

A Case Study of Flipped Learning in Calculus of one Variable on Motivation and Active Learning

JEONG, Moonja

Department of Mathematics, University of Suwon, 17 Wauan-gil, Bongdam-eup, Hwaseong-si, Gyeonggi-do 18323, Korea. E-mail: mjeong@suwon.ac.kr

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Information Technology influenced on classroom to change the teaching and learning method. Recently, flipped learning method became a hot issue in education by using Information Technology. Learning management system that is introduced in our university in the spring semester 2015, made it possible to apply flipped learning method. So, we used the flipped learning method in a calculus course. In this paper, we found that flipped learning in Calculus we was a little bit affirmative in the aspect of motivation and active learning from students' response on flipped learning method. We analyzed the reason that students were not so positive in continuing flipped learning even though they liked flipped learning a little bit better than traditional learning. We suggest what we pay attention to for applying the flipped learning method effectively.

Keywords: flipped learning, learning management system, blended learning, calculus

MESC Classification: D40

MSC2010 Classification: 97D40

I. INTRODUCTION

Rapid development of Information Technology has influence on education in terms of the roles of a teacher and students in the classroom. Traditionally teachers teach the contents of the subject and students listen to the teacher's teaching passively. Students can play a leading role in the flipped learning by learning actively and it is the main change in education.

Nowadays, our government is trying to make creative economy. Dhawan (2015) wrote that creative thinking would play a certain role to make Korea as a hub of start-up companies and innovative products. Active learning gives birth to creative thinking by making students to learn and think by themselves. We can succeed to make creative economy by changing education from traditional teaching and learning to flipped learning.

Flipped learning is a kind of blended learning that is a mixture of online and offline

education. In the flipped learning method, students learn the new contents before the class begins by watching the PowerPoint presentation, websites, video lectures, etc. that are uploaded by the teacher, or the results of group activity and discussion of students by access to the learning management system. So, it is the learner-oriented model (Acelajado, 2014). Often flipped learning is misunderstood as a front in a battle between teachers and technology (Tucker, 2012). But, to make good contents is more important than to know how to deal with technology.

J. Bergmann and A. Sams who were high school teachers of Colorado, USA, designed the flipped learning in 2006. With the recent development of the technology, education using a learning management system (LMS) becomes possible. LMS is a software application for managing the learning process from all aspects. It is a framework that provides contents, handles registering for courses, course administration, tracking, and so on (Watson & Watson, 2007). Like fuel on the fire, it helps to change the education method from traditional learning to flipped learning. In Korea, UNIST (Ulsan National Institute of Science and Technology, Ulsan, Korea) introduced e-Education system in 2009, KAIST introduced education 3.0 program in 2012 (Kim, 2015). Since then, many universities in Korea hurried up to bring LMSs for providing more effective education. The University of Suwon introduced an LMS in 2015 and this research was done under the newly introduced LMS and we underwent many trial and errors.

Flipped learning puts emphasis on students' role. From students' activity, instructor can understand how much they know and natural communication blossoms between instructor and students. With the development of technology, more and more education will be influenced by technology and flipped learning will be generalized. Only a few cases for flipped learning in the university has been reported since the introduction of flipped learning has a short history and the effort for teaching and learning in the university has not been active compared to the effort for doing research. But, nowadays, in the university more concern is given to education. By the report of Strayer (2012), flipped learning in an introductory statistics course in a college didn't give intense interest to students and they were less satisfied than in traditional learning. Calculus course is a basic course for freshmen that many students are disappointed with and didn't pay attention to because there is almost nothing new in it. No research for flipped learning for calculus course of one variable was reported in Korea and wants to check on the effect of flipped learning in calculus about interest and motivation.

Objectives of this research are to show the degree of effectiveness of flipped learning in a calculus course in the aspect of motivation and active learning from the students' response and analyze the reasons of their response. We suggest what we pay attention to for applying the flipped learning method effectively.

II. THEORETICAL BACKGROUND

Flipped learning is defined as a pedagogical approach in which direct lesson moves from the classroom to the individual learning space, and the classroom in class time is changed into an interactive learning space where instructor guides students to be engaged in the learning process actively (Flipped Learning Network (FLN), 2014). According to FLN (2014), flipped learning requires flexible environment, learning culture, intentional content, professional educator that are called the four pillars of F-L-I-P. Flexible environment means that learning spaces of students are flexible and expectations of student timeline for learning are also flexible in flipped learning. Learning culture means that learning model is shifted from the teacher-centered classroom to a student-centered approach. Intentional content means that instructors should determine what to teach by using direct instruction and what material to maximize the classroom time in class by student-centered active learning. Professional educator means that the role of an instructor in flipped learning becomes more important than in a traditional one. In class, instructor should observe the students' situation and give personal feedback in time. Sometimes, the class becomes chaos and instructor should control it.

Flipped learning was designed by J. Bergmann and A. Sams in a high school and is usually being carried out from elementary school to high school. Fulton (2012) reported that in a high school, student achievement in mathematics improved by flipped learning and attitude of teacher, students, and parents changed positively. Hamdan, McKnight, McKnight & Arfstrom (2013) wrote that as is being carried out from elementary school to high school, flipped learning is also being executed in the university and it results in improved performance of students and raises morale of students and instructor. Enfield (2013) analyzed that videos in pre-class gave more positive effect to bottom-level students even though they were more likely to watch the videos because of quizzes in them.

There are not all good effects on flipped learning in the university. Strayer (2012) investigated that in an introductory statistics course in a college; students in flipped learning didn't show deep interest and were less satisfied with the way for the learning tasks than in traditional learning. But, students in flipped learning became affirmative to cooperative and innovative learning method.

In Korea, research about flipped learning began to be carried out within a couple of years and so only a few results for flipped learning were reported and almost all of them are in elementary school and middle school. Lee, Kim & Kim (2014) showed that the change in student achievement was not meaningful, but cognition for flipped learning was positive. Lee, Kang & Kim (2015) reported that flipped learning is more effective in academic achievement to low level student than to high level student. Lee (2014) men-

tioned that it became possible for students to control their own learning via flipped learning. Kim, Chun & Choi (2014) discovered that flipped learning was effective to increase self-efficacy of students though it did not show meaningful change in motivation. Huh (2015) carried out research on teaching model of flipped learning on a course for pre-service mathematics teachers at a university. Until now, only a few researches about flipped learning have been done and so various researches are needed in order to know to what extent flipped learning gives satisfactory result in each subject and every level.

III. RESEARCH METHOD

1. Participants and procedure

Through flipped learning, we anticipate on students' improved self-learning ability, communication skill and cooperation abilities. To carry out flipped learning, students must study to know the contents in advance. Students learned most of the contents of calculus of one variable in high school and so more than half portion of the contents of calculus are familiar to students. Even though Strayer (2012) analyzed that in an introductory statistics course in a college, students didn't have much concern and were less satisfied than in an instructor-centered learning, WE think that calculus, especially calculus of one variable, is the easiest and best subject to take as a flipped learning course among mathematics courses in a university since students feel comfortable about calculus. we expect that if flipped learning is carried out in a calculus course, then gradually students can develop self-learning ability in more difficult courses and communication skill with cooperation ability.

Therefore, we chose 'Calculus 1', a calculus course of one variable, in the department of mathematics of the University of Suwon at the spring semester in 2015 for this research. The University of Suwon is located in Gyeonggi-do near Seoul, Korea and belongs to the group of middle-low level universities. Mathematics department doesn't offer general graduate school program and gives master's degree at the graduate school of education. Plan of Calculus 1 is as follows: It is a 3 credit course and runs 3 hours (2 hours on Tuesday and 1 Hour on Wednesday) per week and text book was the translated version of Stewart (2013). Class consists of 34 freshmen of the department of mathematics and it consists of 8 groups by name order. The class used LMS called "Blackboard" at the spring semester of 2015.

During the semester, 3 exams were taken for effectiveness of study by considering workload. Quizzes were prepared for reviewing the materials before exams except the first exam. Also, a quiz about techniques of integration was given at the 13th week because techniques of integration are important to know and so total 3 quizzes were given.

Also, writing a journal 5 times was a given assignment in order to know the thought and attitude of students as we carried out flipped learning.

Every student were freshmen that entered the university at that semester with no information about flipped learning and stanced out to study so they could be regarded at the same condition about flipped learning since academic achievement was not considered in this research. They were given orientation for LMS from the university in the beginning of March, 2015 and so they became good at using LMS before flipped learning began. Orientation for flipped learning at class was given before flipped learning began. During the semester, in advance, students could watch an uploaded lecture video or a lecture file of PowerPoint on Blackboard. In class, discussion and group work with activity sheet prepared from the materials on Keynes (2001) and Stewart (2013), or personal presentation in a part of the chapter of Techniques of Integration were done and it was operated by one instructor with no assistant. After class, each student was required to write a journal on Blackboard 5 times and solve more exercises after each chapter. In this course there was no graduate assistant and so in order to know students' understanding and communicate with students; we determined to make a journal. Students were asked to write a journal in every 2 or 3 weeks that is considered to be an appropriate interval.

The grade follows from the total score consisting of 3 test scores (80%), attendance (10%) that includes attendance in class and writing journals, and various work (10%) that includes homework, quizzes, group work and personal presentation.

In order to help the students with no confidence or lack of talent in mathematics at the extra study, tutoring program in our university was used. In fact, the tutor was the top ranking sophomore and 5 freshmen became tutees voluntarily, but later we found that students who were in need of help didn't apply as tutees. Calculus 1 is a course for newly enrolled freshmen and so we couldn't enforce to anybody to enroll as a tutee. Later on, we knew that 5 voluntary tutees got very good grade.

The class runs March 3 – June 16, 2015 except the 2nd week of June as shown in Table 1 and the class on the 9th week is fully videotaped. Contents of the text are as follows:

- Ch. 1. Functions and Limits,
- Ch. 2. Derivatives,
- Ch. 3. Inverse Functions,
- Ch. 4. Applications of Differentiation,
- Ch. 5. Integrals,
- Ch. 6. Techniques of Integration, and
- Ch. 7. Applications of Integration.

Table 1. The schedule of the class

Week	Contents of lesson	Uploaded Material on LMS
1	Orientation, Chapter 1	Two (2) "YouTube" Videos
2	Chapter 1	Journal (by student)
3	Chapter 2	Lecture PPT, Video lecture, Journal (by student)
4	Chapter 2	Lecture PPT, Video lecture
5	Exam 1, Chapter 3	Lecture PPT, Video lecture
6	Chapter 3	Lecture PPT, Video lecture, Journal (by student)
7	Chapters 3–4	Lecture PPT, Video lecture
8	Chapter 4	Lecture PPT, Video lecture
9	Chapter 4	Lecture PPT, Video lecture, Journal (by student)
10	Feedback, Exam 2	Quiz 1, One (1) YouTube Video
11	Chapter 5	Lecture PPT, Video lecture
12	Chapters 5–6	Lecture PPT, Video lecture
13	Chapter 6	Lecture PPT, Video lecture, Quiz 2
14	Chapter 7	Lecture PPT, Video lecture, Journal (by student)
15	Exam 3	Quiz 3

At the 1st week, there was an orientation for Calculus 1 and flipped learning. To write a journal about their thoughts after watching uploaded YouTube video "What is Calculus used for?" by Heys (2012), was a homework. As a reference video, "Calculus: What is it?" by New Planet School (2013) was also uploaded. From the 3rd week, the class was really run by flipped learning. The class took 3 exams and 3 quizzes and wrote 5 journals.

We carried out the questionnaires on May 12 in the 11th week and June 16 in the 15th week. We named students by S1, S2, and so on. We did the additional survey on Dec. 1, 2015 asking the reason about the result of Q2 and Q3. We added the survey of evaluation sheet about instructor that should be written by students in order to check the grade of the course at the end of June. Now we show how effective the flipped learning was with respect to motivation and active learning through journals and questionnaires and analyzed the reason for their results.

2. Research contents and analysis

2.1. Result of Group Activity

At the group activity time about differentiation in the 3rd week, students put heads together to solve the problems in the activity sheet. One problem was to determine the existence of $y'(0)$ when $y = \sqrt[3]{x^2}$. A group tried to solve the given problem as shown in Figure 1. We had the presentation time of group activity and it helped students to correct the error that they made by the other group's indication.

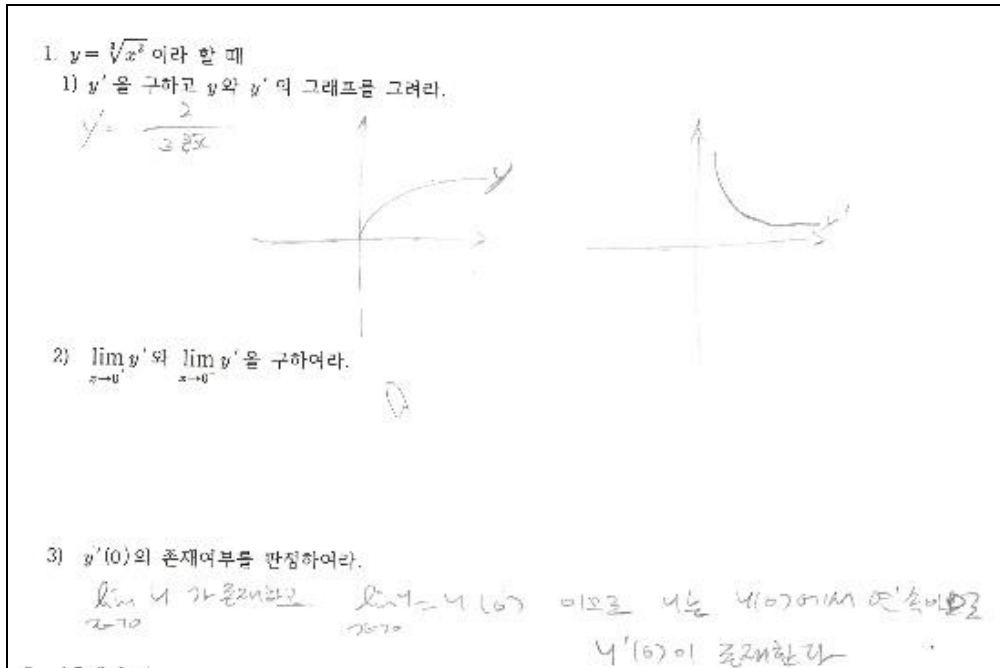


Figure 1. Existence of $y'(0)$

At the group activity time about the applications of derivatives in the 4th week, many groups didn't understand the word problems and so we should explain it by group.

At the group activity time in the 6th week, students really had difficult time in studying inverse trigonometric functions and hyperbolic functions. Such difficulty about trigonometric and hyperbolic functions was also appeared in journal 4. A problem on the activity sheet was to show $\sin^{-1}x + \cos^{-1}x = \frac{\pi}{2}$. Only a group tried to solve it, but even the group assumed the conclusion is true and tried to take the derivative as shown in Figure 2. It is a common fallacy that students made. Training in the class is necessary in order not to make such fallacy.

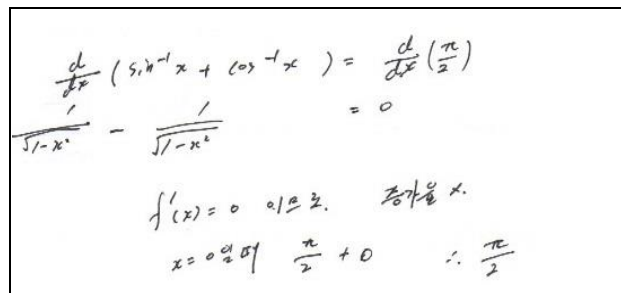


Figure 2. Result of group activity by a Group

When we deal with many techniques of integration in the 12th week and 13th week, students had personal presentation time about a bunch of exercise problems of techniques of integration for making them familiar with techniques of integration.

At the group activity time about applications of integrations in the 14th week, many groups became to understand the integration methods completely by group activity and group presentation even if they didn't watch the uploaded material before class.

During the group activity time, students could learn actively by discussion with each other or with me. Even a student, who couldn't participate at the group discussion at all because of lack of knowledge, could get help by asking basic questions to me and if it was an instructor-centered learning, he could be demotivated.

2.2. Students' response in the journal

A student's response shown in journal 1 after watching the YouTube Video (Heys, 2012) is as follows:

S1: I felt that calculus is very hard and stiff subject, but after I watched the video I was very surprised at calculus and interested in it. I found that it can be used in many ways for predicting the future, conducting effective experiment, and substitute impossible or unethical experiment by mathematical modeling. It is unbelievable that several experiments can be done only by calculus. This video tells us to challenge calculus. It is surprising to me that mathematical modelling helps many researches. With the pride of studying calculus I feel the necessity of studying it.

we realized that the video uploaded as an introduction made students to be motivated in calculus and it is nothing new to say that to upload useful materials in LMS in advance is very effective. A student's response shown in journal 3 after finishing chapters 1-2, and the first exam is as follows:

S2: Foolish errors that I made at the exam are due to my lack of ability. So I went to a study room to prepare for the next class and I could concentrate on it more than other days because I felt sorry for the exam score. Getting feedback often gives me more resilience than studying aimlessly gives. I will study hard consistently without fluctuating between hopes and fears about the exam score.

As in the above journal, we could read students' thought about the class from the journal. In the aspect of checking students' understanding while flipped learning is going on, to get feedback by online is advisable. Students' response in journal 4 after finishing Chapter 3 and 4 is as follows:

S2: Inverse trigonometric functions, hyperbolic functions, and their derivatives are new and

unfamiliar contents and so I should repeat to check them several times in order to deal with easily. Forms of the derivatives of them are similar and I am very curious about them. Experiment using software Maple 12 in class instead of solving problems with a pencil gave me new stimulation. I don't know the relation of the contents that we are now dealing with and computer yet, but, to combine mathematics with computer after improving my knowledge seems to be an interesting subject.

S3: When we deal with many trigonometric and hyperbolic functions, inverses, and derivatives, there were new parts and it was hard to solve the problems. Via group activity we discussed to share the idea and could learn more and understand finally.

Through the journal, we could communicate with students about what they think about the class. After we read journal 4, we uploaded a YouTube video "Applications of Hyperbolic functions" by Kelly (2013) for letting students to know usefulness of such functions.

2.3. Questionnaire and analysis

We conducted a questionnaire twice, one at May 12 just after the second examination, and the other at June 16 in the final week. We denoted flipped learning by FL. We used five-level Likert scale such as:

- ① Strongly Agree ② Agree ③ Neutral ④ Disagree ⑤ Strongly Disagree.

33 students among 34 students answered for it and the result of questionnaires is in Table 2.

Table 2. Questionnaire about FL

No.	Questions	Average (May 12)	Average (June 16)
Q1	I am cognitive of FL from the media.	4.3	4.1
Q2	I watch the uploaded lecture video/lecture PPT in advance.	4.0	3.7
Q3	I want to continue FL.	3.2	3.2
Q4	I like FL than Traditional Lecture.	2.9	2.9
Q5	FL is less boring than traditional lecture.	2.3	2.6
Q6	FL is less sleepy than traditional lecture.	2.4	2.6
Q7	FL gives satisfaction about solving many problems.	2.5	2.5
Q8	FL gives motivation to study necessary contents by oneself.	2.6	2.6
Q9	FL gives the chance for active learning via discussion with friends and question to professor.	2.5	2.4
Q10	FL improves in presentation ability.	2.5	2.5

We produced the lecture video for mobile use, so conveniently students could watch it in any place. Almost half of students usually connect a computer or mobile phone to LMS

at home and the other half of students do it at school or on transportation.

From Q1 of Table 2, we can find that students didn't have any information about the FL before the class. From Q2, we can know that almost they didn't watch the uploaded lecture material in advance. Some of them thought that they knew much of the contents already because it was similar to the contents learned in high school.

On the other hand, there are 2 types of mathematics examinations in the College Scholastic Aptitude Test in Korea. One is called Math Type A for literature and social science majors and the other is called Math Type B for natural science and engineering majors. Trigonometric differentiation and integration are included in Math Type B, but not in Math Type A. Therefore, to take Math Type B, students should study more than to take Math Type A. High ranking universities prevent students who took Math Type A from applying to college of natural science and engineering, but our university is a middle-low ranking university that allows students for applying to college of natural sciences and engineering with any type of mathematics exam and gives a bit of weighted value on Math Type B.

One half of our students took Math Type B in the College Scholastic Aptitude Test, but the other half of them took Math Type A because Math Type A is easier examination than Math Type B to get better examination score even though a bit of weighted value for Math Type B is considered. They probably had difficulty to catch up with the contents, but many of them didn't have the habit to study in advance and tried only to enjoy the university life as freshmen. Systematic counseling for the university life is necessary.

While we study continuity and differentiation of functions before the 2nd examination taken in the 10th week, the contents were somewhat similar to the contents in high school and contents became harder after the 2nd examination. After the 2nd examination, the average score for Q2 is a little bit improved, but still it is a problem to attract students to watch the uploaded material in advance.

From Q3 and Q4 of Table 2, even though they are somewhat positive in FL, they have no opinion about continuing FL. Many students don't like to prepare something in advance and are accustomed not to do anything for preparation of class. To teach the students how to study is required especially in a middle-low ranking university like the University of Suwon where FL was done. From Q5 to Q10 of Table 2, we can know that students think somewhat positively that FL is less boring, less sleepy, gives satisfaction and motivation to study, and improves in presentation skill as is expected.

In addition, students' comments are as follows:

- S4: When the group activity is going on, the group is divided into 2 classes of students, one with students who are solving problems and the other with students who are not participating at the group activity.

- S5: I prefer the middle of FL and traditional lecture. More theoretical explanation in class is needed.
- S6: I am positive in presentation in class, preparation for lesson for FL.
- S7: Preparation for lesson is too much for me.
- S8: The number of students that are participated in the group activity is not much and sometimes it is hard to concentrate on the group activity because of noise.

From the comments, we should be concerned about the students who couldn't participate at the group activity. Many of them told me that problems in activity sheet was somewhat challenging to solve and two students told me that they didn't want to disclose their poor ability during the group activity. Even though students felt somewhat positive for FL, they didn't want to spend much time for preparation for lesson in advance. After we got the comment of S8, we told each group to decide the ratio of participation of each group members at the group activity.

2.4. Additional questionnaire for reasons of the answers of Q2 and Q3

As is shown in Table 2, the result of Q3 is a little bit worse in score than the result of Q4 (degree that we like FL than Traditional Lecture.). To find the reason for it, additionally in Dec. 1, 2015 we surveyed the reasons of the answers for Q2 (degree that we watch the uploaded lecture video/lecture PPT in advance.) and Q3 (degree that we want to continue FL.) from 25 students except 9 students among 34 students who took Calculus 1 in the spring semester. Now, among 9 students, 5 students are taking the fall semester off and 4 students have been in long absence from school this semester. It doesn't matter what score they gave in previous questionnaire and it matters what they thought was the important reason about the average result in the previous survey. The fact that 74% of the students participated at this additional survey is a restriction of this research, but, it is enough to know reasons of answers of Q2 and Q3.

Students were asked to choose the top 3 reasons by the order of importance among the following 8 reasons in Table 3 as reasons of the answer for Q2. In order to calculate the total scores, we gave weight 3 to the leading reason, weight 2 to the second reason, and weight 1 to the third reason.

By analyzing students' opinion, as a reason for not watching the uploaded material in advance, unexpectedly only a very few students chose the fact that it was no problem in doing group activity since almost they knew the contents. As in Table 3, we conclude that the leading reason for not watching the uploaded material in advance is for them to forget to watch the uploaded material in advance, the second reason is for them to be not used to study in advance by themselves, and the third reason is to be inconvenient to connect LMS. Therefore, to inform them about assignment every week by message and make

them to form a good habit of studying by them is the best way to establish FL effectively.

Table 3. Reason for answer of Q2

Reason for answer of Q2	Total Score
1. It took much time to watch and study the uploaded material in advance	6
2. I was not used to study in advance by myself.	27
3. Since almost I knew the contents, it was no problem in doing group activity even though I didn't watch the uploaded material.	6
4. Since to watch the uploaded material bothered me, I didn't watch it	22
5. I forgot to watch the uploaded material in advance.	31
6. Uploaded material was not interesting	5
7. It was inconvenient to connect LMS	25
8. Write the other reason	1

Similarly, students are asked to choose the top 3 reasons by the order of importance among the following 6 reasons in Table 4 as reasons of the answer for Q3. In order to calculate the total scores, we gave the same weight as about the reason for answer of Q2.

Table 4. Reason for answer of Q3

Reason for answer of Q3	Total Score
1. It took much time to watch and study the uploaded material in advance	32
2. I was not used to study in advance by myself.	45
3. Assignments in FL were too much.	18
4. Problems in group activity were too challenging to do.	15
5. I don't like my ability to be exposed to students of the same group.	8
6. Write other reason.	6

As in Table 4, the leading reason that they are not so affirmative to continue FL compared to the degree that they like FL than traditional lecture is for them to be not used to study in advance by themselves, the second reason is to take much time to watch uploaded material in advance, and the third reason is much assignments in FL. Hence, to guide them to form a good habit of studying by themselves and not to evade the given tasks in the university is the best way for implementing FL continuously as analysis of reasons for answers of Q3 shows. That is to say, FL becomes more successful if we guide students to improve fundamental habit of study.

2.5. Analysis of evaluation sheet about instructor

At the evaluation sheet about instructor in spring semester, 2015, students expressed the preference about FL largely in 3 aspects. The most frequently mentioned reason is for FL to allow much time to solve the problems by themselves and the second reason is to be able to study in advance and review the uploaded material. The last reason is to try

new way of learning and do group activity. On the other hand, a few unsatisfactory factors over FL are that students ask teaching in detail and FL permits too much autonomous learning.

FL is like a double-edged sword. Students want to study in advance through uploaded material, but ask teaching in detail in class. Students like much time to be allowed to solve the problems by themselves, but not too much autonomous.

IV. RESULTS

In this research we have done a case study to examine what students think about flipped learning in Calculus 1 in the aspect of motivation and active learning from the students' response and analyze the reasons of their response. We conducted a questionnaire twice, one at May 12, 2015 just after the 2nd examination, the other one at June 16, 2015 in the final week in order to know the change of students' thinking about flipped learning. At the two surveys, consistent result came up. Also, we surveyed the additional short questionnaire for asking the reasons for the result of Q2 and Q3 in Dec. 1, 2015. As a result of this research, we suggest several things how to improve the flipped learning in a calculus course.

Through this research, we have figured out what the students' reaction for flipped learning in Calculus 1 was and how to design flipped learning. Students feel more or less that flipped learning is more attractive, less boring and less sleepy, gives the chance for active learning via discussion, and improves in presentation ability. As Lee, Kim & Kim (2014) reported that cognition for flipped learning on social study at an elementary school was positive; we found that attitude for flipped learning on calculus was somewhat positive. But, they don't prefer flipped learning more than traditional lecture. As Strayer (2012) investigated that in an introductory statistics course in a college, students in flipped learning didn't show much concern and were less satisfied with the way for the learning tasks than in traditional learning, we found that same phenomenon happened in Calculus 1 that is an introductory mathematics course.

According to the comments of S5 and S7, some students thought that in an uploaded video running about 30 minutes, the explanation of mathematics was not enough for students to understand and so they wanted to listen to the professor's detailed explanation in class. But, nobody requested publicly theoretical explanation more in class except how to deal with problems. It needs for students to prepare questions to share in class and in flipped learning personalized guidance is possible. Even so, Horn (2013) said that teacher must keep up a steady pace on the lesson even if some students don't understand in class. Choi & Kim (2015) suggested that the contents that were given in pre-class should not be

summarized or lectured in class because it makes students anticipate it and be demotivated.

Based on the result of the questionnaire, we conclude that students liked flipped learning a little bit better than traditional lecture in the sense of presentation ability, active learning, and motivation, but they didn't want to prepare the lesson except a few students. As a matter of fact, they were not so positive in continuing FL by the following leading reasons. First, they were not used to study in advance by themselves. Second, it took much time to watch uploaded material in advance. Last, there were many assignments in FL.

Hence, in order to implement FL continuously it is necessary to guide them to form a good habit of studying by them and not to evade the given tasks in the university as analysis of reasons for answers of Q3 shows. That is to say, FL becomes more successful if we guide students to improve fundamental habit of study.

Also, according to the comments of S4 and S8 that were complaints about unequal contribution of each member of group on group activity, appropriate compensation were considered by the ratio of students' contribution on group activity. In other words, each group was asked to submit the ratio of workload of each member in order to improve such complaint.

V. SUGGESTION

Flipped learning is entering into the mainstream of education with the development of technology. But, research for flipped learning is still in its infancy. We underwent many trials and errors during this experience of FL. In this case study we examined that students in Calculus 1 were a little bit positive in flipped learning in the aspect of motivation and active learning, but students were not so positive in continuing flipped learning and we analyzed the reasons of their response. The main 3 reasons for it were that they were not used to study in advance by themselves; it took much time to watch uploaded material in advance and many assignments in FL.

For better design of flipped learning we suggest the following: First, it is necessary for instructors to guide students to change their attitude for learning from passive learning to active learning and form a good habit of studying by them. In other words, instructors should guide students to make a switch of students' attitude from learning without effort only by attending the class to active learning by studying by themselves before class and by discussion and cooperation in class. It was based on the analysis of students' reason of the answer for Q3.

Next, instructors should prepare good challenging material for group activity even

though it requires much time and effort. At least one or two problems should be challenging for group discussion as well as plain problems because group discussion is helpful to feel a sense of accomplishment for solving challenging problem. Also, in class instructor should keep an eye on students and show management skill to give class feedback in time and control class from falling into disorder.

Third, instructor should draw up a plan how to make students watch the uploaded video lectures in advance. In our case study, only a few students watched the uploaded video lectures. In an additional survey students gave the reason why they didn't watch them as they forgot to watch, they were not used to study in advance by themselves, and it was inconvenient to connect LMS. So if students were informed to watch them by message every week, then the result will become different. Also, the length of video lectures should be considered. In our case study, a video lecture about 30 minutes was used for a week. A video lecture of 15 minutes is known best to concentrate on. So instructor can choose which is better between 2 video lectures of 15 minutes and one video lecture of 30 minutes if it is a video lecture of 30 minutes. Besides, it will make more students watch uploaded video lecture if a simple quiz can be inserted in the middle of video lecture for giving advantage to students who watch the uploaded video.

Fourth, for the fair grade about each group member's activity, the ratio of each student's assigned and performed work should be taken into account at every activity. They can evaluate their contribution ratio in a group on their own at every activity or assistant can evaluate it if assistant is allowed in each group.

Finally, subject of advanced level is better target for FL. Students don't have much interest in calculus that is an introductory course whether it is operated by flipped learning or traditional learning. Subject of more advanced level is more challenging and so the upper level subject is better suitable for FL.

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