

An Investigation on the Learning Satisfaction of Employing the Flipped Classroom Model in an “Introduction to Computer Science” Course

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Abstract

The employment of the flipped classroom model in instruction has become popular in Taiwan among different levels of education. Reversed from the traditional in-class lectures, students in the flipped classroom model have to preview the learning materials, watch video clips or complete learning sheets provided by the teacher at home before the class. Then, discussion is the main task in class, and the teacher acts as a facilitator to motivate students to work cooperatively in groups to engage in problem solving or hand-on practices. Most studies have revealed the benefits of the flipped classroom models in enhancing students learning achievement and learning motivation. In this model of learning, students are also able to learn at their own pace, utilize the time more effectively, and generate more interaction in class. As a result, this study aimed to investigate the learning satisfaction of using the flipped classroom model in an introductory course of computer science in the university level, including the opinions of benefits and weakness. 50 sophomore students participated in this study. A questionnaire and a semi-structured interview were the two instruments. The findings were as follows,

1. A positive learning satisfaction was found in the use of flipped classroom model, including the online learning materials, pre-classroom activities, and in-class discussion.
2. The amount of time to access to the online videos and the learning preferences were the two major difficulties they have encountered. Some students who were low-achieving in English also felt more frustrated in understanding some of the pre-class video assignments.

Finally, some pedagogical implications were offered.

Key words: flipped classroom model, online learning resources, learning satisfaction

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Introduction

Based on several researches, flipped classroom model is regarded as an important and popular pedagogy of 21st century education (Educause, 2012; Fulton, 2012; Goodwin & Miller, 2013; Peña & Rosson, 2014; Saxena, 2013). With the development and innovation of technology, teaching has flipped, becoming more and more interactive and student-engaged. It is different from the traditional instructions, mostly teacher-centered or lecture-based approaches. This flipped model has been widely implemented and has grown in popularity in many education fields (Edtech, 2012; Johnson, Adam, Estrada, & Freeman, 2014; Srivastava, 2014). The main idea of the flipped classroom model begins with the use of prerecorded lectures or short video clips that students have to view at home or before the class (Hill, 2012; Saxena, 2013). Students are allowed to access new learning materials outside the classroom initially. When they come back to the classroom, they are engaged in the homework-style activities. They enhance content learning through in-class activities or collaborative work with peers. That is, the traditional classroom is strategically reversed and changed into a student-centered style (Vaughan, 2014; Zhang, Ma, & Liu, 2014). The in-class lecture activities and homework elements are reversed (Srivastava, 2014). In other word, the curriculum is designed in a constructivist learning approach, previewing the instructional videos at home. Learners are responsible for the concept construction by themselves. Then, in class, the teacher serves as a facilitator or knowledge expert, offering hand-on practical activities to apply the concepts or clarify challenging parts that students have encountered in self-learning pace (Bergmann & Sams, 2012).

The idea of the flipped classroom has been in existence since 2000, the time when an experiment of inverting the economics course in the Economics Department at Miami University, allowing students to do homework in the classroom and moved traditional lectures outside of the classroom for multimedia learning (Johnson & Renner, 2012; Salik, 2013). In 2006, Salman Khan established the Khan Academy, providing abundant online educational content for teaching and learning (Hill, 2012). Therefore, the flexible course design was widely adopted and many teachers were encouraged to open access to their online courses. In 2007, the concept of the flipped classroom model was spread quickly when high school chemistry teachers Jonathan Bergmann and Aaron Sams from Woodland Park High School at Colorado began to use recorded lectures (Arnold-Garza, 2014). They had their students access the learning materials with the recorded lectures and assisted them to acquire mastery of the content learning and peer interaction. From the speech that Khan presented in the TED platform in 2011 about the use of his videos to flip the curriculum design, more attention on the flip classroom model was received and teachers were inspired to put it into practice in their own classroom. In 2012, a free website for educators, named Flipped Learning Network and Online Community of Practice was established by Jonathan Bergmann and Aaron Sams (Flipped Learning Network, 2013), motivating more learners to participate in online learning. Following this trend, more and more new technologies are involved in the flipped classroom models, including podcasts, flash animations, recorded videos, YouTube, MOOCs, and TED talks (Arnold-Garza, 2014), utilizing electronic means and offering digital learning content to help learners in the flipped classroom model.

In the flipped classroom model, there are several major benefits. First, learners can learn at their own pace regardless of locations and time (Fulton, 2012; Marlowe, 2012). It is more individualized and flexible that students take greater ownership of learning. Students can decide their learning pace to access the learning resources anytime and anywhere. This is quite important for independent learning and self-autonomy (Liu, 2005; Marlowe, 2012). They can schedule their own learning. In addition, the flipped classroom model enables students and teachers to make the class time effectively (Bergmann, Overmyer, & Willie, 2011). They do not have to spend so much time giving lectures; instead, they are able to offer student-centered or collaborative work for students based on the pre-class learning materials or concepts. Teachers can design and customize the curriculum to meet students' needs, and the class activities become various. Also, students become more actively involved in the student-centered learning process (Horn, 2013; Stone, 2012). They work interactively with their peers to discuss questions, solve problems, implement a group task, and complete hand-on practice. Teachers can facilitate the learning process, offer instant feedback, and assist learners who have difficulties in learning. In this way, students' learning motivation can be enhanced positively (Johnson, 2013; Mok, 2014). They prefer on-line preparation or obtain content knowledge through media before the class. Then, the design of making their engagement in the practical applications or discussion in class make the class more interesting and interactively.

With the positive affirmation of numerous empirical studies around the world, the flipped classroom model has been employed in different levels of education and subjects. In the elementary school level, the findings have displayed positively, including Mathematics (Wang, 2014), and English Reading (Lee, 2015). In the high school level, the use of flipped classroom model also show a significant difference has been found in terms of learning English grammar (Yang, 2015) and Mathematics (Johnson, 2013). As for the college level, some researches also demonstrate the effectiveness, such as the Statistics (Strayer, 2012), Physics (Educause, 2012), and Biology (Stone, 2012). These studies illustrate employing the model of flipped classroom can enhance students' learning achievement, learning motivation, and interaction.

On the other hand, some researches have raised different viewpoints and controversial issues. Some researches indicate that no strong evidence was found to support the claim that the flipped classroom model can enhance students' learning. They found students in the traditional lecture-based class improve as much as the ones in the flipped classroom. There was no significant difference found compared to the traditional instruction. (Chin, 2014; Johnson and Renner, 2012). There were some difficulties that students have encountered. Since it shows the different findings, the use of flipped classroom model needs further investigation. So, the main purpose of this research was to investigate students' feedback of the use of flipped classroom model, including benefits and weakness. Two research questions are followed.

1. How effectively of the learning satisfaction of the employing the flipped classroom model in the course of Introduction to Computer Science?
2. What are the difficulties that students may encounter in the flipped classroom model?

Method

In this study, fifty sophomore participants taking a 3-credit college-level course “Introduction to Computer Science” were involved in the study. The course was a required course categorized in General Education, and the participants were not relatively information-science majors. They were from the departments belonging to the School of Arts & Humanities. Two instruments were employed in this study, including a questionnaire and a semi-structured interview. All the participants offered responses to the questionnaire regarding the use of flipped classroom model. Ten participants were selected randomly to schedule an interview with five questions to collect further information about difficulties that they may encounter in the implementation of the flipped classroom model.

There are seven units designed in the “Introduction to Computer Science” course. Each unit lasts for two weeks, and the participants are required to watch the video clips before class (See Appendix A). When they come to the class, the teacher will ask if there is any question about the pre-class activities. After that, a learning sheet with related questions to discuss or tasks to complete is given to each one. They can work in groups to discuss and then the teacher will assign each group to provide answers or to present their discussion.

The questionnaire was revised from the researches of Araño-Ocuaman (2010), Lee (2015) and Yang (2015). Also, it was revised based on two experienced teachers to reach a high expert validity. The 15-item questions, shown in Appendix B, were divided into three parts, including the online learning materials, pre-classroom activities, and in-class discussion. The questions used a four-point Likert scale rating from “fully agree = 4,” “strongly agree = 3,” “slightly disagree = 2,” to “completely disagree = 1” to rate participants’ satisfaction of the use of flipped classroom model. In addition, a semi-structured interview was arranged to investigate the opinions of the use of flipped classroom model, especially the difficulties in the learning process. Ten participants were randomly selected and interviewed individually in a cozy rest area at school in the end of the class. They were told that the interview would be recorded to transcribe the scripts, and all of them agreed. There were four five questions (see Appendix C), and each interview conducted by the researcher took around 20 minutes to implement.

The data of the questionnaire for the first research question was collected in the end of the semester and analyzed by descriptive statistics from SPSS. As for the interview data, it was analyzed qualitatively to answer the second research two. The raw data was transcribed, organized, and compared to find out the similarities or differences.

Results and Discussion

To investigate the participants’ feedback of the flip classroom model, a questionnaire was used. The descriptive statistics of the results was displayed in Table 1. It was found that the participants gave a high positive feedback to the use of the flipped classroom model ($M=3.33$, $SD=.56$), above the midpoint in the scale on all items related to the flipped format. They regarded the employment of flipped classroom model in their “Introduction to Computer Science” course was quite useful for their learning. In terms of each part, the mean is also high, indicating that the participants

are satisfied with the online learning materials, pre-class activities, in-class group discussion and showing students' learning satisfaction was quite positive in the flipped classroom model. One thing that needed to notice was that most of all participants agreed that the pre-class activities took so too much time at time ($M=3.10$, $SD=.74$).

Table 1: Results of Responses to the Use of the Flipped Classroom Model

Question	<i>M</i>	<i>SD</i>
1. Learning from the online learning materials helps me prepare my learning about a new topic well.	3.6	.52
2. Visual images presented online hold my attention and help me understand the concepts of a new topic well.	3.3	.48
3. The online learning materials are clear and easy to understand in explaining the details.	3.5	.53
4. The length of the online is quite acceptable for self-study.	3.0	.67
5. It is easy to access to the online learning materials.	3.2	.42
<i>Subtotal of questions related to online learning materials</i>	3.32	
6. I feel it is much easier to learn a new topic by means of the technology at home.	3.0	.67
7. The pre-class activities takes me too much time at home.	3.1	.74
8. I can learn the new topic at my own pace, rewinding or pausing or moving forward.	3.6	.52
9. I am more responsible for being in control of my own learning in the flipped classroom model.	3.4	.52
10. I prefer using this kind of learning activity to preview.	3.3	.82
<i>Subtotal of questions related to pre-class activities</i>	3.24	
11. The in-class activities help me identify the concepts of the content more deeply.	3.3	.48
12. The discussion within the group in class helps me enhance my learning development.	3.4	.52
13. The in-class activities can help me work out learning problems.	3.5	.53
14. To engage activities with peers in class makes me form good relationship with other group members.	3.4	.52
15. I learn a lot through group collaboration to work on the assignments in class.	3.6	.52
<i>Subtotal of questions related to in-class activities</i>	3.44	
<i>Overall average</i>	3.33	.56

Note. N=50. Positive includes fully agree (4 points) and strongly agree (3 points); negative includes slightly disagree (2 points) and completely disagree (1 point).

This findings demonstrated that students' learning satisfaction was positive with the use of flipped classroom model, and there are three possible to explain the results. First, it is likely that the use of online learning materials enables the participants to access to the learning content with higher learning motivation. Taking the advantages of technology may motivate students' learning because the images in the videos may hold students' attention, which are in line with others' findings. (Artino, & Stephens, 2006; Yang, 2005).

Next, the pre-class activities to preview at home enables the participants to learn at their own pace. They have the opportunity to control the pace of the learning, which is similar as some researchers' findings. (Educause, 2012; Marlowe, 2012; Peña & Rosson, 2014). They can repeat to watch the videos when they do not understand the topic and concepts clearly. They are responsible for their own learning and have the ownership of their learning. However, they also reflect that the pre-class activities take so much time at home from the interview data. They have spent so much time in the pre-learning activities, which may occupy some of their leisure time to chat with friends or play games.

Besides that, it is also possible that the in-class group discussion have generated a cooperative learning environment, making the class supportive and interactive. They use communicative skills within groups and complete the group work with the assistance of group members. The group works facilitate their learning since they share, clarify, and discuss their opinions or tasks. Therefore, they think the flipped classroom model is able to help them be involved in the learning process successfully. It is in accordance with other researches that students have positive learning satisfaction in group work in the flipped classroom model (Gannod, 2008; Li, 2014; Sato & Lyster, 2012).

As for the results of the Research Question 2, the data from the interviewed was collected and analyzed. In terms of the pre-class learning, the 10 interviewees all agreed that the flipped classroom model helped them have a better comprehension of the content learning. They could watch the video as many times as they needed, which enabled them become ready for their class discussion. They were able to decide their own learning pace, too. Once they understood the new concept, they could finish the in-class activities easily. However, a few interviewees mentioned that the difficulties they have encountered included the access to the internet, the time spent and the language used in the videos. Otherwise, there were no difficulties in pre-class activities. Two interviewees thought it was hard to understand the videos used in English at the very beginning. However, key words could be picked up after getting used to the explanation, which is also good for learning. On the other hand, time-consuming is another difficulty because they have to spend some time before the class. Compared to the traditional lectures, the flipped classroom model takes the participants more time to be involved.

Interview Q1: How does the flipped classroom model help you have a better comprehension of the content learning?

"I am a slower learner, so I like this type of learning. I can watch the videos until I understand..." (S1)

"I like this part because I won't feel nervous in class. Watching the online videos have me to prepare for the class..." (S3)

Interview Q2: Are there any difficulties that you may encounter in pre-class learning?
“Not really. Only sometimes it is hard for me to understand the English used in the videos....” (S2)

“My English is not good enough to catch up with the explanation at first. However, I can catch the key words later...” (S6)

“I do not like because I spend so much time watching videos. I spent more time self-study compared to the traditional in-class lectures...” (S4; S5; S9)

“I need to find somewhere with WIFI or internet access when I use the online videos. Because my home is not equipped with WIFI, it is harder to watch the videos at home than in the dorm...” (S10)

As for the in-class learning, all of them showed positive feedback. They became more active in the class to discuss the tasks with their partners. They liked to work with peers in the group, and they could learn from each other. They could clarify and reinforce the concept establishment. Working together made the group members support and interact positively. Although two interviewees said a few students did not preview or prepare well, all the interviewees thought the in-class activities were meaningful and beneficial for their learning. They do not like to work with this kind of team members. As for the teacher’s role in class, he/she was a facilitator, giving assistance when needed. It was quite different from traditional teacher-centered classroom and may not get used to it, but all the interviewees liked this type of learning gradually. They could take the responsibilities of learning.

Interview Q3: What do you think of your role in the in-class activities, such as group discussion or complete learning tasks?

“I am like the orchestra leader because I can integrate each other’s opinions in discussion. I learn a lot...” (S4)

“I am a productive member, always giving my opinions. But one of my classmates in our is not well-prepared...He always listens to each other’s discussion...”(S7)

“I contribute my opinions and ideas. I like the supportive feeling so much...But, some people are not responsible for their learning, like hitch-riders...” (S8)

Interview Q4: What do you think of your teacher’s role in the involvement in class?

“The teacher is supportive whenever the group needs. The teacher will give us some clues when we are confused or when we disagree each other...” (S1)

“I can’t get used to this kind of learning, but more and more I like it. After all, it is my own responsibility to learn...” (S9)

Finally, the overall responses to the employment of flipped classroom model were positive, and their learning was better than the traditional in-class lectures. They gained learning motivation and confidence working with others. However, they also thought somehow this course has brought them some learning pressure.

Interview Q5: What’s your opinion on the integration of flipped classroom model into Introduction of Computer Science overall? Any suggestions or comments?

“Interesting, but I feel a little pressure because I have to preview each week...” (S4)

“I have learned a lot and hope to continue learning in this way...” (S7)

“Overall, I am more confident and become more interested in the learning by using this kind of learning...” (S9)

The results from the interview can correspond to the questionnaire results, both indicating the employment of flipped classroom model is a positive assistance for students' learning. It is likely that this model scaffold the learning from the pre-class activities to the group discussion in class. Students are able to spend time establish key concepts at the beginning at their own pace. Then, their concepts can be reinforced or clarified through group discussion or learning tasks in class. This finding is in line with the conclusions of some researchers (Butt, 2004; Fulton, 2012; Toto & Nguyen, 2009). As for the difficulties that they may encounter, the language used in the videos or the interaction with some group members, it was possible to happen. The language barrier may decrease the learning motivation or effects. Also, to prevent hitchhike riders in the group discussion, the assignment of roles to students may be needed. Each person has his or her own responsibility, such as the chairman, presenter, and recorder. In this way, the effects of cooperative learning may be raised.

Conclusions & Pedagogical implications

The employment of the flipped classroom model has made the learning satisfaction positively in this study, including in the aspects of online learning materials, pre-class activities, and in-class discussion. Learners are able to access to the online videos and become responsible for their preview at their own pace. Then, they are able to clarify, reinforce, or contribute their own opinions of the learning concepts in class. Working in groups enables to form a supportive and less-threatening learning environment. As a result, this model makes students become motivated in the course.

To make the model become more effective in both pre-class and in-class group activities, two pedagogical implications are offered. First, the selection of the videos can focus on the simple language used either in Chinese or in English. For some low-achieving English learners, the aim of the learning is not the language itself but the content. The language may impede and takes lots of time and efforts, which often frustrates learners. On the contrary, if the language is easy to understand, they will not be stuck in the language. Once they understand the learning content, they are able to complete the in-class activities. Otherwise, they are not able to interact with other group members. As a result, key words or some assistance guidelines can be offered with the videos, which is able to be beneficial for those who needs. In this way, it may decrease the amount of time they spend on the videos, and the learning frustration.

Second, the individual accountability in cooperative learning can be emphasized by peer evaluation. To positively make every group member work together to contribute what they have learned from the pre-class activities, individual accountability is quite important. By means of the role assignment in the task, everyone has the role's task and responsibility to implement. Also, the use of peer evaluation can be an aid to the individual accountability. In the end of each unit, the teacher can ask each student to reflect what they have learned and what other members have done. In this way, the hitchhike riders of learning may decrease and will not annoy some group members. Everyone can have positive interdependence, making the cooperative learning more effective.

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Appendix A Video Links for Pre-class Activities

Week	Unit/Topic	Links
2~3	<ol style="list-style-type: none"> 1. Computer Operation 2. numerical system 3. Boolean algebra 	https://www.youtube.com/watch?v=26QPDBe-NB8 https://www.youtube.com/watch?v=cZH0YnFpjwU https://www.youtube.com/watch?v=2zRJ1ShMcgA https://www.youtube.com/watch?v=NwBLk_0dUgQ
4~5	Computer Organization	https://www.youtube.com/watch?v=8eODu6VYxtw https://www.youtube.com/watch?v=ki0A-TDxvEk
6~7	<ol style="list-style-type: none"> 1. Algorithm 2. Flow chart 	https://www.youtube.com/watch?v=AVScy7YsKM0 https://www.youtube.com/watch?v=ENFp49wZfAE https://www.youtube.com/watch?v=aqlfSTCys2U
10~11	Operating System	https://www.youtube.com/watch?v=5AjReRMoG3Y https://www.youtube.com/watch?v=M9rUbHDcvNU https://www.youtube.com/watch?v=qNzhkrrsukc
12~13	<ol style="list-style-type: none"> 1. File Organization 2. Database System 	https://www.youtube.com/watch?v=dpDRg--OuFA https://www.youtube.com/watch?v=zcZ-HgpmCmc http://study.com/academy/lesson/what-is-a-database-management-system-purpose-and-function.html
14~15	Data Communication & Network	https://www.youtube.com/watch?v=cxNxzJsyOfI https://www.youtube.com/watch?v=0zY1vNsHbNs https://www.youtube.com/watch?v=WGWi9TqUrHY
15~16	Information Security & Information Ethics	http://study.com/academy/lesson/information-security-basic-principles.html https://www.youtube.com/watch?v=eUxUUarTRW4 https://www.youtube.com/watch?v=l2CDhcqvVq4 https://www.youtube.com/watch?v=w4OBmQNjG1g
17~18		Questionnaire & Interview

Note: Week 8 & 9-mid-term exam; no new topics for learning

Appendix B The Questionnaire of the Use of the Flipped Classroom Model

Section 1:

1. Gender Male Female
2. How do you evaluate your English proficiency? excellent good fair poor
3. How was your grades in the subject of “English” in the Freshman year? above 90 89~70 69~50 below 50

Section 2: Please answer the questions based on your own personal learning experience by checking one box. “4=fully agree; 3=strongly agree; 2=slightly disagree; 1=completely disagree.”

Item	Statement	4	3	2	1
<i>Questions related to online learning materials</i>					
1	Learning from the online learning materials helps me prepare my learning about a new topic well.				
2	Visual images presented online hold my attention and help me understand the concepts of a new topic well.				
3	The online learning materials are clear and easy to understand.in explaining the details.				
4	The length of the online is quite acceptable for self-study.				
5	It is easy to access to the online learning materials.				
<i>Questions related to pre-class activities</i>					
6	I feel it is much easier to learn a new topic by means of the technology at home.				
7	The pre-class activities takes me too much time at home.				
8	I can learn the new topic at my own pace, rewinding or pausing or moving forward.				
9	I am more responsible for being in control of my own learning in the flipped classroom model.				
10	I prefer using this kind of learning activity to preview.				
<i>Questions related to in-class activities</i>					
11	The in-class activities help me identify the concepts of the content more deeply.				
12	The discussion within the group in class helps me enhance my learning development.				
13	The in-class activities can help me work out learning problems.				
14	To engage activities with peers in class makes me form good relationship with other group members.				
15	I learn a lot through group collaboration to work on the assignments in class.				

Appendix C The Questions for the Semi-structured Interview

Pre-class learning

Q1: How does the flipped classroom model help you have a better comprehension of the content learning?

Q2: Are there any difficulties that you may encounter in pre-class learning?

In-class learning

Q3: What do you think of your role in the in-class activities, such as group discussion or complete learning tasks?

Q4: What do you think of your teacher's role in the involvement in class?

Overall feedback of Flipped Classroom Model

Q5: What's your opinion on the integration of flipped classroom model into Introduction of Computer Science overall? Any suggestions or comments?