Design and Practice of Blended Learning for Logistics System Simulation Course Based on Flipped Classroom

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***Abstract*—Flipped classroom is a kind of popular non-traditional teaching strategy emphasizing on individual learning which intentionally transfers instruction from a teacher-centered to a learner-centered model. The contribution of this paper is to propose a blended learning design based on the flipped classroom. In this paper, we take logistics system simulation, a core course for logistics engineering, as an example to design our blended learning based on flipped classroom. Our model of design has three phases, which are before class, in class and after class. For each of the phase five sections are illustrated, including students' activities, teaching tasks, teacher's activities, teaching methods and teaching tools. In application, we adopt one class of the course to conduct our empirical research in detail. The evaluation is considered the following three aspects: learning feedbacks of online video before class, recognition survey of our class design, and assignment completion scores of the students. Survey and questionnaire methods are used in gathering information. According to the statistics, our design is popular for students to learn. Most of the students consider our design of the class has a positive influence on their learning, and they prefer to the flipped classroom. The overall learning result of the students is well and the design has met our expectations. Our design can provide a good reference for study of flipped classroom teaching and can also provide ideas for the development of other courses.**

***Index Terms*—blended learning, flipped classroom, logistics system simulation, teaching strategy, online video**

I. Introduction

The flipped classroom is a blended learning strategy with the aim to improve teaching effectiveness and student engagement. It is known as the similar with the common terms in pedagogy such as active learning, peer instruction, and problem-based learning, which are blended learning strategies for students to prepare the course before meeting with peers in purposeful activities [1], [2]. The most recognizable contributor to the flipped classroom is Salman Khan who founded Khan Academy based on the requirements of his younger cousin in 2004. Though the videos are only one form of flipped classroom strategy, Khan Academy has become the beginner and synonymous with the flipped classroom [3, 4]. Flipped classroom is a kind of non-traditional teaching strategy emphasizing on individual learning which intentionally transfers instruction from a teacher-centered to a learner-centered model. In the class time, meaning topics in greater depth can be discussed, while the course contents can be delivered to the learners through educational technologies such as online videos outside of the classroom. In recent years, flipped classroom becomes one of the most popular trends in education. Many studies show that flipped classroom using a more application-based approach is extremely convenient for students to solve difficulties by themselves in the physical classroom for having the foundation information of the course at hand via online, and furthermore can help students obtain overall success of the proper and effective education [5]-[12]. Nowadays, with the popularization and development of mobile internet technologies, online learning is rising to boost teacher-student interaction. Flipped classroom is used in the teaching of various specialized courses, which can help solve the problems in traditional curriculum teaching and play an active role in learning.

Logistics engineering, as a major of engineering, mainly cultivates students to find, analyze, and solve problems in logistics especially focuses on training the students to have abilities of hands-on practice and innovation. Logistics system simulation course being the core curriculum of logistics engineering requires students to have solid professional theoretical basis as well as a strong practical ability. Due to the limited time of traditional classroom and many difficult curriculum contents, great pressure has been bought into traditional teaching and learning. This paper aims at cultivating the

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students' self-learning abilities. With applying the flipped classroom teaching strategies and using a variety of teaching methods, the blended learning model of the logistics system simulation course is designed. Through the practice of the designed course, the implementations are analyzed. According to the results of statistics, the design of the blended learning of the logistics system simulation course based on flipped classroom can effectively improve the students' learning efficiency in the classroom, and train their teamwork spirits. It also can promote the "multi-directional communication" and the emergence of differentiated instruction, which helps to cultivate the students' application-based abilities and stimulate their initiative and interests in learning the course.

II. Analysis of Logistics System Simulation Course

A. Brief Introduction of the Course

Logistics system simulation course, as a theoretical and practical course, is mainly to enable students to master the application of system simulation theory and methods in the field of logistics. The simulation contents can be extended from a specific logistics process to the planning of the entire logistics distribution center, which goes into all aspects of logistics. Therefore, for the logistics engineering students, the cultivation of simulation ability is very necessary and important. The logistics system simulation course can be divided into two major complementary parts: theory and practice. The theory is the basis of practice as well as the practice needs the guidance of the theory. According to the requirements of the logistics engineering major, the overall goal of the logistics system simulation course is through the study of logistics system simulation theory and related simulation software to make students master the basic steps of logistics system simulation and use the simulation software, so that they have abilities to analyze and solve problems for specific logistics systems. The goals can also be subdivided into the basic modeling and simulation theories for students, the ability to model basic logistics problems, and the ability to use logistics simulation software to solve problems.

The curriculum of logistics system simulation is comprehensive that focuses on senior students in logistics engineering, which is mainly divided into theoretical and practical contents. Theoretical contents mainly include the basic concepts of logistics system simulation, modeling of discrete event systems, random variables, input data analysis, system simulation algorithms, system simulation algorithms, simulation results analysis, system model verification validation and accreditation. The practical contents are mainly the modeling and simulation of specific logistics systems with some simulation software. The two parts complement each other in the teaching processes.

B. Teaching Status of the Course

The current teaching status of the logistics system simulation is as follows.

1) The theoretical contents of the course are abstract and a wide coverage of large number of knowledge points that the beginners may find it hard to master. In the theoretical teaching, much mathematical knowledge needs to be involved, such as random numbers, random variables, function distribution, probability statistics, and so on. Although advanced mathematics, probabilistic statistics and other related courses have been set up for students in the lower grades, due to their individual differences in mastery of basic knowledge, and considering some basic knowledge has been forgotten with the passage of time some students have become intimidated about difficult and deeper mathematical knowledge.

2) The practical contents of the course should be the part in which most of the students are interested. However, because there are many types of simulation software whose characteristics are different from each other in the market, students are the starting point to learn and operate them. Teachers in the classroom spend much time on explaining the operations of the software, which will lead to restricted time for students to practice among the limited hours of the classes. For some practical tasks, students can only be completed outside the classroom, so that when there are problems they cannot communicate with the teacher in time and teachers also cannot understand what the student actually knows.

3) Traditional teacher-centered teaching strategy makes students lack of initiative learning. The teacher consume a lot of time to explain the knowledge points, while students can only accept them passively. The young students have more active thoughts and stronger hands-on willingness. Simply passively receiving knowledge will be boring and dull over time, resulting in less interested in learning.

4) The student level is uneven, such as the understanding and learning abilities of knowledge are not the same, so that the acceptance of knowledge points taught by teachers is inconsistent. Some students have a good foundation, strong comprehension and quick acceptance, who can easily integrate the knowledge points taught by teachers in the class. However, some students with a poor foundation and comprehension cannot understand the meaning of the knowledge points in one class, as well as they embarrassingly ask questions and cannot review in time, resulting in the poor learning effect of them.

III. Blended Learning Design Based on Flipped Classroom for the Course

Blended learning involves online and face-to-face instruction in order to provide the students a comprehensive learning experience. Flipped classroom is more clear-cut than blended learning in dividing between the technology and face-to-face elements of the learning experience. Learners should be asked to watch an online video or do online learning exercises before coming to class. In the classroom, student-centered strategy is applied that teacher as an instructor to guide students exploring the application of the knowledge that is learned

online, meanwhile the new materials are also be added to the discussion.

A successful blended learning design based on flipped classroom needs obey some rules.

1) Define specific goals and expectations for each unit of the course according to the syllabus. Before starting to bring education technology into the class, what elements of the lesson should be covered and which are better suited for classroom time should be figured out. A curriculum schedule is established for determining a specific learning goal at the top of the list. For each of the class, it should probably be covered in an e-learning video before the class and during the face-to-face instruction.

2) Give learners the opportunity to apply the knowledge. The key point for successful of flipped classroom strategy is giving the learners the opportunity to apply what they have learned before the class time. Instead of holding much time lecture about the knowledge point of the class, instructors have more time to encourage learners through project-based learning activities to apply their new skills and information which is obtained from e-learning video.

3) Make online videos as short and concise as possible. Online video design is very important for flipped classroom, which should be included all of the major knowledge points for the course. For each of the video, try to make it concise and clear, especially keep the video time around five to ten minutes, as the longer one runs the risk of boring the learners and overloading them mentally. Educating with these short online videos is also called as microlecture mainly referring to a piece of audios or videos that use multimedia technology to give targeted explanation of knowledge points in about several minutes.

In accordance with the characteristics of the logistics system simulation and the tips of blended learning design based on flipped classroom, we design our flipped learning model for the course, as shown in Figure1. There are three parts in our model for blended learning design: before class, in class and after class. For each of them five sections, which are students' activities, teaching tasks, teacher's activities, teaching methods and teaching tools, are illustrated how flipped classroom teaching. Teaching tasks is the bridge between activities of students and teachers, while teaching methods and tools serve the whole teaching activities. For each class, the following shows the three phases of specific design.

1) Before class, teacher first makes online video, and then uploads the video, related electronic files and pre-class assignment through online teaching tools. Students learn these materials independently and complete their assignment. After students submitting the assignments through the internet, teacher collects the data and makes statistics, and then the teacher adjusts the contents of the classroom face-to-face teaching through the feedback results of the students' assignments. The teaching method of this process is on-line instruction.

2) In class, student-centered strategy is adopted. Teacher focuses on instructing students to apply the knowledge point having been learned before class, also uses heuristic and case teaching to expand the knowledge point, and explain the difficulties of students according to the statistics of pre-class assignments. Teacher encourages students to cooperate with each other to discuss in the teamwork and show presentations, moreover necessary practice should be guided. The effect of teaching in class can be tested by quizzes, teacher collect the assignments of students face-to-face, if there is enough time, the teacher can also personalize the students according to the test results. At the end of the class, teacher needs to arrange after-class tasks. The in-class link is a face-to-face instruction, which teacher can use traditional multimedia and modern mobile phone as teaching tools.

3) After class, on-line instruction also can be used. Students review the knowledge point, and expand the application proposed in class. Then submit after-class assignment according to the teacher's requirement. Teacher also needs to check the results, and can answer questions online with students. Finally, teacher reflects on the content and completes the teaching summary of this class.

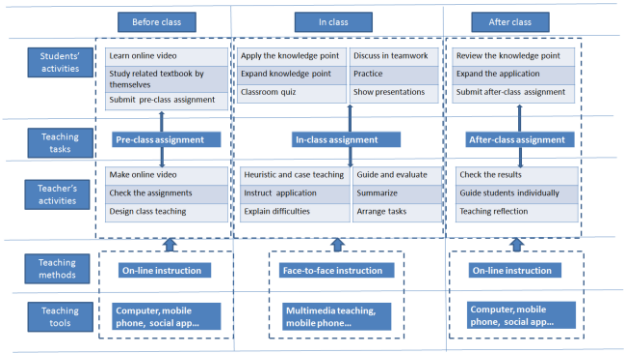

Figure 1. Our blended learning design based on flipped classroom for logistics system simulation course.

IV. Practice and Evaluation of our Design

In order to test the operability and effectiveness of our blended learning designed model based on flipped classroom for logistics system simulation course. We use the inverse function method to generate random numbers meeting with a certain distribution in the chapter of random variables as an example to conduct our empirical research. Through the selection of senior students major in logistics engineering, carry out this part of blended teaching design and practice based on flipped classroom. On this basis, the use of questionnaires and interviews as well as statistics of test quizzes in class can make us understand the learning effect and recognition of teaching mode with this teaching strategy.

The logistics system simulation course has been established the network class, there are a large number of teaching materials on the website. In the past teaching process, students have already used the online platform to do the homework, view the courseware and teaching cases, and complete online quizzes for all students. That is to say all the students have the conditions for online learning and the abilities to learn on their own. The

content of this class about inverse function method is relatively abstract and theoretical. We designed the class as follows.

1) Before class, we made a micro-video of 8m11s on the knowledge point of "using the inverse function method to generate random numbers that meets a certain distribution". Setting up pre-class assignment, including the purpose of this class and some surveys, in order to make students master the basic principle of inverse function method, and learn to derive the process of using inverse function method to stimulate an exponential distribution with a parameter λ. Meanwhile we collected the feedbacks of students through pre-class assignments and interviewed students online for about questions such as the completion time of the task and how difficult this knowledge point was.

2) In class, first of all, most of students had difficulties in proving the inverse function method according to the feedbacks of students before class, so we emphasized to explain this part in detail and expand this knowledge point. Then, the students were grouped in class to discuss how to apply the learned inverse function method to generate a set of random numbers that conform to uniform distribution within an interval. After discussion, delegates selected from the groups showed the results on the platform and displayed the procedure of how to prove. We commented on the presentations of the students. Afterwards, we instructed the students to use Excel software to practice, which should generate a set of random numbers that related to the distributions based on the results obtained by the inverse function method. Finally, we conducted a class quiz to test how students grasp.

3) After class, we gave the students an extension of the after-school homework and application of this part of the knowledge. The main assignment was to let students use inverse function method to deduce the process of generating a random number with the given probability density function of continuous random variable, and then use Excel to generate 200 related random numbers. Students completed the related tasks online. After that, we examined each of their assignments, and gave them feedbacks online individually. At last, we summarized the class and conducted teaching reflections.

The evaluation of our blended learning for logistics system simulation course based on flipped classroom mainly considers the following three aspects: learning feedbacks of online video before class, recognition survey of our class design, and assignment completion scores of the students. The first two aspects can be carried out through questionnaire surveys, and the last aspect can be analyzed through students' scores.

The survey was carried out by 44 students who participated in the class and conducted online questionnaires. The response rate reached 100%. The questionnaire separated two parts, the first part is for learning feedbacks of online video before class, and the second part is about recognition level survey of our class design. The statistics of the first part and the second part are shown in Table I and Table II. The statistics of the levels of students' scores are in Table.3, which is the according to the average score of assignments before class, in class and after class.

TABLE I. STATISTICS OF PART.1 LEARNING FEEDBACKS OF ONLINE BEFORE CLASS VIDEO

Questions	Options	Number of samples	Percentage
1. Do you think online video is easily to understand?	Very easily	10	20.45%
	Easily	22	50.00%
	Average	10	25.00%
	Hard	2	4.55%
	Very hard	0	0.00%
2. Can you finish the pre-class assignment well according to online video and other given materials?	Excellent	13	29.55%
	Good	20	45.45%
	Average	11	25.00%
	Bad	0	0.00%
	Very bad	0	0.00%
3. How long does it take for you to complete all learning tasks before class?	In 30 minutes	14	31.82%
	Between 30 and 60 minutes	24	52.27%
	More than 60 minutes	6	15.91%

TABLE II. STATISTICS OF PART.2 RECOGNITION SURVEY OF OUR CLASS DESIGN

Questions	Options	Number of samples	Percentage
1. Are you satisfied with this kind of flipped classroom?	Very satisfied	10	22.73%
	Satisfied	25	56.82%
	Just so so	9	20.45%
	Unsatisfied	0	0.00%
	Completely unsatisfied	0	0.00%
2. Which part of this teaching design do you like?	Before class	17	38.64%
	In class	20	45.45%
	After class	7	15.91%
3. How do you think the effect of our design?	Excellent	12	27.27%
	Good	26	59.09%
	Average	6	13.64%
	Bad	0	0.00%
	Very Bad	0	0.00%
4. Which teaching mode do you prefer, flipped classroom or traditional classroom?	Flipped classroom	39	88.64%
	Traditional classroom	5	11.36%

TABLE III. THE STATISTICS OF STUDENTS' SCORES

Level	Excellent	Good	Fair	Poor	Failed
The number of students	5	29	10	0	0
Percentage	11.36%	65.91%	27.73%	0.00%	0.00%

Table I shows the statistics of learning feedbacks of online video before class. There are three questions about this part. More than 60% of students agree that the online video is easy to understand. Most of the students can finish the pre-class assignment well according to the online video and other given materials. 84.09% of students spend less than one hour on completing all learning tasks, indicating our online video and assignment are designed reasonably for students to study. 15.91% of students have some difficulties in learning the knowledge point before class, which is related to their own basic and comprehensive skills.

The statistics of recognition survey of our class design is shown in Table II, including four questions are designed. About 80% of students are satisfied this kind of flipped classroom. Among all three parts of class design, students more like the design before class and in class, which means our blending design is popular. Most of the students consider our design of the class have a positive influence on their learning and prefer to the flipped classroom.

According to the statistics of students' scores shown in Table III, 77.27% of students got a good result. However, there are also 27.73% of students have moderate scores,

which is related to their own ability and the difficulty of the class quiz or assignment. For this level of students, we have conducted individualized tutorials after class to urge them to better grasp what they have learned.

V. Conclusion

We advocate that the process of undergraduate learning should be autonomy and exploratory. Therefore, teachers should pay attention to cultivate independent learning of students during the teaching process. In our design of blended learning based on flipped classroom, before class teachers use modern information technology to provide students with micro-course video and course materials. Students can arrange learning time, learning speed and learning location according to their actual situation, and also collect related course files by themselves. Meanwhile, students can self-evaluate their own learning effects according to the teacher's questionnaires. In this process, student learning is autonomous learning. In and after class, teachers instruct students in application expansion, discussion, presentation, practice, and review, all of which can mobilize the initiative for students in learning.

Our teaching model is a blending design with a variety of teaching methods. During this process, students are encouraged to analyze and solve problems by group collaboration. Furthermore, the communication and collaboration skills of students are enhanced. Especially our design focuses on applying and practice, which can trigger to active students' deeper thinking and then enhance their creative ability. In flipped classroom, the roles of teachers and students have reversed. Teachers have become leaders and supervisors of learning, and students are the master of the learning. The main task of teacher is to guide students to apply the target knowledge points to analyze and solve problems. In this process, teachers can better understand how students grasp, and provide targeted guidance to students through more frequent and open communication with them.

In the future, we will continue to complete and improve our design to the entire course, and conduct more extensive surveys and statistics to conduct more in-depth research.

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