructor and Students</td>
</tr>
<tr>
<td>Humanities (HUM)</td>
<td>Problem solving in small groups</td>
<td>Discussion of group projects for assigned time in classroom</td>
<td>The small group discussion without the presence of the Instructor; recording a discussion</td>
</tr>
<tr>
<td></td>
<td>Online video lecture; Quiz; comments on the videos</td>
<td>Small group project via technologies</td>
<td>Instructor ’s review of group discussions</td>
</tr>
<tr>
<td></td>
<td>YouTube, LMS</td>
<td>YouTube, LMS, Google Docs</td>
<td>Google Hangout, Video Cam, Dropbox</td>
</tr>
</tbody>
</table>

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3.2.3. Instructor reflection

In order to understand the evolving status of the flipped classrooms, at the beginning of the semester we collected each of the instructor's syllabi. Notes were created for nine meetings with the professors. Stored data including the syllabus was gathered via the repositories. After conducting their final exams, the instructors submitted their reflections on the semester-long flipped classroom experiment according to a guiding protocol. The protocol focused on three areas: (a) how flipped classroom events were defined by specific instances; (b) how the instructors implemented the designed events; and (c) how their students engaged in the events (see Appendix D).

3.3. Data analysis

The use of several types of data from multiple sources serves as validation and reliability of the research findings, a method that is often referred to as triangulation and saturation. First, we investigated student perceptions of the value of the flipped classrooms and the relations of six factors (Teaching Orientation, Four RCOI factors, and Technology Use), drawing on quantitative data. Descriptive statistics and correlation-coefficient analysis methods were applied for analysis using SPSS 21. The results provided us with overall trends in the three flipped classrooms.

Subsequently a qualitative data review was conducted to identify cases that describe participant experiences from which it was possible to draw meaningful guidance for the design of the flipped classrooms. As described in Table 4, according to the ROIc framework, we investigated qualitative data collected from multiple sources (i.e., documents, interviews, and reflections) and sorted instances of positive or negative comments into each sub-category. Two reviewers discussed the coding scheme and had two coding practices to be in closer alignment with the sorting. One reviewer investigated the data and organized the identified instances, and then the other reviewer reviewed the instances sorted by the first reviewer. For conflicting views about a given instance, the two reviewers discussed it until they reached an agreement about how it should be categorized. Nvivo 10 was used for the qualitative analysis.

4. Student perception: the value of the flipped classroom

Overall students were satisfied with the flipped classroom activities, with many agreeing that the class time interaction was helpful to their understanding of course concepts. Students perceived that the flipped classroom activities were more student-oriented than traditional class

![Fig. 2. Items for the teaching orientation.](image-url)
activities (mean = 3.7 out of 4) (see Table 5). The four elements of the RCOI illustrated the specific values of student-centered experience in the flipped classrooms (over 2.9 out of 4): Teaching Presence (3.18); Social Presence (3.08); Cognitive Presence (2.94); and Learner Presence (2.90).

First, Teaching Presence had the highest level of satisfaction (3.18 out of 4). Students responded that their instructors appropriately structured the assignments and provided information about learning goals, due dates, and time frames for activities. Students universally sought clearer instructions on the details of how to participate in the learner-centered activities, and sought immediate feedback to verify their participation and performance (see Appendix B).

Second, Social Presence posed a value of 3.08. The flipped classroom assignments (e.g., in-class group problem solving and hybrid group projects through on/off-line collaboration) promoted students’ positive affect, interaction, and cohesion. In particular, students felt that the class environments were very open. Students perceived that their contributions were acknowledged by other participants (93% positive response to the items S7; see Appendix B). In contrast, students felt the need to improve upon online discussion strategies toward helping them engage more in collaboration with peers (56% positive response to the items S8).

Third, Cognitive Presence denotes the extent to which the assignments challenged students to utilize their higher-order thinking skills (e.g., evaluation, problem solving, and critical thinking) and to apply what they learned into the broader areas (2.94 out of 4). Students perceived that the assignments challenged them to construct solutions (85% positive response to the item C6). However, relatively, they wanted to be more motivated to explore problems, questioning themselves about diverse issues associated with the contents (see items C2 and C3).

Lastly, the perceived level of the Learner Presence was 2.9. Overall the flipped classroom assignments helped students to regulate learning by self or by peers in terms of goal setting, monitoring their progression, and evaluating their own achievements. Students were confident about confirming whether they understood a concept (90% positive response to item L7), while they had a need for advancing their ability to evaluate and control their knowledge and skills in complex problem solving (see items L2 and L3). In addition, they thought appropriate technologies were adopted to support the flipped classroom assignments (3.0 out of 4).

This study investigated the impacts of the flipped classroom experience with the merged data from three classes. In order to use the merged data to produce general discussions, it was necessary to support the argument that the flipped classroom experience across three classes was similar in terms of RCOI factors. As Table 6 describes, we compared ENG and SOC class for the key factors. The HUM class was not included because there were not enough student responses (only four responses out of fifteen). Amongst six factors, only the Teaching Orientation had a significant difference between the ENG and SOC class. The student perception of the levels of student-centeredness was higher in the SOC class than ENG class ($t (33) = -2.362, p < .05$). The result seemed partly affected by the types of the assignments. The SOC class assigned research-oriented projects in groups that expand student collaboration into online environments, while student interaction in the ENG was limited to in-class problem-solving activities. Considering other factors made no difference, we decided that it is safe to merge data for further review.

To examine the associations among the factors, correlation-coefficient analyses were conducted (see Table 7). Admittedly, the correlation values of the four factors (i.e., Teaching, Social, Cognitive, and Learner Presence) of the Revised Community of Inquiry Model were significantly high, ranging from 0.403 to 0.601. The expanded associations with the Teaching Orientation also showed significant relations except for the Social Presence, ranging from $r = 0.370$ to $r = 0.512$. Interestingly, in contrast to what common sense might dictate, the student-oriented learning culture had no significant positive relation with students’ affect and cohesion (association between Teaching Orientation and Social Presence, $r = 0.278$).

For content analysis, elements indicating positive or negative views were identified and counted based on the coding protocol (see Table 4). For the Cognitive Presence, positive comments were more than negative

### Table 4
Descriptive statistics.

<table>
<thead>
<tr>
<th>N</th>
<th>Mean</th>
<th>Std.</th>
<th>Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>T</td>
<td>E</td>
<td>S</td>
<td>T</td>
</tr>
<tr>
<td>Teaching Orientation</td>
<td>41</td>
<td>13</td>
<td>22</td>
</tr>
<tr>
<td>Teaching presence</td>
<td>40</td>
<td>13</td>
<td>22</td>
</tr>
<tr>
<td>Social Presence</td>
<td>40</td>
<td>13</td>
<td>22</td>
</tr>
<tr>
<td>Cognitive Presence</td>
<td>40</td>
<td>13</td>
<td>22</td>
</tr>
<tr>
<td>Learner Presence</td>
<td>40</td>
<td>13</td>
<td>22</td>
</tr>
<tr>
<td>Technology Use</td>
<td>40</td>
<td>13</td>
<td>22</td>
</tr>
</tbody>
</table>

Note: T (Total), E (Engineering class), S (Social Studies class).
Only positive comments pointed to specific adaptive guidance and they have ownership in their learning tightly (see Table 8). For the Learner Presence and Social Presence, overall there was no big difference between the numbers of positive and negative comments. However, in the SOC class negative cases outnumbered positive remarks. For all classes, students remarked they needed more support and facilitation from the instructors (Teaching Presence). In addition, there were very few negative comments about technology, and no specific technologies were mentioned in a negative manner. Only positive comments pointed to specific supporting technologies (e.g., Google Docs were mentioned by many students as useful to their collaboration work). Students were savvy about using technology for learning and as discerning digital consumers, they required better networking, richer multimedia, and more collaboration through social media.

5. An emerging design framework

Fig. 3 describes the selected relations among key variables that were higher correlations over 0.5 except for the relation between the Teaching Orientation and Social Presence that was the lowest correlation ($r = 0.278$). The figure informs us of how the flipped classroom events worked and where we need to improve in the design of a flipped classroom.

First, Cognitive Presence is at the center of the relationship with the other domains. This means that students tend to be better engaged in higher-order thinking such as complex problem solving when other domains are developed and implemented in an appropriate manner in support of students’ active learning. The level of the instructors’ facilitation and support (Teaching Presence) had the highest association ($r = 0.648$, $p < 0.5$) followed by the Learner Presence (the level of self-regulation, $r = 0.601$, $p < 0.5$). Admittedly, students seem better motivated to do problem solving in a condition that teachers provide adaptive guidance and they have ownership in their learning tightly connected with other students.

Second, Teaching Presence was a critical factor in making the flipped classroom activities successful. The instructors’ role was changed to acting more like a facilitator and helper. The significance of the instructor’s active role was never diminished, but became greater in the flipped, student-centered learning environments. Students’ open-ended comments were largely consistent with the correlation-coefficient scores. Students often had trouble in regulating themselves and working with other group members during problem-solving activities. Students asked for more structured guidance and timely support from the instructors. Students believed that the better the instructors facilitate online discussions, the more they can be engaged in problem-solving assignments (association with Social Presence). Students wanted to be better motivated to explore issues related to the course content and given problems (association with Cognitive Presence).

Third, interestingly, a low correlation between Teaching Orientation and Social Presence was identified ($r = 0.278$), just providing student-centered instructional events was not directly connected with building close relationships among students even though students reported high levels of perceived value in both Teaching Presence and Social Presence, $m = 3.67$ and 3.08, respectively (see Table 5). These results imply that instructors need to design elaborated strategies and do more to facilitate student interaction so that students can better collaborate and bond with one another.

6. Design principles of flipped classrooms

This study proposes nine design principles for the flipped classroom on the basis of the design framework that emerged from the data. The first three design principles of this study were adopted and validated from the design suggestions of Brame (n.d.): Provide an opportunity for students to gain first exposure prior to class; provide an incentive for students to prepare for class; provide a mechanism to assess student understanding. The other six principles were developed as new suggestions for creating flipped events to better foster student-centered learning (see Fig. 4).

6.1. Provide an opportunity for students to gain first exposure prior to class

One of the benefits of the flipped classroom is that students are able to prepare for in-class activities by watching and exploring on-line learning materials (e.g., online video lectures) outside the classroom according to their own time schedules and levels of understanding (Davies et al., 2013; Foertsch et al., 2002). This differentiated learning (Keeffe, 2007) has been materialized by the provision of technologies such as webcasting (He, Swenson, & Lents, 2012; Hill & Nelson, 2011; Holbrook & Dupont, 2011; Kay & Kleskin, 2012; Traphagan, Kucsera, & Kishi, 2010; Vajoczki, Watt, Marquis, & Holshausen, 2010). Indeed, students tried to accommodate their understanding of the given online content and explored different types and levels of resources.

### Table 6

<table>
<thead>
<tr>
<th>ENG</th>
<th>SOC</th>
<th>t-value</th>
<th>df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching Orientation</td>
<td>3.23</td>
<td>3.81</td>
<td>-2.362</td>
<td>33</td>
</tr>
<tr>
<td>Teaching Presence</td>
<td>3.21</td>
<td>3.20</td>
<td>0.068</td>
<td>33</td>
</tr>
<tr>
<td>Social Presence</td>
<td>3.03</td>
<td>3.11</td>
<td>-0.452</td>
<td>33</td>
</tr>
<tr>
<td>Cognitive Presence</td>
<td>2.85</td>
<td>2.99</td>
<td>-0.778</td>
<td>33</td>
</tr>
<tr>
<td>Learner Presence</td>
<td>2.84</td>
<td>2.98</td>
<td>-0.808</td>
<td>33</td>
</tr>
<tr>
<td>Technology Use</td>
<td>2.90</td>
<td>3.16</td>
<td>-1.940</td>
<td>33</td>
</tr>
</tbody>
</table>

* $p < 0.05$.

### Table 7

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Teaching Orientation</td>
<td>1</td>
<td>0.370*</td>
<td>0.278</td>
<td>0.512**</td>
<td>0.385*</td>
<td>0.219</td>
</tr>
<tr>
<td>2. Teaching Presence</td>
<td>1</td>
<td>0.609**</td>
<td>0.648**</td>
<td>0.403*</td>
<td>0.249</td>
<td></td>
</tr>
<tr>
<td>3. Social Presence</td>
<td>1</td>
<td>0.535**</td>
<td>0.494**</td>
<td>0.328*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Cognitive Presence</td>
<td>1</td>
<td>0.601**</td>
<td>0.328*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Learner Presence</td>
<td>1</td>
<td>0.412**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Technology Use</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. *, $p < 0.05$. **, $p < 0.01$.

### Table 8

<table>
<thead>
<tr>
<th>ENG</th>
<th>SOC</th>
<th>HUM</th>
<th>Sum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>All</td>
<td>78 (3.0)</td>
<td>66 (2.8)</td>
</tr>
<tr>
<td>Negative</td>
<td>21 (1.6)</td>
<td>41 (1.7)</td>
<td>4 (1.0)</td>
</tr>
<tr>
<td>Positive</td>
<td>18 (1.4)</td>
<td>25 (1.0)</td>
<td>3 (0.8)</td>
</tr>
<tr>
<td>Cognitive Presence</td>
<td>All</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Negative</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Positive</td>
<td>3</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Learner Presence</td>
<td>All</td>
<td>9</td>
<td>13</td>
</tr>
<tr>
<td>Negative</td>
<td>3</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>Positive</td>
<td>6</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Social Presence</td>
<td>All</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>Negative</td>
<td>0</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Positive</td>
<td>1</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Teaching Presence</td>
<td>All</td>
<td>14</td>
<td>27</td>
</tr>
<tr>
<td>Negative</td>
<td>13</td>
<td>26</td>
<td>2</td>
</tr>
<tr>
<td>Positive</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

Note. The value in parenthesis is mean. ‘n’ is the number of students who responded.
I watched online videos and looked up things on the Internet if I didn’t understand; I would look up information if I didn’t originally understand what he was lecturing on YouTube; In watching the videos, I can pause them, or rewind when I missed something to need time to take notes (an ENG student). I used the online library resource and PowerPoint along with the Internet to complete the inverted classroom project (a SOC student).

6.2. Provide an incentive for students to prepare for class

Successful face-to-face interaction, in a typical flipped classroom, depends on the extent to which students have prepared before engaging with the in-class activities. However, in reality, one of the participating instructors observed that about 25% of the students had not watched online lectures in his previous experiment. This observation was reinforced by an interview with a student in his class. The student described:

Not all students watched videos. Learning depends on self. Without preparation meant low participation in a group work. Instructor became aware of that and added activities such as weekly quiz and annotating video lectures. These really worked.

Online discussions (e.g., YouTube comments) with low-stakes grading appear to have motivated many students to engage the learning activities/assignments and problem solving. The ENG instructor stated: “To foster more interaction and connection between out-of-class and in-class activities, I required students to submit questions/comments on YouTube by giving them points on homework assignments. This drastically boosted the number of questions posted on YouTube and I used those as a springboard for the next lecture.”

6.3. Provide a mechanism to assess student understanding

Low-stakes quizzes and other forms of formative assessment appeared to be effective in both ensuring out-of-classroom activities and helping to prepare students for in-class activities.

Throughout the semester, students generally appreciate having the videos and having more time to work on problems in class. Most students seem to watch the videos once as I asked them to, but would usually not watch them again for review. Short quizzes (3–5 multiple choice questions) were created on Blackboard for them to answer. Questions were intentionally made simple. Most (~85%) students were able to correctly answer all questions (ENG instructor).

Fig. 3. An emerging design framework. Asterisk (*) denotes a significant coefficient-correlation value.

Fig. 4. Nine design principles of the flipped classrooms.
Despite these positive findings, a student's confession implied that there is still room for improvement: “When I didn’t have enough time to watch the videos I just clicked on the link and then made up a question/comment so I got points on my homework.”

6.4. Provide clear connections between in-class and out-of-class activities

Online content and activities should directly support or connect with the associated in-class activities. Many studies have warned that the lack of cohesive alignment of face-to-face and online portions of blended learning classes can distract students from engaging in given activities (Buerck, Malmstrom, & Peppers, 2003; Elen & Clarebout, 2001). Strayer (2012) observed even very active and hard-working students often found it difficult to map online assignments onto in-class activities. Considering flipped classrooms are a form of blended learning, it is crucial to tie online and in-class activities clearly and cohesively so that students can successfully achieve learning goals (Ginns & Ellis, 2007; Strayer, 2012). The ENG instructor demonstrated this good practice:

To foster even more interaction during the last lecture period in this module, I still required students to post questions on YouTube, but in class I had students self-assemble into groups and had them answer each other's questions that were posed on YouTube. Groups were then asked to post their answer back onto YouTube in a reply. I met with each group for about 5 minutes to help answer any questions that the group could not.

6.5. Provide clearly defined and well-structured guidance

Students require clearly defined and well-structured guidance and scaffolding for flipped classroom activities. At the beginning, students may be resistant to a new method that requires them to be more engaged in the out-of-class assignments to prepare for in-class problem solving. Strayer (2012) stated that it is still beneficial to employ the task-oriented environment supported by a well-designed structure that clearly guides students to solve given problems. Evidently, a clear course structure with supporting tools such as guiding prompts and instructions must be designed to help students prepare for participation and then success in achieving learning goals.

With a clear set of instructions and a structure, instructors and TAs can also facilitate in-class activities to help reinforce the connections between the in-class activities and the out-of-class activities.

For example, an ENG student claimed “There should have been more specific goals for each day of in-class work to focus the groups' discussions.” A more serious issue was found in a SOC student’s comments:

Even though the concept of the “inverted classroom” project and the deadlines for the project and the fact that we were to use class time to work on specific things were clear, what the actual project should have looked like when we were done was not (a SOC student).

6.6. Provide enough time for students to carry out the assignments

In-class activities should be designed with adequate time to apply the knowledge, information, and skills class students acquire online. As Gannod et al. (2008) described, given a finite number of minutes in a classroom meeting, instructors mixed traditional lecture with some active learning, which often created tension between two portions of the use of classroom time. Students in one course perceived the need for more in-class time to apply information and skills they acquired online in preparation for the class and to conduct group work. The timing of out-of-class activities was considered important by many students, with the ability to review content online as a major benefit to preparing for in-class activities. The positive responses relating to the ability to review content in this context indicates a positive sense of learning self-regulation amongst those students.

As related to the assigned group presentation, giving us at least 4 full class meetings to meet with our groups and work on our parts would be necessary. Otherwise, there is no point in giving us any time at all in class as the time provided does not allow for any progress to be made (a SOC student). Time Constraints – more time outside of lecture is necessary in order for this to be beneficial. The timing of when the videos were posted was occasionally not at an ideal time (a ENG student).

6.7. Provide facilitation for building a learning community

A learning community can provide students with space to take in new ideas by learning from one another. It is critical for instructors to create learning communities that connect students and help them collaborate well (Garrison & Kanuka, 2004; So & Brush, 2008). Especially since group work continues to be a universal challenge, there should be well-prepared facilitation and guidance for student collaboration. In-class group work appears to be difficult for many students (i.e. group dynamics, roles and levels of participation, and satisfaction with grading schema). Students valued the effect of peer collaboration in groups or as a whole group while they often encountered the lack of guidance to equip better group work.

The flipped classroom activities were valuable because they allowed me to network with people in the class. I am a new student at this university so this allowed me to meet people and network. It was also an interesting methodology and approach to class activities (a SOC student).

Indeed, the instructors’ role as an initiator and facilitator for building a good community and collaborative learning culture could not be emphasized more.

A HUM student told: The initial peer interactions could have been facilitated so that there were icebreakers. Students should be encouraged to share their opinions freely. This proved to be difficult in the first few interactions regarding the first assignment. I didn’t really enjoy this project because I felt like my teammates and I weren’t exactly on the same page, but it was very difficult to all get us on the same level. There was a pretty unequal distribution of work, and the project is set up so that it’s really hard to have equal participation (a SOC student).

6.8. Provide prompt/adaptive feedback on individual or group works

Some students did not consider in-class activities as increasing engagement (i.e., ability to answer questions raised in course activities, constructing explanations/solutions, motivated to explore content related to the questions raised). Many students mentioned the need for greater and more prompt feedback for various reasons including improved group work and/or to connect the in-class problem-solving activities with the out-of-class preparation. Instructors need to provide adaptive feedback and instructional supports
suited to students’ different needs (Forman, 2003). For example, students who tended to be more engaged reported difficulty in maintaining their engagement for the duration of class time. These students, appear not to need the same level of highly-structured in-class set of activities and may have been bored at the end of a problem-solving activity.

During the flipped classroom activities, my role was similar since the other parts of the course were already partially inverted. However, I felt that my lecturing and my interaction with the students catered more to their questions/confusion about the material. I met with each group for about 5 minutes to help answer any questions that the group could not. Based again on my perception alone, this approach was much more interactive (ENG instructor).

6.9. Provide technologies familiar and easy to access

For most students there was no technological barrier. They were actually very familiar with current learning technologies. However, it appeared worthwhile to use familiar and easy to access technologies and establish acceptable standards for the development and delivery of online content. For example, a student in the ENG class said “The videos should be shorter and on a specific topic with more enthusiasm.” In addition, technology must be selected and aligned with flipped events for the purpose of learning goals. Admittedly, how to integrate technology into pedagogy is much more important than mere technology use.

The video artifacts would have been better if students had simply captured their original conversation. I suspected that the presence of the camera triggered a “reality TV” paradigm that potentially disoriented students: “we’re not all ready for our on-camera moment.” Particularly for undergraduate learners, who are struggling to master tough theoretical concepts, the added self-consciousness that the camera seemed to have imparted was unwelcome (HUM instructor).

7. Conclusion

7.1. Recommendations for future research

This study piloted flipped classroom activities across three classes selected from different disciplines so as to find design guidance within the broader definition of the flipped classroom. As a result, a design framework and nine design principles of the flipped classroom were proposed. All of the implementation and design principles offer actionable ways by which instructors can meet learner needs in the context of the flipped classroom, irrespective of the specific flipping strategy invoked. In spite of all benefits from this study, there are a few limitations that require further research.

First, it is necessary to further investigate and define design specifications that integrate technology into flipped classrooms. This study used a short survey and open-ended questions to see how students and instructors used technologies in the flipped classrooms. However, low internal reliability of the survey items limited the interpretation of the results. Agreeing with Strayer’s (2012) claim that the systematic use of interactive technology is a key feature of flipped classrooms, we suggest future studies that more deeply investigate the use of technology and that employ superior assessment instruments. For example, we can elaborate ways to integrate technologies with the applications according to the respective nine design principles.

Second, there is still the need to explore the implementation feasibility of the flipped classroom approach in large-size classes. This study included undergraduate classes that are mid-sized or less (i.e., the number of students in the classrooms was less than 50). The heart of flipped classroom is to engage students in their own learning in the context of collaboration and frequent interactions amongst individuals, which necessarily demands significant facilitation and administration on the instructor’s side. Accordingly, the nine principles might not always work in every classroom instance or may require specific design details applied in different course contexts that address the varying sizes of classes.

Third, this study primarily relied upon the participants’ perception of their own experiences in the flipped classrooms to evaluate the quality of the teaching model. However, this study did not include the participants’ performance (i.e., achievement scores) and changes in motivation and emotion. Future research should consider contradictory reports regarding the impact of flipped classrooms on performance, and more research including other dependent indicators (i.e., non-cognitive domains) is required.

Lastly, evaluation accountability needs to be shared with instructors. We found it very difficult to obtain sufficient evaluation data from participants. Two classes of the three participating classes resulted in only a 25% response rate for the student survey, which reduced average rate down by 36%. Students’ voluntary participation in the interview was much lower than expected for this study. Shared evaluation ownership could be established by means of getting instructors involved in evaluation planning where they set their expected benefits from evaluation results. Professors’ active role in evaluation is critical to produce valuable directions for implementation and following improvements.

7.2. Closing thoughts

This study is unique in terms of: (a) applying the broader definition of the flipped classroom whereby traditional activities and events are exchanged between in-class and online environments for an improved learning experience; and (b) examining multi-disciplinary applications of the flipped classroom.

Given the broader definition of the flipped classroom focused on the hybrid or blended learning model, it becomes obvious that these same principles can be broadly applied to a typical undergraduate course. Today’s typical undergraduate student uses an online learning management system (LMS) for most of their courses. Predictably, most instructors today use an online LMS for teaching courses. Upon examination and not surprisingly, most of the nine emergent design principles appear also to apply to a typical undergraduate face-to-face course.

While this study is unique as a multi-disciplinary examination of the flipped classroom together with the broader definition of ‘flipping’ applied, the ability to test discipline-specific flipping strategies across a larger set of instances and a diverse set of disciplines would help emerge a more robust set of discipline-specific flipping strategies, especially in light of the relevance to typical undergraduate courses. Having more specific and tested strategies that support course learning goals while offering the student a higher value within their own learning experience across online and in-class environments, also guides the institution in identifying effective and sustainable instructional technologies that support the respective flipping strategies.

Sustainable support of flipping strategies is arguably tantamount to a sustainable support strategy for the majority of undergraduate courses toward providing a higher value for students without adding unnecessary complications and workloads for the instructor. More efforts in this regard would appear to render a significant benefit for the institution, its students, and its instructors.
Appendix A. Student Survey

Select the radio buttons nearest the descriptions that most closely characterize your in-class activities and your instructor’s role. Review the above description of your specific class to recall the “inverted classroom” activities to which these items refer.

<table>
<thead>
<tr>
<th>Statement</th>
<th>□</th>
<th>□</th>
<th>□</th>
<th>□</th>
<th>□</th>
</tr>
</thead>
<tbody>
<tr>
<td>You look for a correct answer.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>You did not reflect on the comments and ideas of peers and the instructor.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teacher asked you to answer questions, make comments, use memory and facts.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Classroom activities were structured and sequential.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Classroom activities focused on knowledge abstraction and acquisition.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The following statements relate to your perceptions of the inverted classroom activities. Please indicate your agreement or disagreement with each statement

[Teaching Presence]
1. The instructor clearly communicated important activity goals.
2. The instructor provided clear instructions on how to participate in the learning activities.
3. The instructor clearly communicated important due dates/time frames for the learning activities.
4. The instructor helped to keep course participants engaged and participating in productive dialogue.
5. The instructor encouraged course participants to explore new concepts in the activities.
6. Instructor actions reinforced the development of a sense of community among course participants.
7. My instructor provided useful illustrations that helped me make the course content more understandable to me.
8. My instructor provided clarifying explanations or other feedback that allowed me to better carry out the activities.

[Social Presence]
9. Getting to know other course participants gave me a sense of belonging in the course.
10. I was able to form distinct impressions of some course participants.
11. I felt comfortable conversing through the online medium.
12. I felt comfortable participating in the course discussions.
13. I felt comfortable interacting with other course participants.
14. I felt comfortable disagreeing with other course participants while still maintaining a sense of trust.
15. I felt that my point of view was acknowledged by other participants.
16. (Online) discussions helped me to develop a sense of collaboration.

[Cognitive Presence]
17. Problems posed increased my interest in course issues.
18. I felt motivated to explore content related questions.
19. I utilized a variety of information sources to explore problems posed in this course.
20. Brainstorming and finding relevant information helped me resolve content related questions.
21. Combining new information helped me answer questions raised in course activities.
22. Learning activities helped me construct explanations/solutions.
23. Reflection on course content and discussions helped me understand fundamental concepts in this class.

24. I can apply the knowledge created in this course to my work or other non-class related activities.

[Learner Presence]
25. When I studied for the activities, I set goals for myself in order to direct my activities in each study period.
26. I asked myself questions to make sure I know the assigned activities I have been worked on.
27. I tried to change the way I studied in order to fit the activity requirements and the instructor’s teaching style.
28. I worked hard to get a good grade even when I was not interested in some topics.
29. I tried to think through a topic and decide what I am supposed to learn from it rather than just reading materials or following directions.
30. Before I began studying I thought about the things I will need to do to learn.
31. When studying for the activities I tried to determine which concepts I didn’t understand well.
32. When I was working on learning activities I stopped once in a while and went over what I have done.
33. In general, I felt confident using the technologies associated with the out-of-class activities.

[Technology Use]
34. It was easy for me to find and access the out-of-class materials associated with inverted classroom activities in Blackboard.
35. In general, technologies associated with the out-of-class activities were easy to use.
36. The technologies used for the out-of-class activities interfered with my ability to learn.
37. The technologies used for the out-of-class activities enabled me to collaborate with other students.

Please surmise your semester-long experience of your Inverted Classroom experience and answer the following questions:

33. Describe how you would change the “Inverted Classroom” activities to be more valuable to you.
34. Describe how you used technology to support your work on the “Inverted Classroom” activities.
35. Describe if you were nervous about your ability to use the technology. If you were nervous, did your anxiety lessen as you worked with the tools, stay the same, or increase?
36. Describe any technologies that might improve the “Inverted Classroom” activities.
37. Provide any additional comments about your experience with “Inverted Classroom” course activities.
Appendix B. Student survey responses

Students’ perception of the characteristics of in-class activities and the instructor’s role.

<table>
<thead>
<tr>
<th>Traditional/structured</th>
<th>Problem-solving/inquiry</th>
</tr>
</thead>
<tbody>
<tr>
<td>You look for a correct answer.</td>
<td>You accept or revise your hypotheses based on evidence.</td>
</tr>
<tr>
<td>3 6 9 12 11</td>
<td>7% 15% 22% 29% 27%</td>
</tr>
<tr>
<td>You did not reflect on the comments and ideas of peers and the instructor.</td>
<td>You reflected on the comments and ideas of peers and the instructor.</td>
</tr>
<tr>
<td>0 2 6 10 23</td>
<td>0% 3% 5% 15% 24% 27%</td>
</tr>
<tr>
<td>You seek information to complete the assigned work.</td>
<td>You seek clarification for conceptual understanding.</td>
</tr>
<tr>
<td>3 6 7 11 14</td>
<td>7% 15% 17% 27% 34%</td>
</tr>
<tr>
<td>The instructor’s role was to provide knowledge.</td>
<td>The instructor’s role was to facilitate activities.</td>
</tr>
<tr>
<td>5 5 10 10 11</td>
<td>0% 5% 15% 20% 34%</td>
</tr>
<tr>
<td>The instructor asked you to answer questions, make comments, use memory and facts.</td>
<td>The instructor asked you to answer questions, make comments, demonstrate comprehension and give opinions.</td>
</tr>
<tr>
<td>2 8 9 8 14</td>
<td>0% 5% 20% 22% 31%</td>
</tr>
<tr>
<td>Classroom activities were structured and sequential.</td>
<td>Classroom activities were experience and discovery based.</td>
</tr>
<tr>
<td>3 6 14 11 7</td>
<td>7% 15% 24% 27% 37%</td>
</tr>
<tr>
<td>Classroom activities focused on knowledge abstraction and acquisition.</td>
<td>Classroom activities focused on making real world connections.</td>
</tr>
<tr>
<td>3 1 10 12 15</td>
<td>7% 2% 24% 29% 37%</td>
</tr>
</tbody>
</table>

Students’ perception of the inverted classroom activities.

<table>
<thead>
<tr>
<th>Items</th>
<th>Strongly disagree</th>
<th>Somewhat disagree</th>
<th>Somewhat agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1. My instructor clearly communicated the goals of course activities.</td>
<td># 0 3 30 10</td>
<td>2% 0% 7% 70% 23%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T2. My instructor provided clear instructions on how to participate in course activities.</td>
<td>1 8 20 14</td>
<td>1% 1% 14% 47% 33%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T3. My instructor clearly communicated important due dates/time frames for course activities.</td>
<td>0 1 23 19</td>
<td>0% 2% 53% 44%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T4. My instructor kept course participants engaged in productive dialogue.</td>
<td>0 7 25 11</td>
<td>0% 1% 58% 26%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T5. The instructor encouraged course participants to explore new concepts through course activities.</td>
<td>0 6 20 17</td>
<td>0% 1% 14% 47% 40%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T6. My instructor provided illustrations that made the course content more understandable to me.</td>
<td>0 7 21 15</td>
<td>0% 1% 16% 49% 35%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T7. My instructor provided clarifying explanations and feedback that helped me to better carry out the course activities.</td>
<td>1 9 19 14</td>
<td>2% 2% 21% 44% 33%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T8. My instructor reinforced the development of a sense of community among course participants.</td>
<td>0 8 22 13</td>
<td>0% 1% 19% 51% 30%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S1. Getting to know some of the course participants gave me a sense of belonging in the course.</td>
<td>2 7 22 12</td>
<td>5% 1% 16% 51% 28%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S2. I was able to form distinct impressions of some course participants.</td>
<td>0 6 24 13</td>
<td>0% 5% 14% 56% 30%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S3. I felt comfortable conversing through the online medium.</td>
<td>0 9 24 10</td>
<td>0% 0% 21% 56% 23%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S4. I felt comfortable participating in the course discussions.</td>
<td>0 5 29 9</td>
<td>0% 0% 12% 67% 21%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S5. I felt comfortable interacting with other course participants.</td>
<td>0 1 26 15</td>
<td>0% 0% 5% 60% 35%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S6. I felt comfortable disagreeing with other course participants while still maintaining a sense of trust.</td>
<td>0 4 31 8</td>
<td>0% 0% 3% 9% 72% 19%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S7. I felt that my point of view was acknowledged by other course participants.</td>
<td>0 3 27 13</td>
<td>0% 0% 7% 63% 30%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S8. (Online) discussions helped me to develop a sense of collaboration.</td>
<td>6 13 17 7</td>
<td>0% 0% 14% 30% 40% 16%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The following statements related to your perception of "Teaching Presence" – the design of and facilitation of the activities.

The following statements related to your perception of "Social Presence" – the degree to which you feel socially and emotionally connected with others in the activities.

The following statements related to your perception of "Cognitive Presence" – the extent to which you were able to develop a good understanding of course topics.
Appendix B (continued)

<table>
<thead>
<tr>
<th>Items</th>
<th>Strongly disagree</th>
<th>Somewhat disagree</th>
<th>Somewhat agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>C6. Learning activities helped me construct explanations/solutions.</td>
<td>0</td>
<td>7</td>
<td>29</td>
<td>6</td>
</tr>
<tr>
<td>C7. Reflection on course content and discussions helped me understand fundamental concepts in this class.</td>
<td>0% 17% 69% 14%</td>
<td>0</td>
<td>9</td>
<td>23</td>
</tr>
<tr>
<td>C8. I can apply the knowledge created in this course to my work or other non-class related activities.</td>
<td>0% 21% 55% 24%</td>
<td>1</td>
<td>7</td>
<td>25</td>
</tr>
</tbody>
</table>

The following statements related to your perception of “Learner Presence” – the extent to which you were able to regulate or co-regulate your behaviors in order to achieve learning goals:

1. When I studied for the course, I set goals for myself in order to direct my activities in each study period.
2. I asked myself questions to make sure I understood the assigned activities I had worked on.
3. I tried to change the way I studied in order to meet the activity requirements and the instructor’s teaching style.
4. I worked hard to get a good grade even when I was not interested in some course topics.
5. I tried to think about a topic and decide what I was supposed to learn from it rather than just reading materials or following directions.
6. Before I began studying I thought about the things I would need to do in order to learn.
7. When studying for course activities I tried to determine which concepts I didn’t understand well.
8. When I was working on course activities I stopped once in a while and went over what I had done.

Appendix C. Student interview protocol

Thank you for taking the time to speak with me today. This interview will take 60 minutes to complete. This interview intends to solicit your thoughts and reactions during your participation in the Inverted Classroom activities. This interview will be used only for this purpose and will be kept confidential. The interview will also be digitally recorded and transcribed. Note that all recordings will be completely discarded once this study finishes.

Please take your time in answering. Feel free to “pass” on any question you don’t care to answer. Do you have any questions for me before we start?

1. Would you mind briefly introducing yourself?
   a. Name, grade, and major
2. Please, tell me about the activity in your class.
   a. What was the activity?
   b. Were there technologies to support the activity?
   c. How did you access and use online lectures if there are?
   d. How was technology-supported communication and collaboration involved in the activity?
3. What was your role in doing the activity?
   a. Was this something that you decided to do by yourself? If yes, what did you determine and how?
   b. How did you look for resources (information) and how did you determine what to use?
   c. How did you evaluate what you did? What questions did you ask to yourself?
   d. How did you organize your work? How did you think doing that would help you?
4. What was the role of the teacher when you were working on that activity?
5. What was the role of your group mates in completing the activity? What were your group members doing?
6. What specific difficulties do you remember?
   a. What were you trying to do at that moment?
   b. What was unhelpful or redundant/unnecessary?
   c. What suggestions do you have to make the activity better?

These are all the questions I have. I appreciate your cooperation. You’ve shared some very interesting ideas. Anything else would you like to add about your experience or thoughts of this activity? Thank you so much for answering all my questions and participating in my study.

Appendix D. Instructors Reflection Protocol

Describe your Inverted Classroom activities in the following context (questions below should be incorporated into your answer in some form/order):

a. What were the issues and what changes did you expect to happen (i.e., how were your learning objectives impacted or changed)?
b. What were the instructional strategies you introduced to your class?
c. What technologies were employed to support implementing the instructional strategies? How were the technologies integrated with your inverted classroom activities?

d. What was your role in general through the class? What was your c role during the Inverted Classroom activities? How did c technologies support or work against the implementation of your learning activities?

e. What changes did you make to deal with the issues?

Describe how students engaged in the learning activities:

a. How would you characterize students and their attitude toward the learning activities required in the inverted classroom?
b. If any, what were there notable nonverbal behaviors?
c. What were the special instances related to student participation that surprised/concerned you?
d. How did students use the technologies?

Are there any areas in which you might modify in the future implementation so as to strengthen the course?
Please provide additional comments or thoughts about the Inverted Classroom project.

Please describe any future efforts that you might wish to engage relating to this grant that might involve a publication.

Please describe any future efforts that you might wish to engage relating to this grant that might involve external funding.

References


