ACTIVE LEARNING STRATEGIES IN LOCAL UNIVERSITY MATHEMATICAL ANALYSIS

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ABSTRACT

Mathematical analysis is one of the most important and fundamental courses for students of mathematics. In this paper, analyzed the status of mathematical analysis teaching of the higher teachers professional, and proposed to active learning strategies in the mathematical analysis teaching, which can enhance students study motivation, foster their self-esteem and develop their interpersonal skills. Furthermore, these strategies are expected to improve the quality of mathematical analysis teaching.

Keywords: Mathematical Analysis research, Active Learning, Assessment

I BACKGROUND

Mathematical analysis is a branch of mathematics that includes the theories of differentiation, integration, measure, limits, infinite series and analytic functions. Mathematical analysis is important basic course with specialized mathematics of the university, and is also a course that students generally feel uninteresting, abstract and difficult to study.

In our university, all students of majoring in mathematics are required to study Mathematical analysis in first year. It is one of the most important compulsory courses in their four years of university study with a credit point value of 16. Mathematical analysis is a three semester course, 6 hours lectures per week. We want to combine basic training with the cultivation of creative abilities in the teaching. The aims of the Mathematical analysis courses are that students should gain a basic knowledge of the concepts and theories of calculus, understand the idea of analysis, develop skill in corresponding computations and learn to work independently.

The teacher assigned homework once or twice a week. Students were asked to accomplish their tasks individually within the deadline. Every week, they were asked to hand in their homework. For each student, the marks from each homework task contributed to his/her final mark. At the end of each semester, all the students are expected to attend closed-book examinations, which account for 80% of the final mark respectively, the other 20% coming from records of exercises (include homework). The total mark is 100, if a student's final mark is less than 60, he fails the Mathematical analysis course.

Mathematical analysis has its specific characteristics. It is difficult to understand, rich in content and especially, it is arranged in a logical order. For most students, it is not easy for learning independently, especially for the first year students. In recent years, with the growing amount of university enrollment, the quality of students showed a downward trend. Most students find it is hard to learn Mathematical analysis. A considerable number of students do not gain a deep understanding of key concepts and theories and some of them forget what they have learned soon after the final examination. Even some semester more than 35% of students fail this course. Taking the more suitable measures and improving the quality of teaching for the status of the students learning Mathematical analysis, it has become an urgent need solving the problem in the teaching strategies.

II ACTIVE LEARNING STRATEGIES

Active learning is an umbrella term that refers to several models of instruction that focus the responsibility of learning on learners. Bonwell and Eison (1991) popularized this approach to instruction [1]. This buzzword of the 1980s became their 1990s report to the Association for the Study of Higher Education (ASHE). In this report they discuss a variety of methodologies for promoting "active learning". They cite literature which indicates that to learn, students must do more than just listen: They must read, write, discuss, or be engaged in solving problems. In particular, students must engage in such higher-order thinking tasks as analysis, synthesis, and evaluation [2]. Active learning engages students in two aspects – doing things and thinking about the things they are doing.

Passive learning is relatively easy for both lecturers and students, but what we teach is carefully selected and usually involves simplified materials. Students passively involved in class will lack an understanding of the mathematical ideas used to solve problems, and will be confused in their future study and work when they encounter problems that are not in textbooks. We are not only teaching mathematical theorems and formulae but also the mathematical way of thinking needed to analyze and solve problems. We should avoid so-called ‘high mark but low ability’ phenomena. In order to motivate students to become independent and active learners, our program of teaching strategies needs to include methods and tasks, which are interesting and motivating, and require both team and individual learning tasks. Students will be able to be more actively involved in learning by having the opportunity to discuss, to express their ideas, make short presentations and debate their opinions.

2.1 Collaborative Learning Group

A collaborative learning group[3] is a successful way to learn different material for different classes. It is where you assign students in groups of 4-6 people and they are given an assignment or task to work on together. This assignment could be either to answer a question to present to the entire class or a project. Make sure that the students in the group choose a leader and a note-taker to keep them on track with the process. This is a good example of active learning because it causes the students to review the work that is being required at an earlier time to participate.

According to the actual situation, more tasks can be given if necessary. The group work will create an active and interactive learning environment for students. In their own groups, students will work with each other, share their ideas, discuss, debate and convince each other. Discussions are typically more effective in collaborative learning group settings, it helps students explore a diversity of perspectives, it increases intellectual agility, it shows respect for students' voices and experiences. In this group work, students will be more fully engaged in the learning process. I believe that they will be active and try their best. Additionally, with the implementation of the one-child policy in China, more students become self-centered and lack team spirit. Some educationalists worry about this situation very much. But we should not just blame our students. Instead, we should take responsibility for creating more opportunities for them to cooperate. Thus, collaborative learning group work has great significance for Chinese students. It is not only a good approach for student-centered learning, but a good way to cultivate their generic skills, especially presentation and writing skills. Students are expected to learn cooperation by cooperating.

2.2 Proofs without Words

Proofs without Words is a collection of pictures or diagrams that help the reader see why a particular mathematical statement may be true, and how one could begin to go about proving it. While in some proofs without words an equation or two may appear to help guide that process, the emphasis is clearly on providing visual clues to stimulate mathematical thought. The proofs in this collection are arranged by topic into five chapters: geometry and algebra; trigonometry, calculus and analytic geometry; inequalities; integer sums; and sequences and series. Teachers will find that many of the proofs in this collection are well suited for classroom discussion and for helping students to think visually in mathematics.

Example1:

If $f(x)$ and $g(x)$ are differentiable functions on a closed interval with endpoints a and b, then

$$\int_a^b f(x)g'(x)dx = f(x)g(x)|_a^b - \int_a^b f'(x)g(x)dx \qquad (1)$$

The Proof Without Words of Integration by parts is found in Nelsen's first collection [4], and is reproduced in Figure 1.

This picture graphically represents the quantities $f(b)g(b)$ and $f(a)g(a)$ as rectangles formed in a coordinate system, where the function $u = f(x)$ is expressed on the horizontal axis, and. $v = g(x)$ is expressed on the vertical axis. By convention, we assume that $a < b$. The blue area, which represents $\int_a^b f'(x)g(x)dx$, can be found in three steps:

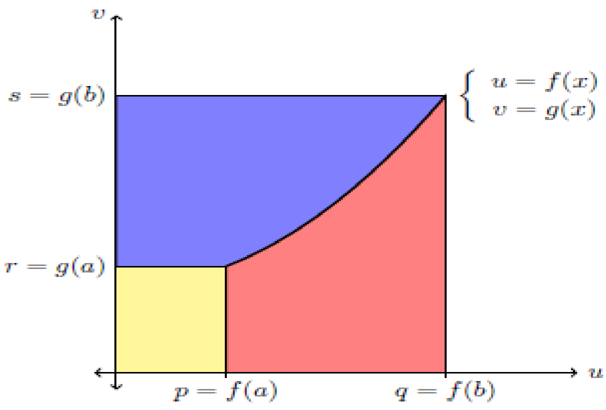

Figure 1: Integration By Parts [4]

1) Notice that the area of the whole rectangle (RED + BLUE + YELLOW) is $f(b)g(b)$.

2) Then from that subtract the area of the YELLOW rectangle, which is $f(a)g(a)$.

3) Then subtract the RED area, which is mathematically represented by $\int_a^b f'(x)g(x)dx$.

This gives us that BLUE = [total - YELLOW] - RED, or mathematically,

$$\int_a^b f(x)g'(x)dx = f(x)g(x)\big|_a^b - \int_a^b f'(x)g(x)dx,$$

which is equivalent to Equation (1).

Although it is not real proof in the strict sense, and there are many famous mathematicians who didn't think it is a kind of proof, but such proofs can be considered more elegant than more formal and mathematically rigorous proofs due to their self-evident nature.

In order to develop abilities of lifelong learning, students should strengthen their own learning strategies. Two methods are introduced in the following.

Self-study is an important method for students' learning. Students are responsible for their learning processes independently while teachers are only the guides to students' learning. In my calculus course, there is some content, such as differentials for approximation, Newton's method for finding solutions to equations, and so on, which are suitable to learn through self-study. Through learning this content by themselves, students can solidify the new material they have learnt, enhance their learning, problem solving skills and develop their abilities to work on the questions independently. Sometimes, self-study inspires interests in the subject. Some students learn materials by themselves simply because they like the material. Students can develop abilities of lifelong learning through this method.

Writing summaries is another method for students' learning. At the end of each chapter, I will ask students to write a summary. Go back over the lecture for each section and review any examples that the instructor worked to make sure that students understand the ideas from that section. Make note of any common errors that the instructor may have mentioned. By doing so, students can review the content, deepen their understanding and find the relationships among the various concepts.

III IMPROVE ASSESSMENT METHOD

As we know, assessment is a significant component of teaching and learning. In the past, the final closed-book examination at the end of each semester contributed 80% to the assessment. Some students study very hard in the last few weeks for the examination. Some of students successfully pass the examination, but they forget most of the knowledge when they have completed the examination. This assessment does not evaluate students properly. Our principles of assessment will mainly be to stimulate students to work hard and produce deep level learning. The final examination will not rely on memory but on understanding. We will introduce some theories of good learning and let students discuss the assessment problem. Every group should write a report and some representatives will be asked to make a presentation of the report. Surface level learning will not get a high mark. Students can choose a surface learning strategy if they just want to pass the examination and do not like hard work. So we should modify the traditional assessment as following Table 1

Table 1 Original and new assessment of numerical compare

Original assessment	New assessment
Homework 20%	Homework 10%
	student's ordinary performance 20%
	Group report and group presentation 10%
Final examination 80%	Final examination 60%

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