# Chapter 14
# A Comparative Study of the Teaching Effect of 'Flipped' MOOC Class and Conventional Class


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**Abstract** MOOC and flipped classes are models of instruction which have sprung up in the last few years, in educational circles all over the world. In the School of Physics and Engineering at Tongji University, we have integrated a flipped class into a MOOC teaching method, which is called a 'flipped' MOOC class. The aim of this paper is to assess whether this improves the quality of instruction in university physics classes and enhances student performance. Two second-year physics classes were randomly chosen as the research subjects, with one class being taught in the conventional way and the other with the flipped MOOC method. In order to guarantee a reliable foundation for comparing students' learning effectiveness in these two approaches, we analysed the rationality of the teaching process and the evaluation method. After a correlation analysis of the students' records for both classes, we concluded that the flipped MOOC class showed an enhanced teaching effect and better student grades than the conventional class. In the process, we encountered some unexpected problems. So, we figured out why they were happening and reflected on how we could handle these difficulties if we wanted to promote quality instruction and improve students' ability by this flipped MOOC approach.

**Keywords** Massive open online courses · MOOC · Flipped class · Teaching effect

## Background

Flipped classrooms and MOOCs are both new teaching models which arose in the USA and then rapidly became popular in international higher education and educational theory. They were selected by the NMC Horizon Reports in 2013 and 2014 as important educational technologies which would have a major effect on education in the near future. In China, a National Plan for educational reform advocated 'using national advanced educational concepts and educational experience to promote reform and development of our education, and elevate the level, influence and the

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competitiveness of the educational system on the national stage' (National Plan for Medium and Long-term Education Reform and Development, 2010). It also points out that we should try new pedagogical approaches and be more motivated to carry on educational informationisation.

## Literature Review

The flipped classrooms began in Forest Park High School, Colorado, in the USA, and the videos of Salman Khan and his Khan Academy in 2011 became a milestone in the flipped classroom development process. In 2012, in Education Week, Katie Ash said that a rapidly increasing number of scholars are replacing lectures with on-demand videos; and, according to Yang, Yang and Chen (2012), this new way of teaching in the classroom very soon attracted worldwide attention. Gardner (2012) points out that the studies on flipped classrooms in foreign countries are centred on how they work in educational practice; Strayer (2012) compares such classrooms with the conventional teaching mode; and Cannod, Burge, and Helmick (2008) point out the educational effect when we connect the flipped classroom with other educational methods and technologies. These researchers concentrate on the application of flipped classrooms as an important issue and take an extensive period of time to test this new teaching model; and with accumulating experience of the process, they argue that it is a proven improved practice in classroom teaching. However, there are many differences between the educational concepts and teaching forms of China and America, so we cannot just transplant their experience into our courses. We need to examine closely the benefits and limitations of this new teaching model in the Chinese context.

MOOC originated from the development of open education resources (OER). Following the launch of the major OER platforms (e.g. Coursera, edX and FutureLearn) in about 2012, MOOC has become fashionable worldwide. Many universities in China are starting to organise their own MOOC courses, such as molecular biology at Wuhan University, flipped classroom instruction at Beijing University, preventive medicine at Fudan University and college physics at Tongji University. For supporting progress in this development, online education platforms have been set up. For example, Shanghai Jiao Tong University developed the platform 'Good University Online', and Tsinghua University took the initiative to find 'online courses'. Both the Ministry of Education and Ministry of Finance are together supporting funding for i-course platforms; and some platforms are designed by commercial companies.

According to Zhang (2012), the practice of flipped classrooms in China is just at the beginning and is still at an introductory stage. His paper about flipped classrooms is mainly concerned with theoretical analysis, discussing this new teaching model, implementation strategy and teaching design, though there is much more theoretical than practice and more about description of educational belief than providing empirical research findings. Wang and Zhang (2013) indicate in their research that

there are ongoing discussions about this new pedagogical approach in primary and middle schools but little about its application in colleges. Also, there is little comparative study of the teaching effectiveness of flipped classrooms and conventional classes.

We combine the flipped classroom with a MOOC platform because of the expanding functions of MOOC platforms, which promotes the educational process in a more open and free educational environment. Meanwhile, the discussion segment in the flipped classroom could offset the disadvantages of MOOC in comparison with the conventional face-to-face didactic teaching in the classroom.

## The Research Study

This section outlines our research subjects, the educational processes involved in the 'flipped' MOOC classroom compared with conventional education and the reasons for evaluating the two educational models. Then it presents a contrastive analysis of what was achieved.

### *Research Subjects*

Second-year students in two physics classes at Tongji University were chosen as the research subjects. We divided the students into classes randomly according to their entrance scores, so we can assume that the classes had no essential differences.

### *Contrasts in the Teaching Process*

Table 14.1 gives details of the different educational processes in the 'flipped' MOOC model and conventional classes at various stages.

Some pedagogical stages are essential in the flipped MOOC class: pre-learning content class → discussing in the class →teacher's guidance and problem-solving →summarising. This is different from the teaching process in the conventional class: prepare lessons before the class →teacher's explanation in class →exercises after the class.

As seen in Table 14.1, we use the 'flipped classroom' process in the 'flipped' MOOC class, but almost two-thirds of the process taking place in the MOOC platform is different. Before class, the teacher uploads the necessary resources into the platform, and the students just learn from those resources provided by the teacher and complete the test. In class, the teacher's major tasks are organising student discussion, to be supplemented by explaining misunderstanding of the questions and missing knowledge, and assigning homework – while students discuss the pretest

**Table 14.1** The contrast in the teaching process between the 'flipped' MOOC class and a conventional class

| Phase | Time | 'Flipped' MOOC class | | Conventional class | |
|---|---|---|---|---|---|
| | | Activity of the teacher | Activity of the student | Activity of the teacher | Activity of the student |
| Pre-class | A week before class | Upload the necessary resources | Understand the teaching videos and teaching materials, the basic teaching tasks and teaching requirements | Prepare the teaching content and teaching materials | Preview the basic knowledge in the educational content |
| In-class | The first class | Introduce the teaching contents – Their emphasis and difficulty | Complete the teaching videos, the online test and assessment | Complete the first part of the content | Complete the study mission and homework after the class |
| | The second class | According to the students' feedback in the process of the online class, organise students to discuss the problems | Participate in group discussion; reflect the problems in the online course to the teacher and solve them; actively help group members to solve problems | Study the second part of the content, and solve the problems about the lesson in the class | Reflect the problems in the first lesson to the teacher; complete the learning tasks in this course |
| | The third class | Give supplementary explanation, unriddling and homework | Correct the mistakes in the discussion and, before class, submit the network operation | Complete the course, sum up the knowledge, and arrange homework | Finish homework |
| After-class | A week after class | Provide online support | Communicate with peers online about homework questions after class | Nil | Consolidate knowledge |
| Platform | | A network teaching platform will be required for the release of study guides, learning resources and teaching videos, online testing and test results of the real-time statistics and feedback | | Nil | |

questions cooperatively with their teammates and modify misunderstandings with the help of the teacher. After class, the teacher can discuss any problems with the students online, and they can also interact with each other on the platform. In the conventional classes, the teachers give a lecture, and students just listen to it.

**Table 14.2** Standards of evaluation

| Standards of evaluation | | | | | | |
|---|---|---|---|---|---|---|
| | Procedure | | | Online | | Exam (%) |
| | Homework (%) | Attendance (%) | Course (discussion) (%) | Participation (%) | Online test (%) | |
| 'Flipped' MOOC class | 10 | 5 | 15 | 15 | 15 | 40 |
| Conventional class | 10 | 10 | 10 | Nil | | 70 |

## *Standards of Evaluation*

The standards of evaluation are shown in Table 14.2. As the standards of evaluation are the basis of effectiveness of learning and teaching, it is important to ensure that the contrast in teaching results between the 'flipped' MOOC class and the conventional class is reliable and reasonable.

As shown in Table 14.2, in a 'flipped' MOOC class, the final score = the procedure score * 30% + the online score * 30% + the exam score * 40%. The procedure score includes homework, class attendance and participation in discussion; and the online test comprises an online score. In the conventional class, the final score = the procedure score * 30% + the exam score * 70%; and the procedure score also includes homework, class attendance and discussion. The conventional class has no online component, so the exam score takes up 70% of the final score. As seen in Table 14.2, in the procedure score, the proportion of the total score for the 'flipped' MOOC class is the same as in the conventional class, but there is some difference between them in classroom learning, as about one-third of the attendance time is used for online learning – and so the disparity between the two classes is reasonable. There is more discussion – a more educational part – in the 'flipped' MOOC class than in the conventional class; and it can also be seen that the proportion for the online test and exam score in the 'flipped' MOOC class is equal to the proportion for the exam score in the conventional class because the online course takes one-third of the total time and every single section has a test. The data for tests were collected for a process evaluation and a supplement to the exam.

## *Contrastive Analysis of the Teaching Effectiveness*

The examination papers used in the two classes were the same, and no students knew the details in the papers before the exam, so it is reliable. The procedure scores, online scores, exam scores and final scores in the two classes were analysed by SPSS and Excel.

**Table 14.3** The score table for the 'flipped' MOOC class

| 'Flipped' MOOC class | | | | | | |
|---|---|---|---|---|---|---|
| | Highest score | Lowest score | Average score | Population variance | Sample variance | Standard deviation |
| Exam scores | 94 | 35 | 71.75 | 191.53 | 193.66 | 13.91 |
| Final scores | 94 | 29.8 | 79.59 | 139.29 | 140.83 | 11.86 |
| Online scores | 100 | 33 | 79.4 | 353.04 | 357.01 | 19.01 |
| Procedure scores | 97 | 9 | 86.7 | 142 | 143.4 | 14.9 |

**Table 14.4** The score table for the conventional class

| Conventional class | | | | | | |
|---|---|---|---|---|---|---|
| | Highest score | Lowest score | Average score | Population variance | Sample variance | Standard deviation |
| Exam scores | 97 | 0 | 67.73 | 351.73 | 354.02 | 18.75 |
| Final scores | 96.1 | 9.3 | 73.8 | 244.23 | 245.81 | 15.62 |
| Procedure scores | 100 | 23 | 88 | 208.3 | 209.7 | 14.43 |

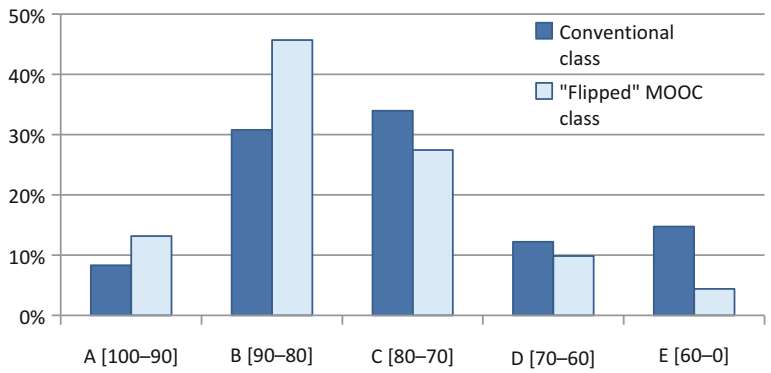


**Fig. 14.1** The grade distribution statistics

The scores for the 'flipped' MOOC class are shown in Table 14.3 and for the conventional class in Table 14.4. The difference between the two classes in different items was analysed, and Fig. 14.1 presents the grade distribution statistics. The *t*-test correlation analysis is presented in Table 14.5.

The highest score, lowest score, mean score and variance of the exam scores and final scores were analysed, and the results for the two classes were compared. As Tables 14.3 and 14.4 show, although the highest exam score and final score in the 'flipped' MOOC class were slightly lower than those in the conventional class (i.e. 3

**Table 14.5** *T*-test correlation analysis

| | *T* double tail critical | *P* ($T <= T$) double tail | F single tail critical | *P* ($F <= F$) single tail |
|---|---|---|---|---|
| Exam scores | 1.97 | 0.046 | 1.816 | 0.0011 |
| Procedure scores | 1.97 | 0.575 | 0.991 | 0.474 |
| Final scores | 1.97 | 0.001 | 1.734 | 0.002 |

and 2.1 scores, respectively), the lowest exam score and final score were much higher in the 'flipped' MOOC class than those in the control group, i.e. the conventional class where they were 0 and 9.3. The mean exam score in the 'flipped' MOOC class was 71.75, which was 4.02 higher than the mean exam score of 67.73 in the conventional class; and the average final score in the 'flipped' MOOC class was 79.59, which is 5.79 higher than the average final score of 73.8 in the conventional class. Finally, the variance in the conventional class was higher than that in the 'flipped' MOOC class – that is, the grades in the conventional class were much more scattered.

The students' scores were divided into five groups: A [100–90], B [90–80], C [80–70], D [70–60] and E [60–0]. Figure 14.1 shows that the percentages in the five groups in the 'flipped' MOOC class, respectively, were 13.18%, 45.76%, 27.47%, 9.89% and 4.39%; while in the conventional class, the respective figures were 8.33%, 30.76%, 33.97%, 12.18% and 14.74%. In Groups A and B, the percentages for the 'flipped' MOOC class were 4.85% and 15% higher, respectively, than in the conventional class; and, in Groups C, D and E, they were 6.5%, 2.29% and 10.35% lower than in the conventional class. Therefore, it can be said that at the higher levels, the learning outcomes in the 'flipped' MOOC class were much better than those in the conventional class.

A correlation analysis was then carried out for the exam scores, procedure scores and final scores. For the exam scores, using analysis of variance methods to do a significance test of the homogeneity of variance in the two classes, the results were $F = 1.816$, $p = 0.0011$ – thus indicating homogeneity. A bilateral *t*-test ($t = 1.97$, $p = 0.046 < 0.05$) showed that the difference was significant. As the average exam scores for the 'flipped' MOOC class and conventional class were 71.75 and 67.73, respectively, the average exam score for the former class was therefore much better than for the latter. For the procedure scores, using the same method, $F = 0.991$, $p = 0.474$, showing homogeneity. The bilateral *t*-test result – $t = 1.97$, $p = 0.575 > 0.05$ – indicated that the difference was not significant. The average procedure scores in the 'flipped' MOOC and conventional classes were 86.7 and 88, respectively, so the average procedure score for the former class was a little better than for the latter. Lastly, again using the same approach for the final scores in the two classes, the result ($F = 1.734$, $p = 0.002$) showed homogeneity. The result of the bilateral *t*-test ($t = 1.97$, $p = 0.001 < 0.05$) indicated that the difference was significant. As the average final scores in the 'flipped' MOOC class and

conventional class were 79.59 and 73.80, respectively, one can see that the average final scores for the former were much higher than for the latter.

## Conclusion

In conclusion, the average exam score in the 'flipped' MOOC class was better than the average exam score in the conventional class, and the *t*-test showed that the difference between them was significant; and the same applied to the average final scores. However, there was not a significant difference in procedure scores. So, compared with the conventional class, the learning outcomes in the 'flipped' MOOC class were better. It is suggested that this outcome was due to student interest and learning involvement and that the online course may have extended the learning time.

There were 106 students in the 'flipped' MOOC class, excluding 91 students who did not register for the online course (i.e. 85% of the total). There were 163 students at the beginning. However, some students dropped out in the process, leaving only 156 students in the conventional class attending throughout the course, i.e. 93% of the total. Compared with the conventional class, more students in the 'flipped' MOOC class did not register for attendance. There are several possible reasons for this. First, some students resist the new teaching methods and did not want to sign up for the online course. Second, the way in which the 'flipped' MOOC was introduced was not clear so that some students misunderstood what was involved in the process. Also, technology problems in the MOOC platform, if any, may result in deregistering.

The 'flipped' MOOC class did not just enhance students' knowledge. The students also learned cooperative, self-management, communicative and organisational skills, and so the 'flipped' MOOC class has good prospects.

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