Using A Flipped-Classroom Instructional Model in A Large-Enrollment Undergraduate Genetics Class: An Action Research Study

Taotao Long, Chunlei Su, Michael Waugh
The University of Tennessee-Knoxville

Keywords: flipped classroom, flipping the classroom, large class, teaching strategy

Abstract

The flipped classroom, often referenced as “flipping the classroom”, is a teaching and learning model in which the students spend a short period of time learning the basic concepts outside the classroom prior to the introduction of the concept topic in the classroom setting, and then use class time for authentic experiences such as problem solving. This action research study described the implementation of a collaboratively-designed, flipped classroom instructional model in a large-enrollment introductory Genetics class for undergraduates. The aim of implementing the flipped classroom model in this class was to improve students’ learning motivation, enhance the students’ ability to apply knowledge, and improve the teaching and learning efficiency by transforming the traditional lecture into a more interactive instruction. This paper provided information for instructional designers and higher education instructors about the general framework of introducing the flipped classroom strategies in a large introductory biology class. The purpose of the paper is also to share the instructor’s and students’ perceptions towards the new learning approach, their performance in teaching and learning, and lessons learned in the role of instructional designer and teaching assistant.

Introduction

The term “the flipped classroom” was first put forward by Jonathan Bergmann and Aaron Sam in 2006 (Makice, 2012). Bergmann and Sam are chemistry teachers in Colorado who pioneered using screen casting and video podcasting to deliver the learning content for their science courses in high school. The flipped classroom has since become a teaching and learning model in which the lecture content or background informational material is not presented in the classroom but is experienced by students through various and alternative forms of media prior to the classroom instructional session in which the material is addressed. This frees the valuable class time is allowed for active learning, and the content that was removed is delivered to students via online video or other formats (Baker, 2000; Zappe, Messner, Litzinger, & Lee, 2009).

Different from traditional lectured-based instructional approaches, the two main phases of instruction are reversed, or “flipped.” In the traditional lecture-based instructional approach, the first phase is the classroom presentation of the learning content. This is typically followed by a second phase, which is practice, memorization, or application of the knowledge to new settings. In the flipped classroom approach, the presentation of learning content is done before the class meeting through various media. Then the classroom part becomes a setting for various types of active learning, such as problem solving, laboratory experiments, collaborative designing and creating projects, happens during the class time (Gerstein, 2011). The class meeting is not for the introduction of new learning content but rather a where the introduction is elaborated in some meaningful way.

The fundamental idea behind flipping the classroom is that more classroom time should be devoted to active learning and that the teacher can provide immediate feedback and support for learning during the classroom session (Warter-Perez & Dong, 2012). The flipped classroom approach is a flexible set of teaching and learning strategies for organizing student learning experiences in a manner that requires active student engagement throughout the learning process, rather than a specific educational approach (Makice, 2012). In recent years, videos and podcasts have been used to stimulate the students’ interest in pre-class basic concept learning (Demetry, 2010; Gerstein, 2011). Various ways can be used in the two phases of the flipped classroom model, the pre-class phase and the in-class phase, to start with student effort before a class meeting and engage students in active learning activities in class.

The flipped classroom model can be adapted to many different classroom environments (Warter-Perez & Dong, 2012). Creating a learner-centered active learning environment in a large introductory class by replacing the classroom focus on lectures or information presentation to students with active learning activities can increase students’ engagement, critical thinking skills, and interests (Moravec, Williams, Aguilar-Roca, & O'Dowd, 2010).
Nevertheless, the need for immediate teacher feedback in the classroom part of learning provides challenges to the instructor to introduce the flipped classroom and other student-centered active learning models in large classes (Pastirik, 2006), and the teacher would have less time to provide individual support (Arias & Walker, 2004). Moreover, in large classes, not all the students like active learning, and it is difficult for the instructor to pay close attention to each student’s performance and engage all the students in learning (Bates, 2005). Instructors can have various interventions to promote students’ engagement in active learning. These interventions include peer instruction (Lage, Platt, & Treglia, 2000), “re-shaping” the large class into small groups, and introducing hands-on activities and problem solving in class (Tolley, Johnson, & Koszalka, 2012), etc.

This study examined the process of introducing a flipped classroom model in a large-enrollment undergraduate introductory biology class. This study had several purposes: (a) presenting the general framework of the flipped classroom in a large undergraduate biology class to produce a student-centered active learning environment; (b) examining the students’ and teacher’s performances during the whole class; (c) determining the students’ and teacher’s perceptions towards the flipped classroom model.

Background

The course

The course selected for this study addressed the topic of “General Genetics.” It was an introductory level course for the undergraduate students in biology and biology related majors such as microbiology, biomedical engineering, and plant science. The course objectives focus on the principles of heredity, meiosis and transmission genetics, DNA/RNA structure, gene expression and regulation, mutation and genome structure, and population and evolutionary genetics. This course is also a required course for the students who wish to apply for medical school. The course was delivered in face-to-face format without significant use of outside-of-classroom electronic communications media for instructional interactions among students, teachers and teaching assistants. There were three classes per week, and each class section lasted for 50 minutes. The classroom was a traditional lecture hall with the capacity of 150 students.

Participants

A total of 120 students who registered for the course participated in this study. All were from biology related majors. Five of the students planned to apply to medical school. Most students were sophomores and juniors.

The instructor was of Chinese ethnicity and worked as an associate professor in biology in a large research university in the Southeastern US. He had been teaching this course for more than ten years. Prior to this study, he expressed the desire to introduce something new in his course to motivate the students’ learning, but still adhered to the traditional lecture teaching method and the same teaching materials for many years because he had “no time” and “no idea” for change his teaching format. The pressure of research made him have little time and energy to devote into undergraduate instruction, and the lack of educational knowledge made him feel more confused and challenged on improving his instruction. This study was proposed as a way to implement a new teaching strategy to help him attain his goals, and would provide data to help him determine the efficacy of the flipped classroom instructional approach.

The researcher was a Chinese doctoral student in instructional technology in the same university with the instructor. They collaborated to design and implement the flipped classroom approach described in this paper. The researcher played two roles in this study, that of instructional designer and teaching assistant in this course. However, the researcher had no biology background, so she could only assist the instructor on the issues related to instructional design and answering the students’ questions about the learning activities. It was the first time the researcher had designed and implemented active learning activities independently, and also the first time she had communicated with so many American undergraduate students in the role of teaching assistant.

The problem

The instructor was concerned with two problems. First, in his experience of teaching this course for more than ten years, he found it was a common problem that the students never read the textbook, and did not know how to read and teach themselves from scientific writing. The textbook, “Introduction to Genetics Analysis” (Griffiths, Miller, Suzuki, Lewontin, & Gelbart, 2010) had been updated for 10 editions, but most knowledge the course covered, such as chromosome structure, and DNA/RNA synthesis, remained the same. In the first meeting with the instructor, he told the researcher “it is impossible to absorb all the information in the textbook, but the students don’t know which they should focus on when they read.” Without a basic knowledge of genetics, the students faced enormous difficulties in understanding the class lectures, and the instructor had to spend large amount of class time
illustrating the basic concepts. As a result, the instructor felt that the students’ learning was not optimal. He was
tired of lecturing to the students and sensing that they were not actively involved in learning.

The second problem that concerned the instructor was the time issue. He had heard of more student-
centered learning models implemented by some other professors in the College of Engineering, but he worried it
would take too much time to learn the educational knowledge, and design totally new course materials, in order to
introduce new teaching and learning approaches into his course. As a result, he concluded that he would not be able
to implement a new instructional model in his course.

**New practice**

The researcher and the instructor worked collaboratively to develop and implement the flipped classroom
model. This model required three major changes to the pre-existing course.

The first change was adding a “reflective journal” learning activity in the course, in order to help the
students focus on pre-class reading and be better prepared for the in-class activities, and also to motivate their
higher-order thinking.

At the beginning of learning each new chapter, the researcher made an orientation to the students about the
requirement of the reflective journal activity. The students were required to submit a pre-class reflective journal
about what they had learned in reading the chapter topics, such as key points outline, summary, understanding,
discovery, and confusion, etc. They were encouraged to write in their own words, share their own understanding,
and relate what they gained from reading with real life experiences. After the class activities of each topic, the
students were required to revise the pre-class reflective journal in another color font and submit it for credit as the
post-class reflective journal. They were encouraged to correct the misunderstandings in the pre-class journal, write
down the answers to the difficult questions put forward in their pre-class reflective journals, and add something
more on understanding about the learning content. During the course, the students had to finish 12 reflective
journals, but only 5 of them were selected for grading. The students were only told that 5 of the journals would be
randomly selected to grade, and they should do their best in working on each journal because it may be calculated
into their final grades.

The second change was that the amount of in-class lecture was reduced. More class time was spent for
student-generated Question and Answer and group discussions about genetics problems. The instructor had more
time to work on Genetics problems with the students.

The third change was that collaborative projects were added in the course learning. The students were
divided into groups of 10 students. Each group was assigned a Genetics topic related to real life, for example,
genetically modified food, blood type, and Thalassemia. The students were required to collaborate on the assigned
topic, and give a presentation to share their findings with the classmates.

In order to motivate the students to collaborate, the students were informed that all the students in the same
group would share the same grade, so they should try their best to improve the effectiveness of their teamwork.
However, in order to avoid the phenomenon where only one or two students in a group did most of the work but all
others “shared” the grade without making contributions, the researcher designed a peer assessment for the students
to monitor each other’s contributions to the group. All the students were also notified that the peer assessment was
not to make them compete with each other, but to provide a mechanism for them to report on the collaborative effort
of other group members.

**Method**

**Data collection**

To determine the effectiveness of the flipped classroom model used in this class, the researcher chose
action research as the methodology of this study. Action research would enable the researcher to plan the learning
activities and make modifications as the model was implemented (Koshy, 2010). Moreover, reflection is a key
component of the action research process (Mertler, 2009). In this study, the researcher’s reflection played an
important role in designing and modifying the learning activities, communicating with the instructor, students, and
other people involved in this course.

Students’ free responses in their pre-class and post-class reflective journals were selected as one of the
sources of data for analysis. According to the requirements for the reflective journal, in their pre-class reflective
journals, the students should write their outline of key points in each chapter, along with the summary of what
they’d read, their personal understandings, discoveries, and misunderstandings. When they worked on revising their
pre-class reflective journals after class, they were required to expand their understandings and reflections about the
chapter, and the revision of their former understandings or misunderstandings. They students were also required to
simply state what they liked and disliked about the reflective journal learning activity.
In the first reflective journal, lots of students misunderstood the requirement. Some even submitted several sentences such as “I understand this chapter, it’s easy”, “I’ve learned it in high school”. The researcher spent lots of time grading the students’ first reflective journal and gave them individual feedback. After the grade was released, the researcher received lots of questions about grading. What concerned the students most, especially those planning to apply for medical school, was how to get a higher grade. GPA was very important to them, and they worked very hard to complete the assignments.

Considering the large number of misunderstandings and general confusion about the first reflective journal, the instructor and the researcher decided that the grade on the first reflective journal would not be calculated in the final grade. Moreover, the researcher made the reflective journal guideline more detailed. The researcher required the students to write their pre-class reflective journals according to the structure of “outline”, “summary”, “understanding”, and “discoveries”. The researcher also informed the students that if they had nothing to say in some of the four parts, just keep them blank. In order to get students’ feedback and improve the instructional design, the researcher suggested that the students provide feedback at the end of their journals if they had suggestions about instruction and the learning activity.

The instructor and the researcher arrived at consensus on selecting five reflective journal assignments for a better and broad ranging set of responses across the whole semester. The students’ responses on sharing understandings and discoveries were selected because their independent thinking and higher-order thinking skills could be seen through sharing their personal understandings and discoveries in their reading journals.

The researcher acquired data about the students’ participation and contribution to the collaborative projects from the peer assessment. Additionally, following the collaborative projects, an online anonymous survey was administered to the students. The survey contained rating scale items and open-ended questions designed to discover how the students searched the material, how they explored, how they collaborated with other group members, and how they liked the collaborative project learning activity.

The researcher’s journal was also an important source of data collected in this study. It was the first time for the researcher to design and facilitate the activities in a science course, and it was the first time for the researcher to work with a professor to transform the traditional lecture teaching model into student-centered learning model. In the journal, the researcher recorded all the instructional design plans, and modifications, together with all the communications with the instructor, the students, and other people who provided support. The researcher’s journal is also the record of the researcher’s reflection, which is important in action research (Mertler, 2009).

Data analysis

Students’ reflective journals were analyzed to gain the students’ understandings on the genetics topics. Data analyses were conducted on three variables related to the pre-class reflective journal responses. The first variable, “submission rate”, was defined as the percentage of the students completing the pre-class reflective journals, i.e., did the student complete the pre-class reflective journal ahead of the classroom activity as scheduled. The second variable, “share understanding”, was defined as the percentage of students who interpreted their personal understanding in their own words in their pre-class reflective journals. The third variable, “share discovery”, was defined to be the percentage of the students whose per-class reflective writing demonstrated making connections to real world problems, hot spots in biology, and laboratory experiences in other courses.

For the closed-ended questions in the survey, descriptive analyze determined students’ perceptions and values on the collaborative project learning activities. For the open-ended questions in the survey, document analysis was used to determine the students’ key ideas about collaboration and suggestions to improve learning efficiency. The researcher’s journal recorded the information from the instructor and two biology graduate students about their efforts and attitudes related to the implementation of the flipped classroom model in the genetics class.

Results

The sources of data described above were analyzed to determine the impact of the flipped classroom instructional approach on student’s attitudes, behaviors, and understandings of genetics ideas. The following are the interpreted results.

Findings from reflective journals

The students were required to submit 12 reflective journals during the semester. The five reflective journals selected for data analysis were the 3rd, 4th, 7th, 9th, and 11th reflective assignment the students submitted. In the 3th reading journal, 100 of the 120 students submitted the pre-class reflective journal on time. However, the students did not perform very well on deep thinking and presenting their own thoughts as demonstrated by the lower number
of “share understanding” and “share discovery” students included in their writing. Among the 100 students who submitted their pre-class reflective journals on time, only 54 (54%) “share understandings”. The other students’ pre-class reflective journals resembled an outline of key points in the textbook (Figure 1). Only 17 (17%) students among the 100 students included “share discovery” in their writing (Figure 2). The others constrained their writing specifically addressed in the chapter of the course textbook.

Students’ submission rate, “share understanding”, and “share discoveries”, is shown in Table 1. Although there were some inconsistencies overtime, students’ writing showed increases across the three variables over the course (Table 1).

Students’ submission rate, “share understanding”, and “share discoveries”, is shown in Table 1. Although there were some inconsistencies overtime, students’ writing showed increases across the three variables over the course (Table 1).

Table 1

<table>
<thead>
<tr>
<th>Three variables related to student’s pre-class reflective journals</th>
<th>3th</th>
<th>4th</th>
<th>7th</th>
<th>9th</th>
<th>11th</th>
</tr>
</thead>
<tbody>
<tr>
<td>Submission rate</td>
<td>83.3%</td>
<td>89.2%</td>
<td>84.2%</td>
<td>88.3%</td>
<td>84.2%</td>
</tr>
<tr>
<td>Share understanding</td>
<td>54%</td>
<td>69.2%</td>
<td>78.2%</td>
<td>79.2%</td>
<td>76.2%</td>
</tr>
<tr>
<td>Share discovery</td>
<td>17%</td>
<td>28.9%</td>
<td>46.5%</td>
<td>49.1%</td>
<td>52.5%</td>
</tr>
</tbody>
</table>

In the five reflective journals selected for grading, all the students revised their pre-class reflective journals after class. Some of them revised or extended their explanations on former understanding, and some of them found the answers to the questions they asked in their pre-class reflective journals.

Findings from the collaborative project work

The researcher’s original design of collaborative project was to let the students explore and give presentations in class time. Considering the limited class time and the large class (120 students), the instructor and the researcher arrived at consensus to require the students to make online presentations on Blackboard discussion board and not occupy the class time.
The researcher collaborated with the instructor and two graduate students in biology on designing the collaborative project topics. These topics were all related with real-life situations, and challenging for the students to fulfill the requirement with the knowledge they learned from the course. After arriving at consensus with the instructor on the design of the topics and learning activity requirements, the researcher divided the students into 12 groups (10 per group) according to the alphabetized sorting of their family name, and made sure there were both males and females in all groups. Then the researcher created a thread for each group in the discussion board on Blackboard. The researcher posted each group’s topic and group members’ names in the first post in each thread, and sent an email to the each group about their topics, peers, and project requirement. In the next day, the researcher made a presentation of the detailed requirements of the collaborative projects. After the presentation, the researcher and the instructor answered the students’ questions about the collaborative projects in Q & A.

The students were required to collaborate with their peers on the assigned topics, and post their findings and thoughts on the thread the researcher created for each group on the discussion board. Each group of students were supposed to work as an expert panel on their group’s topics and should give an online demonstration of their findings for the other groups. Each group was required to summarize their findings with PowerPoint slides and upload them to their group’s thread on the discussion board before the date when their project work was due. In addition, each group were required to submit a project report that briefly introduced their findings and summarized their collaboration process, including each member’s role and contributions to the group work.

In the two days after the group work was due, the students were required to view other group’s projects and pick up five topics they were interested in, and post at least one comment on each project, such as doubts, understandings, and suggestions. In addition, the students were encouraged to keep an eye on the questions other groups asked in their own group’s thread and answer them in a timely fashion.

In order to promote the students’ collaboration, the researcher emphasized that all the students in the same group were supposed to share the same grade according to the quality of their group work. However, there was a peer assessment for the students to evaluate each of their group mate’s efforts devoted to the group work. If a student were to receive a poor grade in the peer assessment, he/she would get a lower grade than the other students in the same group. Before the collaborative project, all the students were informed that they should work hard to improve their group work in order to get a higher grade for their group, but if someone were to receive a poor peer assessment grade, his/her grade would be decreased. The students were also informed that each member of the group would have the opportunity to evaluate each teammate’s contribution to the group work. The peer assessment was released on Blackboard two days after the group work was due.

The closed-ended questions in the anonymous survey collected the data about the students’ overall attitudes towards the collaborative projects, problem-solving skills, learning gains, and collaboration. The survey results showed that a majority of the students had a positive attitude towards the collaborative project learning activity. Of the 78 students who finished the survey, 90% agreed that they felt the collaborative projects were interesting and they were willing to work actively on the collaborative projects. Up to 85% stated that they learned lots of new knowledge related to real life through the project. However, students were not sure whether the collaborative project learning activity could improve their information searching abilities in future. Approximately 40% agreed that the collaborative project helped them learn to obtain information from a variety of sources. Only 27% of the students agreed that they could apply the knowledge they learned to solve other problems, while only 23% asserted that their ability to analyze information had been improved.

Slightly more than 80% of the students expressed a positive attitude towards their collaboration process, and 75.6% stated that the other members had showed respect to them and their learning styles. However, 14% of the students complained that they did not feel comfortable when asking for help from their peers, while 23% chose the option “I feel uncomfortable sharing information with others”. Slightly more than 52% agreed that they benefited from other groups’ demonstrations. Additionally, 52% hold a positive attitude towards the peer-assessment, reflecting that they “liked the idea of evaluating others”.

There was an open-ended question in the anonymous survey requiring the students to give a brief summary of their own contributions to their group works. Students’ responsibilities in their project work could be classified into leader, complier, and common contributor. The leaders usually came up with an idea as the whole outline of the group work, specified the topic, and assigned each member tasks. They also coordinated the other group member’s works, such as contacting group members, organizing meetings, and helping to keep everyone up to date on their roles and responsibilities. The complier’s responsibility was integrating the materials all the group members contributed into a whole piece of group work. One compiler described his/her work as “pulling all the sources together for the group”, and “fixing the PowerPoint slides for well-organized presentation”. In some groups, leaders also played the role of compiler. The common contributors fulfilled the tasks assigned to them by their group leaders, and some of them contributed some resources for the group work. In sum, all the students contributed and
worked hard in their respective groups. Most students worked well and almost no one was cited by others as having been lazy or uncooperative in contributing to the group work. Almost no student reported that any conflicts occurred during the collaborative project work.

However, there was one incident of disharmony in the collaborative project activities. The instructor received the emails from six students who claimed that they missed the announcement of the collaborative project requirements, and their group members had nearly finished all the work when they noticed that they would have missed the project assignments. A decision was made by the instructor to make the six students into another group to work on an extra project topic. They would have 20% credits deduction for penalty.

Students’ suggestions for improvement

The feedback option in reflective journals and the open-ended questions in the survey provided the students with an opportunity to offer their suggestions to improve the instructional design of this course in future. Most students suggested that they needed more detailed and clearer guidelines for both the reflective journals and collaborative projects. In addition, the students expressed their desire for more timely feedback from the reflective journal assignments. They also reported they needed more time to complete their collaborative projects.

In the survey about the collaborative project learning activity, most students admitted that they felt excited to see some real life examples, with which they were familiar. The examples were about how genetics explain human nature. However, the students wished to have a more detailed activity guideline and grading policy that would allow them to do a better job in the collaborative project activity. A similar sentiment was expressed about the reflective journal activity. Some students, especially the students who planned to apply for medical school, desired more instructions to tell them how to achieve higher grades, because they cared so much on their grade and GPA. At the beginning of the semester, the guideline for the reflective journal learning activity was not clear enough and caused some students’ problems in completing finished their first reflective. Based on the students’ feedback, the researcher revised the guideline of the reflective journal activity, so the students would better understand what they were required to do.

A few students’ suggested they need more time to finish their collaborative project. Students stated that they would have had more in depth thinking and done a better job, but the limited time made their work into a busy work.

Students also suggested that more timely feedback should be provided to the students about their performance in the reflective journals. They also desired more timely answers to their questions about the learning activity requirements.

Instructor’s perceptions

As mentioned earlier, the instructor was concerned that he might need to devote more time for preparing and grading the student-centered learning activities. He also worried that the students could not do well in the collaborative project learning activity. He had limited knowledge of the field of education. These were the reasons that he was concerned that the flipped classroom model might not work well in his classroom.

The same native language and cultural background made the communication between him and the researcher more convenient, but the age gap and the different cognitive styles formed by long-term subject learning and research caused some misunderstandings between them. For example, when rating the students’ reflective journals, the researcher advocated “personalization”, giving students different and personal feedback, but the instructor advocated “standardization”, giving the students’ same and standard feedback according to the grades they got.

The instructor was astonished at the students’ active performance and creativity in the learning activities. His new awareness of the students’ thought process from the reflective journal learning activity dispelled his misconception about the student laziness in reading the textbook and poor understanding in genetics knowledge. Moreover, he was pleasantly surprised to see the students’ creativity and active performances in the collaborative project learning activity. He even admitted that “these young students can build a skyscraper in a day” (personal communication, May 6, 2012). He was very satisfied with the students’ active performance in group discussion and Q & A during the class time. His concerns about the possibility that the students might have been distracted by the student-centered learning activities never materialized.

The schedule of this course was tight, so he was afraid that the more than 100 students’ collaborative project and group presentation would take too much class time. That’s why the format of the collaborative project was changed from face-to-face into online format.

Keeping the balance between the students’ peer pressure and competition was another concern the instructor had about the collaborative project. When the instructor discussed with the researcher about the student’s
guideline of the collaborative project, he expressed his concern that it was difficult to manage the 120 students, and some students might share the grade without active contribution in their projects. When the researcher told him that peer pressure and peer assessment can facilitate students’ collaboration and contribution, he questioned how to avoid the students competing with each other. According to the instructor’s suggestion, the researcher highlighted in the guideline that all the students in the same group were supposed to get the same grade but the students who failed to contribute, when reported by 3 other group members, would get a lower grade. The peer assessment technique effectively facilitated the students’ collaboration by peer pressure and also avoided them forming a competitive relationship.

Challenges
Throughout the semester, the researcher felt that the biggest challenge was working as an instructional designer and teaching assistant in a genetics course, which was not in the researcher’s academic field. The researcher had no background in science, and only learned biology in high school. In addition, as a Chinese student, the researcher had the difficulty in understanding biological terminology. In order to overcome this obstacle, the researcher worked hard to read the textbook in order to understand the subject matter in the course. In addition, the researcher collaborated with two biology graduate students. They explained the knowledge to the researcher and helped the researcher to understand. When designing the collaborative projects, the researcher also consulted with the two biology students.

A big challenge for both the instructor and the researcher was the lack of time. The researcher had limited time to learn the biology knowledge. In the student-centered learning activities, the feedback should include the detailed evaluation for students’ performance and suggestions for their improvement. What concerned the researcher most was that there was limited time to give students detailed feedback on this talk. The time was so limited that it was impossible for the researcher to read through all the students’ reflective journals and give them detailed and personalized feedback, and this was why the researcher accepted the instructor’s recommendations to give the students “standardized” feedback. In addition, the instructor and the researcher had limited time for face-to-face discussion about the design of learning activities and students’ evaluations. They communicated more via email, but it made the discussion superficial and less timely.

Student management was a challenge for the researcher. It was difficult to manage a large class of more than 100 students. The Blackboard course management system helped a lot in announcing, grading, grouping, and communicating with the students. Improving the peer collaboration among students was also an approach to decrease the workload for the researcher.

Moreover, both the instructor and the researcher were concerned about the cultural barrier between them and the students. Although the instructor had been teaching in this university for more than 10 years, he always expressed difficulty in understanding American students’ thoughts. The instructor and the researcher both found it was too difficult to probe into the young American students’ inner world. The researcher was always worried that the misunderstandings caused by cultural barrier would have negative influences on the students’ learning. The cultural issues are very complicated and should be explored in future studies.

Discussion
Overall, the flipped classroom was an efficient teaching and learning model to facilitate the students’ active learning, independent thinking, knowledge application, and collaborative learning in a large biology class. It was the first time for the instructor to introduce student-centered learning activities in his class, and also the first time for the researcher to work as an instructional designer and teaching assistant in a large undergraduate science course. Although the overall goal of improving students’ engagement had been achieved through flipped classroom activities, there were some limitations to this study and room for improvement.

It’s a transitional flipped classroom course
The organization of the genetics course in this study may not be what some scholar talked flipped classroom. According to Bergmann, Overmyer and Wilie (2011), a flipped classroom is called “flipped” because what used to be classwork is done at home by learning the basic concepts via teacher-created videos, and what used to be homework is done in class through participating in student-centered learning activities. Students not only should have self-directed learning at home via videos, but also should finish short tests or reflective surveys to evaluate their learning (O’Neil, Kelly, & Bone, 2012). Most of the class time should be spent on active learning activities.
However, in this study, the students learned basic concepts at home, but via textbooks. There was an attempt to evaluate their understanding of knowledge before class, through writing reflective journals, but not tests. Moreover, the time allowed for the student-centered active learning activities was not a large part overall class time. The classroom work had not been completely changed to activity-based learning. Although the instructor added group discussion and Q & A to in-class time, the in-class activity was simple, and lecture still filled a major part of class time. The researcher initially designed a collaborative project model and planned to implement it in class, but because of the tight schedule and large class size, it was carried out after class in online format. However, one whole class was spent for announcing the requirement and Q & A in order to help the students get familiar with the new learning approach. Nevertheless, it was the beginning of “flipping” the classroom. Although there was room for improvement and completing the task of “flipping” the classroom, this instructional model was a step in the right direction for implementing a flipped classroom model. It had made the course more like a flipped classroom model than a traditional lecture approach. In this sense, the genetics course in this study was called “transitional flip”.

“Flipping the classroom requires more than video”

Textbook was used as the pre-class learning material in the genetics course in this study, not video lecture that was usually used as a typical pre-class learning material in literature. In many flipped classroom models, video is viewed as a necessary component in flipping the classroom, and always used in small classes (Demetry, 2010; Moravec, Williams, Aguilar-Roca, & O'Dowd, 2010), but this is not necessarily essential. In another study with undergraduates, Demetry (2010) found that watching videos as the pre-class learning experience can stimulate the students’ interest in spending outside class time learning the basic concepts.

The flipped classroom is not a specific activity, but an innovative model of teaching and learning which utilizes educational technology and student-centered active learning activities to positively impact the learning environment (O’Neil et al., 2012). Makice (2011) argued that flipping the classroom was an ideology evolved into empowering students to consume information outside class and demonstrate understanding of concepts in various ways. He summarized that it would be efficient only if videos were a part of the plan to connect students’ learning with active and real-life experience. Any flipped classroom model should be adopted to meet the needs of the students, or the learning effectiveness may be even worse than that in the traditional learning model.

As Miller (2012) suggested, the primary focus of flipping the classroom should be on increasing students’ engagement. Any use of technology and learning activity design must support the goals of increasing students’ engagement, teacher’s productivity and facilitation, and the support for innovative instruction, to allow flipped classroom to be effective and efficient. Any technology or media which can efficiently support students’ learning should be adopted, but not limited to video. In this study, reading the textbook was the pre-class learning activity and pre-class journal was adopted to measure students’ understanding of knowledge before coming to class. Although textbook reading may not stimulate students’ pre-class learning interest as well as video lectures, this could be examined by future research in which more multimedia learning materials will be designed for pre-class learning.

The value of collaboration in instruction

The researcher was more aware of the value of the collaboration with the instructor, students, and the two biology graduate student subject experts. This collaboration did decrease the workload for the researcher.

In this study, the researcher had the knowledge background in instructional technology, but had no subject knowledge background in biology; while the instructor had rich subject knowledge in biology, and had taught this course for many years in the traditional lecture format, but he had paid limited attention to educational innovations. The success of the transition from traditional lecture teaching approach to the flipped classroom approach required the instructor and instructional designer to collaborate and take advantage of their individual expertise. Prior to the beginning of the course, the researcher explained the theory of the flipped classroom to the instructor and they agreed on the design of learning activities. During the course, the instructor and the researcher kept in contact via email, and had a face-to-face meeting every week. However, their communications focused more on the students’ management, and ignored the integration of their educational expertise and subject expertise. That also caused the researcher to feel anxious when designing the collaborative projects.

The collaboration between the instructional designer and subject experts also played an important role in this study. When designing the collaborative project topics, the researcher only met the instructor only one time. Because of this, the researcher was referred to the two biology students for help. They gave some illustrations of the subject knowledge the researcher should use potentially in designing the project topics and provided some cues. The two biology students played the role of subject expert in this course. Although they didn’t participate in the
instruction directly, their expertise had an important influence on the quality of instruction. In future, if more student-centered learning activities added, the more collaboration on instruction would be needed.

The communication with the students helped the researcher know more about the characteristics of American undergraduate students, and facilitated the researcher and the instructor in bridging the cultural barrier. The researcher sincerely encouraged the students to provide feedback on learning activity design in various format, such as email, face-to-face meeting, and the “feedback” part in reading journal. The researcher was the teaching assistant in students’ eyes, but also learned American culture from the undergraduate students. At the end of the course, the researcher even felt reluctant to leave these students. The researcher learned lots about the inner world and life of American undergraduates. What the researcher appreciated most was the students’ thanks. Based on the students’ feedback, the researcher appeared to be accepted by them, and was more popular than the instructor because the researcher was closer to the students’ age.

A limitation of this study was that the data analysis on the students’ reflective journals was subjective. Only the researcher analyzed the reflective journals. In future study, more raters should be used and inter-rater reliability should be calculated.

In sum, more research and other types of studies need to be conducted with students in diverse disciplines, and diverse class organizations, to get a more comprehensive picture of the effectiveness of a flipped classroom model in different learning environments. More experiments are needed to complete the transformation from a traditional lecture-based instructional model to a flipped classroom instructional model.

References


