



# Flipped Classroom Based on E-Learning in Computer Science and Technology: A Case Study

Chengyan Li<sup>(✉)</sup>, Jun Gao, Shenghui Liu, and Guanglu Sun

School of Computer Science and Technology,  
Harbin University of Science and Technology, Harbin 150080, China  
chengyan@hrbust.edu.cn

**Abstract.** Flipped classroom are widely adopted to improve students' learning, especially in deeper understanding and interactive learning. We designed and provided a flipped classroom combined with e-learning in a computer science and technology course to help students develop their computing and programming skills. We presented the course setting, process of flipped classroom and online material making. The flipped classroom is composed of before-class phase, in-class phase and after-class phase. All learning materials are provided by e-learning platform. Further, the detail analysis of results obtained was using to conclude that students are inclined to accept the new teaching model.

**Keywords:** Flipped classroom · e-learning · Computer science and technology Database course

## 1 Introduction

In recent years, flipped classroom have become very popular technique for delivery knowledge. The flipped classroom is different from traditional learning activities in which the teacher assigns introductory materials, such as instructional videos or basic assignment to be learned before class, so that class time can be spent with more advanced activities and higher thinking [1].

The flipped classroom adopts a student-centred approach and the teachers are no longer the transmitter of knowledge, in fact, the teachers can utilize class time more efficiently for group discussion and peer-to-peer interactions, or use more class time to look at specific examples and work them out. In a typical flipped classroom, the students will control the learning process in class, collaborating in small groups and solving the problems using basic knowledge they have acquired before class, and therefore increases their learning motivation, self-confidence and self-management. Thus, the students will be able to apply, analyze, evaluate, integrate, create and discuss, make a deeper understanding of knowledge in class than just remember it, and can improve their practical skills and collaborative learning skills [2].

According to learning analytics, flipped classroom is more efficient and scalable than traditional classroom in subjects like Mathematics, Health education, Science, Technology and English reading comprehension [3, 4]. Many students praised the

flipped format, the course quality and enjoy the course [5]. The flipped classroom provides more flexibility and improves achievements for students' learning, and is widely used by universities all over the world [6].

The flipped classroom is greatly facilitated by making use of Information and Communication Technology (ICT), involving learning on computers outside the classroom, and interacting with peers in small group online [7]. ICT is used to promote connections: student-to-student communication and student-to-teacher communication.

With the rapid and continuous development of Internet and computer technology, the trend of adopting e-learning has been emerging and expanding in the field of education.

E-learning (or online learning) is an approach that use of digital devices such as computers, smartphones, iPads, the Web, and managed learning environments to organize or fulfill teaching and learning [8]. E-learning is a resource-based learning, which provides an educational environment where learners are able to access educational materials, at every time and at everywhere [9]. This approach is learner-centred, that is, it developed the individual and adaptive learning courses and taken on learners into the learning process, customized to the individual learner's needs and goals. Educational materials, which also known as learning objects (LOs) located in the Web environment or in the form of digital objects [10]. Many teachers think that e-learning is an important third-class platform of education. The Internet and e-learning has been the new classroom for learning and ubiquitous as a major form throughout China.

In this paper, we take a view on the integrated of flipped classroom and e-learning environment. In Sect. 2, we give an overall taxonomy of the approach. In Sect. 3, the course setting, and the teaching point of the class is discussed in detail based on a case study. In Sect. 4, a conclusion is made, and future research is proposed.

## 2 Integrated of Flipped Classroom with E-Learning

### 2.1 The Architecture of Learning System

The flipped classroom is composed of three phases of instruction that are before-class learning, in-class learning and after-class learning.

Figure 1 shows the overall taxonomy of our learning system.

In this taxonomy (Fig. 1) we show the associations among the levels of before-class learning, in-class learning and after-class learning. For each phase, the learning object will be discussed in detail. Subsequently, the e-learning platform provides material and context for the procedure. Accordingly, these processes are associated with the content adaptation and models. Moreover, the challenges in the course are considered.

The first phase of the flipped classroom is before-class learning phase. In this phase, students acquire basic knowledge by viewing on-line learning materials provided by e-learning platform, such as videos, power point presentations or documentations.

The second phase of the flipped classroom is in-class learning phase. In this phase, the time could be free for active learning. Students have student-centred interactive learning activities and could have more practice, such as lectures, problem solving,

group discussion, peer-to-peer interactions, and higher order thinking. The in-class practice led students' learning into a more in-depth way.

The individual learning in the in-class phase is self-regulate their learning (SRL), focus on four dimensions of student self-management: planning, control, regulating and evaluation.

The team learning in the in-class phase is collaborative and cooperative forms of learning. Students should participate in discussions and interact with others by groups, so they must acquire a strong knowledge base in the before-class learning.

The third phase of the flipped classroom is after-class learning phase. In this phase, students should do some assignment to review the subject knowledge and technical skills. Homework can be followed review is carried out by students in online learning platform. There are section tests to check out the outcome of learning.

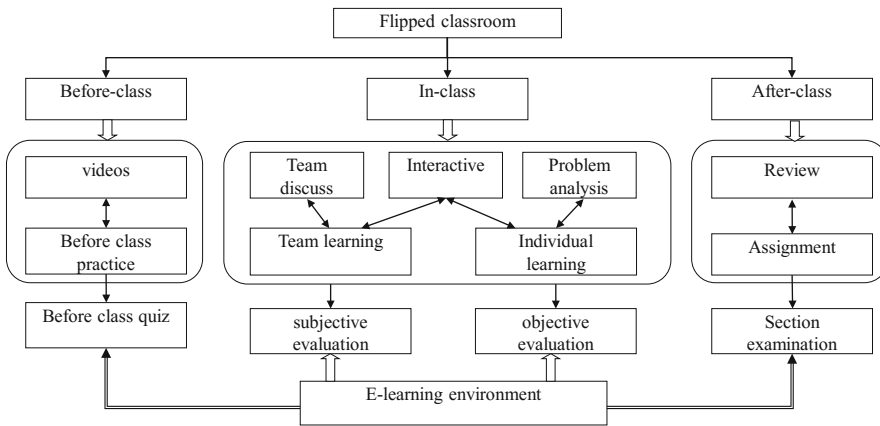


Fig. 1. Flipped classroom based on e-learning taxonomy

### 2.2 E-Learning Environment

The E-learning environment in the learning system or architecture is based on an online learning platform, which is composed of co-operative learning and question-answer system.

**Online Co-operative Learning.** The online cooperative learning helps the teaching and learning process in a number of useful ways. The students should use new learning technologies, such as online learning platforms and online discussion groups. Moreover, this method provides a means for group based learning, and the opportunities for teacher-student communication and student-student communication. The ICT in online cooperative learning is used to promote connections.

The online modules consist of power point presentations (PPTs), documentations, instructional videos and online question-answer following all the techniques that students will meet during the course. Students navigate the modules at their own pace, allowing flexibility and self-directed while meeting specific classroom deadlines and to

reinforce teaching points. For example, students may learn structure query language (SQL) command program in the models, and in class the following day, work in group to do some exercise for complex SQL query.

**Online Question-Answer.** This module provides individualized online access to guidance, recommendations and assistance to promote student’s learning and performance. Students can pose a question via Internet and need not be afraid of face-to-face interaction. In addition, students’ questions can be feedback immediately, and they have instant support during this process. As online learning environments provide less threatening opportunities to seek help, students would prefer using this approach because it is easier and more efficient than traditional educational settings. For example, a student may ask a question about “the error of insufficient privilege”, and the teacher can reply that “this problem can be solved using grant”, furthermore, the teacher can give the student a screenshot using Print-Screen to demonstrate the solution. Moreover, the instructors are easy to identify which topics were difficult for students and pay more attention to these topics.

### 3 Case Study

#### 3.1 Course Setting

The experiment of the flipped classroom combined with e-learning was conducted in a course entitled “Oracle Database Management System”, which was a semester-long, 3 credit-hour course, targeting third year university students of Computer Science and Technology. The major focus of this course was to develop students’ database basic concepts and principles, database management skills and database programming skills.

Below are descriptions of the content in some examples of the modules.

**Database Setup and Configuration Videos.** The videos are short instructional videos covering a variety of topics, including relational database management system software (RDBMS) installation and configuration, database network configuration, database creation, database startup and shutdown, etc. All the videos were developed at our institution using Screen-capture application.

**SQL Programming PPTs.** The PPTs covering the program of data definition language (DDL), data manipulate language (DML) and data control language (DCL). We made all the PPTs using Microsoft PowerPoint.

**Assignments.** Students submit their homework via Internet to promote their programming skills, for example, database management, database configuration, data query, data backup and restore.

**Total Grade Calculating.** Students want to achieve excellent total scores, exam performance is not the only to assess, they should do good at all the quizzes, actively participate in the classroom activities and discussions and assignments.

According to our experiences, preparing to initiate the flipped classroom model will consume more time than to initiate the traditional lecture-based instruction, because there are a lot of material should be prepared prior to the class. But the time was well

spent for the materials, such as videos, PPTs and documentations can be used for future classes. Last but not least, when designing the learning material and activities, the instructors should think as students and should concern the students' feedback.

The setting of the course is listed in Table 1.

**Table 1.** Teaching points of database course

No.	Module of the course	Number of teaching points	Contents	Hours
1	Introduction	6	Database introduction, RDBMS architecture	2
2	Install, configuration and tools	18	Database installation under different OS, configuration and tools	4
3	Account and security	21	Creation of role, user and security management	2
4	Network and database management	4	Configuration of network, creation and management of database	2
5	Table	18	Create and update table, data type	6
6	Index and view	8	Management of index and view	4
7	Other schema object	5	Sequence, synonym and database link	6
8	Data manipulate language	5	Insert, delete, update and transaction control	4
9	Query and SQL function	11	Select, single line function, group function	4
10	PL/SQL	10	Program and instance of procedure, function, cursor, trigger and package	6

We have made PPTs, documentations, short videos, quiz questions, assignments and discussion topics. There are 96 videos were captured by a video-capture application, each of which is less than 10 min in length.

### 3.2 Classroom Sessions

The classroom sessions are interactive and collaborative activities for students to apply and make deeper understanding knowledge. The session is project-based, with explicit learning objectives, for example, to develop a human resource (HR) management system or an identity (ID) card management system. The final goals are divided into many topics, each with specific target, focusing on core teaching points, for example, database design, database create and configuration, user role and privilege, table and view, index and user interface.

All students in the class were divided into small teams of 4–5 members at the beginning of the semester, and a team leader was elected by all the members. As every student has a smartphone and laptop, each one in the study was assigned a userID of the e-learning system. Students were asked to submit their group discussions and problem solving to the course Web site before classroom session.

The flipped classroom format was examined in the 2015/16 academic year. There were 52 students registered on the course. The course is a third year undergraduate engineering course. The total number of hours for this course is 40, and the flipped approach consisted of 3 h class each week. In advance of the class time, teaching material (PPTs, documentations and videos) were uploaded onto the university's e-learning platform for students to study. The class time was spent on student-centred learning activities.

### 3.3 Challenges of the Course

The flipped classroom is a method that depends heavily on students preparing outside of class. The lack of students' preparation in before-class learning is a main trouble in the flipped classroom. If students show up no prepared, for example, come to class without doing the video lecture at home, they will get lost during in-class learning. The before class practice and quiz via Internet is used to ensure students have prepared prior to class. These quizzes are not difficult and should not cost students too much time. Moreover, the quizzes will bring the students in at a level of preparation, and the score will be calculated into the total grade.

Some students are not enjoy the active learning format is another trouble in the flipped classroom. These students are used to the traditional passive lecture learning format that the instructors explain all the subject knowledge. The teachers are difficult to know whether the students have acquired the knowledge, and the same group mark is awarded to each individual in the group despite their level of participation. So the in-class learning should be well-organized in instruction.

At last, students might not collaborate well or not contribute to the work of group in the in-class learning activities should be concerned. Some students may work on their own and with a low level of collaboration.

The learning feature of the e-learning platform allows the instructor to determine how many students are preparing for class.

Figure 2 is an example for detail analysis for some students of watching video. The video is 7.8 min long. The green bar indicates the completion of watching video. The deeper green of the bar means the better preparation before-class, on the contrary, the lighter green means the worse. The Repeating Ratio (%) indicates the repetition of the student for watch the video, it is calculated by Total Time for Watching Video divide the video length.

### 3.4 Course Evaluation

In order to evaluate the effect of course and improve future practice, an anonymous survey was conducted at the end of the semester. Student evaluation questionnaires (SEQs) are seen as a good means by reviewing what has come before [11]. We collected qualitative data, and display the questions and representative comments in Table 2.

From these data, we can conclude that students highlighted the overall course, and they give some useful suggestions in addition.

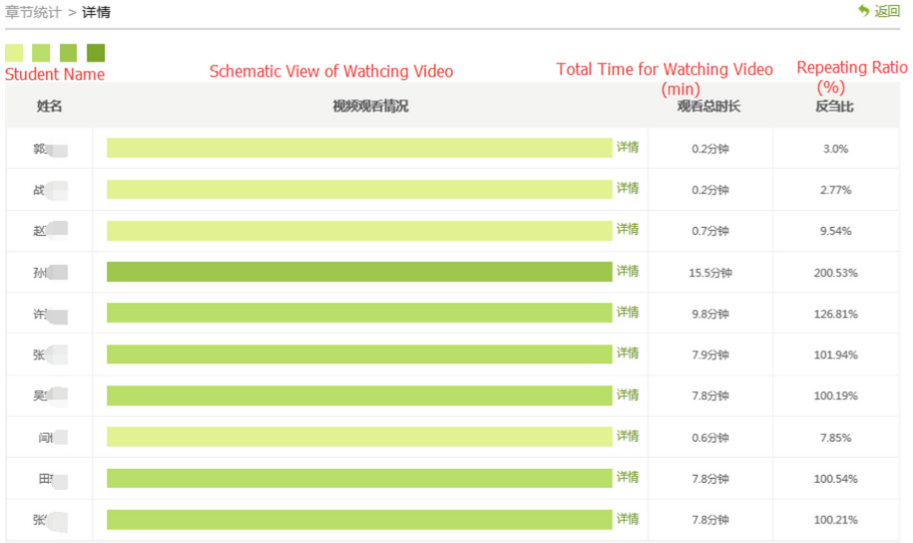


Fig. 2. Detail analysis of watching video by e-learning platform (the picture is a screenshot of the e-learning platform, so we translated the Chinese into English.) (Color figure online)

Table 2. Results from qualitative data

No.	Questions	Representative comments
1	What do you think of flipped classroom? (positive/negative)	Almost all participants chose “positive”
2	What do you think is the main advantage of the course?	“It’s more convenient to hand in homework” “I can review the content by myself, if I don’t understand it well in the class” “The flipped classroom can stimulate the students’ learning interests and thirst for knowledge” “There is a better learning effect in this course”
3	What do you think is the main weakness of the course?	“It’s a bit bother for using the e-learning platform” “There is no reminder of the deadline for the homework” “The curriculum is relatively scatter and requires higher self-management to the students”
4	What improvement suggestions do you have for the course?	“The e-learning platform should be improved” “More teacher’s online instruction are needed during the course”

## 4 Conclusion

Providing an interactive environment to the instructors’ and learners’ need is an important research area. Flipped classroom is the most popular teaching approach during the decade. The process of flipped classroom faces a wide problem such as

delivery of materials, interaction of student-student and student-teacher. E-learning system rises as a natural platform to support flipped classroom.

In this research, we combined the flipped classroom with e-learning environment and provide a platform for teachers and students. The study gave an overall taxonomy of the learning system with structure, phases of learning and challenges.

A case study shows that the proposed learning system has good effects on the education modes and flipped classroom is an attractive method for providing seamless learning services.

In the future work, we are working on the design and implement of production of teaching materials and online answer and help system.

**Acknowledgments.** This work was supported by grant No. 16G116 from the Research Program in 13th Five-Year the project of the Higher Education Society of Heilongjiang Province, and No. SJGZ20170056 from the Research Program of Education Department of Heilongjiang Province, China.

## References

1. Gilliland, K.O.: The flipped classroom and learning analytics in histology. *Med. Sci. Educ.* **27**, 1–5 (2017)
2. Long, T., Cummins, J., Waugh, M.: Use of the flipped classroom instructional model in higher education: instructors' perspectives. *J. Comput. High. Educ.* **29**, 179–200 (2017)
3. Tsai, C.W., Shen, P.D., Chiang, Y.C., Lin, C.H.: How to solve students' problems in a flipped classroom: a quasi-experimental approach. *Univers. Access Inf. Soc.* **16**(1), 225–233 (2017)
4. Huang, Y.N., Hong, Z.R.: The effects of a flipped english classroom intervention on students' information and communication technology and english reading comprehension. *Educ. Tech. Res. Dev.* **64**(2), 175–193 (2016)
5. Manson, D.K., Amiel, J.M., Gordon, R.J.: Using a flipped, blended learning model to build a modern classroom for senior medical students transitioning to residency. *Med. Sci. Educ.* **26**, 553–556 (2016)
6. Lee, K.Y., Lai, Y.C.: Facilitating higher-order thinking with the flipped classroom model: a student teacher's experience in a Hong Kong secondary school. *Res. Pract. Technol. Enhanc. Learn.* **12**(8), 1–14 (2017)
7. El Mhouti, A., Erradi, M., Nasseh, A.: Using cloud computing services in e-learning process: benefits and challenges. *Educ. Inf. Technol.* **23**(2), 1–17 (2017)
8. McConnell, D.: E-learning in Chinese higher education: the view from inside. *High. Educ.* **4**, 1–15 (2017)
9. Premalatha, K.R., Geetha, T.V.: Learning content design and learner adaptation for adaptive e-learning environment: a survey. *Artif. Intell. Rev.* **44**(4), 443–465 (2015)
10. Hwang, G.J., Lai, C.L., Wang, S.Y.: Seamless flipped learning: a mobile technology-enhanced flipped classroom with effective learning strategies. *J. Comput. Educ.* **2**(4), 449–473 (2015)
11. Blair, E., Maharaj, C., Primus, S.: Performance and perception in the flipped classroom. *Educ. Inf. Technol.* **21**, 1465–1482 (2016)