



Application of Micro-lecture in Calculus

Rong Wang

Department of mathematics, Southern University of Science & Technology,
Shenzhen, P. R. China

Email: wangr3@sustech.edu.cn

Abstract. In this paper, we describe the importance of micro-lecture in the Calculus teaching. First the demerits of the traditional classroom teaching approach are discussed. Then we introduce an innovative hybrid teaching approach using the micro-lecture together with the usage of the rain classroom system and the blackboard learning platform. This new teaching approach produced very good feedback.

Keywords: Calculus, Micro-lecture, Rain Classroom, Blackboard Platform.

1 Introduction

Calculus ^[1,2,3] is one of the most fundamental mathematical courses for undergraduate students major in Science or Engineer. There are quite a lot of developments on teaching skills and methods to improve the teaching quality of the Calculus course in recent years. The micro-lectures ^[4,6,7] are widely applied to improve the traditional classroom teaching modes. In this paper we first discuss the issues arisen in the current classroom teaching mode for Calculus and the purpose of the usage of micro-lecture. Secondly, an innovative teaching approach is introduced in detail. This teaching approach is implemented with micro-lecture, the rain classroom system ^[5] and the blackboard learning platform ^[11]. Finally, we will share the feedback from our students and faculties for the smart teaching mode.

2 Purpose

A typical traditional teaching approach usually involves a standard curriculum delivered by a teacher in-person. Standardized tests are administered at regular intervals to test students' comprehension. This mode is where students' time, place and pace of learning remain constant. It is true that these traditional teaching modes often allow us to continue with the lecture-based mode with some success as evident by the past accomplishments. However, it is often argued that the traditional approach may not provide students with valuable skills and indeed some even go as far as saying the traditional method leads to a student not retaining knowledge after exams ^[8,9,10]. That is, they have little or no recall of the body of knowledge learnt beyond the end of a semester.

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Furthermore, there is a trend that many Chinese universities are reducing the total time for first-year undergraduate courses. For example, the total teaching time for Calculus I (or Calculus II) is reduced from 72 class sessions to 64 class sessions in our universities while the same amount of teaching materials is required. In other words, professors must find a way to improve the efficiency of teaching mode. This is one of the main reasons why micro-lectures are necessary to be implemented to the traditional classroom teaching approach as well as the usage of the rain classroom system and the blackboard learning platform.

3 Property of Micro-lecture

The core of the micro-lecture is a series of short classroom videos. A micro-lecture video is a short, recorded audio or video presentation on a single, tightly defined topic. Micro-lectures are typically produced by an instructor, who might begin by drafting a rough script that includes an introduction, a list of key points to cover, and a conclusion. Good micro-lectures also include lecture notes, practice problems, student feedback as well as the comments from teachers. The micro-lecture is an innovative teaching resource that has the following properties.

1. Each micro-lecture video is short and concise. The duration of a micro-lecture video is usually less than 10 minutes. Compared with traditional instructional videos that record a class session that is 45 minutes or even longer, micro-lectures have the advantage of acknowledging the typical student's attention span and thus sustaining students' focused attention to the content.

2. The content of each video is relatively limited. In other words, it only emphasizes a specified definition, theorem, or a certain application (such as an integration method, the Euler method for ODEs).

3. The size of each video is small. Therefore, the video is easy to be saved in a computer or a smartphone.

4. Students can watch the micro-lecture videos repeatedly if they are unable to fully understand the contents.

5. It is necessary to implement some computer-based software for lecture notes, practice problems, student feedback as well as the comments from teachers. In our approach, we use the rain classroom system and the blackboard learning platform.

4 Hybrid Teaching Approach

Now we propose a hybrid teaching approach for Calculus in detail.

4.1 Teaching Contents in Micro-lecture Videos

The teaching contents of micro-lecture videos for Calculus should be chosen carefully. Not all the topics in Calculus are suitable for recording the micro-lecture videos. For example, the trigonometric integrals are very important for single-variable integration.

However, this content is not suitable for micro-lecture because it includes several different type of integrals, such as $\int \sin^m x \cos^n x dx$. And the integration methods for each type of integral are relatively complicated (, for example, the specified integration technique to compute $\int \sin^m x \cos^n x dx$ depends on whether m or n is even or odd). That is, it is very difficult to cover the entire contents in a short time. Therefore, it is not suitable for micro-lecture. In our experience, there are two types of topics that are suitable for micro-lectures. First, in most sections, the most important or the most difficult property/theorem should be chosen. For example, the intermediate value theorem is one of the important theorems for understanding the continuity of functions, so it should be one of the teaching contents covered in the micro-lecture video. These topics are condensed into short videos for students to prepare lessons before classes. Second, contents in some relatively easy sections should be carefully chosen. As we mentioned before, nowadays professors are required to cover the same teaching materials. Therefore, if we can condense some relatively easy sections into short micro-lecture videos and students can study by themselves. Then flipped classroom are used to cover these sections. This approach will improve the efficiency by saving the traditional lecture time.

4.2 Record and Edit the Micro-lecture Videos

After a good topic is chosen, photography recording and editing is also important for the success of a micro-lecture video. There are several ways to record the videos. For example, one can share the lecture notes on a laptop computer or a pad and teach online using an apple pencil. Then record the entire process. This can be done by the professor himself. Other professors may feel more comfortable using the blackboard (with the multimedia lecture notes). Then a camcorder is necessary for the process. No matter which way for recording the videos, it is important to perform the photography editing. Sometime a proper animation increases the quality of the micro-lecture videos dramatically. For example, when introducing the definition for orientation, the calculus textbooks ^[1,2] usually include the graph of Mobius band (which is a two-dimensional example) only. However, if one can include an animation of Klein bottle as a three-dimensional example in the micro-lecture video, it can increase the students' interest dramatically.

4.3 Arrangement for Classroom Teaching and Flipped Classroom

Before each class session, a micro-lecture video is provided through the blackboard system. Therefore, the classroom teaching mode can be more efficient. Depending on the type of the content in the video (see Sec. 4.1), the classroom teaching can be separated into two different modes. First, if the video covers the most important or the most difficult property/theorem in the section, we will apply a similar approach as the traditional classroom teaching style. However, we will spend less time on the proof of the property/theorem since we assume that the students already watched the video. At the same time, we allow the students to ask questions if they feel confused about the content of the video. This process not only increases the learning interest of the students, but

also improved the teaching effectiveness and efficiency. On the other hand, the flipped classroom teaching approach should be applied if the video covers contents in some relatively easy sections (especially for Chinese students), such as introduction of natural logarithm functions, graphical solutions of autonomous ordinary differential equations. That is, students encounter information by watch the micro-lecture video before class, freeing class time for activities that involve higher order thinking. The flipped classroom strategy makes lectures interactive and is welcome by students. Here we emphasis that, especially for Calculus, only contents from relatively easy sections are suitable for applying the flipped classroom approach. Finally, in our experience, the first approach, which is like the traditional classroom teaching style, counts for 80% of the total classroom teaching sessions, while the flipped classroom approach counts for only 20%.

4.4 Rain Classroom System and Blackboard Learning Platform

The rain classroom system is an interactive teaching instrument. We recommend that, in any type of classroom teaching style, professors should use the rain classroom system. When the rain classroom system starts, it first produces a QR code. Then students can join the live session by scanning the QR code. This software system allows professors to embed interactive quizzes during the lecture. For example, the quizzes can be multiple-choice questions, so students can see their grades, review the correct answers, or provide explanations to correct answers instantly. And professors can see the statistics of the grade as well. Furthermore, on the screen, there is a button which writes “confused”. If any student clicks it, the professor can see the anonymous question immediately, and be able to re-explain the current content. This works perfect for Chinese students because a lot of Chinese students are shy to show that they are unable to understand the current contents in classroom. In our experience, the students' learning consciousness and enthusiasm have been greatly improved with the usage of the rain classroom system.

The blackboard learning platform serves as another interactive teaching instrument. Professors first set up the course on the platform. Then one can upload the micro-lecture videos, lecture notes, exams from previous years, and other complementary materials. Furthermore, a course discussion board can be set up. Students can ask questions or give answers to questions. In this case it is easy for student to ask for help when encountering difficulties during the study. Sometime professors can also post certain challenging questions. Besides, the grades for quizzes and midterm exams can be uploaded on the platform by teaching assistants. Then it is easy for professors to track the grade of each student.

Empirical research reveals that the implementation of the rain classroom system and the blackboard learning platform can significantly increase learning performance.

4.5 Feedback from Students

This new hybrid teaching approach is still in an exploratory phase. The professors should have more communications with students during and after classes. In our

university, each professor has three hours each week as the office hours. The office hours not only serve for answering the questions in Calculus, but also is very useful for obtaining the feedbacks from students. The comments and suggestions from students are very useful for the future improvements in most cases. For example, if a large percentage of students feel that they are unable to follow some of the micro-lecture videos, it means that maybe the contents in these videos are not suitable. So these videos may have to be re-recorded and re-edited using other contents. Another way to track the performance of the students is the statistics of the grades from the online, in-class quizzes by the rain classroom system. This tells how well the students understand the micro-lecture video and how well the students follow the classroom lecture. In summary, the professors should make necessary adjustments for this hybrid teaching approach according to the comments and suggestions from students.

5 Conclusions

In this paper, we share the experience of our hybrid teaching approach in Calculus in the past few years. First, one should choose the teaching contents of micro-lecture videos carefully. Then short and concise micro-lecture videos are recorded and edited. Later we discuss the in-class teaching approach, i.e., flipped classroom or not. Then the rain classroom system and the blackboard learning platform are introduced to complement the in-class teaching. Empirical research shows that, for the success of the hybrid teaching approach, necessary adjustments to the contents of the micro-lecture videos are highly recommended because the professors should individualize the teaching approach to each person's aptitude, personality and interest. This innovative hybrid teaching approach is a long-term and arduous task, but students in our university provided very good feedback in the past few years.

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