

# Research on Blended and Dynamic Stratified Teaching Model of Advanced Mathematics

Xiaoyan Liu \*, Zhiqin Zhao, and Huali Liu

School of Science, Xi'an Shiyou University, Shaanxi, Xi'an, China

**Abstract.** According to the present teaching situation of advanced mathematics course, the blended and dynamic stratified (BDS) teaching model is put forward. The new model integrates various teaching forms, methods and information technology, and carries out stratified teaching dynamically based on the course contents and actual learning situation. And from the resource construction, teaching design and assessment system three aspects of reform, maximize to meet the needs of students flexible learning and personalized development; The teaching practice shows that BDS teaching model is beneficial to the cultivation of students' mathematical thinking and knowledge application ability.

## 1 Introduction

With the rapid development of technology, new era requires higher training of innovative talents in universities. Advanced mathematics contains rich theoretical knowledge and research methods, which is one of the basic disciplines for cultivating innovative talents. It plays an important role in cultivating the undergraduates' thinking ability and innovative consciousness in the new era. Therefore, universities pay attention to its teaching situation, and vigorously support the reform and innovation of the teaching contents and methods of advanced mathematics, so as to better support the realization of the goal of talent training.

The mixed teaching model based on online and offline is the mainstream of education development at present, which mainly takes advantage of highly targeted of Small Private Online Course (SPOC) [1]. Throughing the process of "independent learning online--guided learning offline--supplementary learning online", it launches teaching with integration of various methods. Kang M. build the "three-stage and four-step" flipping classroom based on SPOC platform[2], which shown the mixed teaching model can effectively improve students' enthusiasm for learning. The blended teaching could achieve stratified teaching objectives to a certain extent[3]. And on the basis of mixed teaching, the offline layering homework is implemented [4], which met the students' needs for personalized education to some extent, but there is no further research.

Compared to purely online or offline classroom, the blended teaching model has the advantages of pertinence and flexibility, which attracted many educational researchers to carry on more in-depth exploration and practice. And it became the mainstream learning mode today also. At this point, this paper puts forward a blended and dynamic stratified (BDS) teaching model

for advanced mathematics.

## 2 Teaching situation of advanced-math

As a basic subject, mathematics provides strong support for the development of various scientific fields and it is also an important basis for the further development of modern high technology. In order to better serve professional construction of new engineering, many mathematics educators have been exploring and practicing, but there is a certain gap between its teaching effect and professional development.

(1) Personalized education needs to be strengthened.

Regional differences in education gradually emerged with the increase of school enrollment and geographical expansion. Students in the same class have great differences in basic knowledge and learning ability, and this difference is more prominent in the learning of advanced-math. At the same time, Most universities use large classes of about 120 students because the basic mathematics teacher is shortage. Teaching design depends on the logical starting point of learning, not the realistic starting point of students' learning, which is not conducive to the development of personalized education and the cultivation of mathematical ability. Even if graded teaching is implemented, due to the large number of students, adjustments are made only once a semester or longer, which cannot meet the needs of students' individualized development.

(2) Course-professional development fit needs to be improved

Since China officially became a member of Washington Accord in 2016, Outcome-Based Education (OBE) concept has gradually penetrated into the whole process of higher education. OBE concept holds that the syllabus of each course should be designed reversely according to the graduation requirements, and give

\* Corresponding author: liuxiaoyan@xsyu.edu.cn

support to the realization of professional personnel training program [5]. While advanced-math is used to explaining concepts, theorems and calculation methods from its own idea, and paying attention to the completeness of its own curriculum system. The unified syllabus is used for all majors, the differences in demands of different majors for higher mathematics knowledge are ignored. The curriculum lacks pertinence and doesn't fit well with professional development.

In short, under the guidance of OBE concept, especially in the teaching process of large-class, how to ensure students can obtain substantial successful experience in the future life, cultivate students' mathematical ability, practical ability and innovation consciousness, and improve the adaptability of the curriculum have become the urgent problems.

### **3 Blended and dynamic stratified teaching model**

#### **3.1 The proposal of teaching model**

The stratified teaching model first appeared in the United States. It sets different teaching objectives, contents and methods for student groups with different knowledge bases, so as to teach individualized instruction and classified guidance. It was introduced into our country in the 1980s and mainly applied in the public basic subjects such as mathematics and English. The stratification is mainly based on performance, usually implemented by flexible mechanism with adjustment once a semester or a academic year [6-8]. Stratified teaching model takes into account individual differences of students and avoids the phenomenon of "one size fits all". However, under the background of the popularization of higher education, the large-scale stratified teaching needs to redivide into classes, which brings great difficulties to the teaching management, and the being "diverted" students are prone to inferiority complex[9]. In fact, students' individual differences are manifested not only in different disciplines, but also in different stages of the same discipline. That is to say, in process of stratified teaching, the composition of members at each level should be an ever-changing dynamic combination, rather than a fixed stratification for semester or even longer. So, setting group learning objectives according to the chapter content and actual learning situation, the teaching objectives will be realized more effectively throughing short-term group teaching.

Constructivism learning theory holds that knowledge acquisition is the process of learners' "participate in communication" and "cultural practice"[10]. That is, in the learning process, teachers are guides, their main task is to know the students' learning situation in time and provide individualized guidance and targeted help for students' independent learning. Fortunately, we already have abundant online resources with the accelerated development of education information in China. And students could conduct online independent learning with the convenience of online teaching. Based on this, stratified teaching is implemented according to learning

situation which will provide more communication opportunities for teachers and students, provide opportunities for teachers to lead students to think, practice and innovate, especially. Therefore, combining the advantages of stratified teaching and blended teaching mode, the BDS teaching model is proposed.

#### **3.2 The definition of related concepts**

BDS teaching model uses information technology and resources comprehensively, whose starting point of teaching design is the actual needs of students and majors. It pays attention to the individuation and pertinence of education, and takes improving students' learning ability and knowledge application ability as the teaching goal. In BDS teaching model, the "blended" is not only an organic combination of online and offline teaching, but also a combination of various teaching methods and modern information technology. The so called "dynamic" includes two aspects, one is referring to the timely selection of online, offline or mixed classroom according to the teaching content, another is referring to the timely centralized teaching or group teaching based on the actual learning situation and the students' wishes.

### **4 Blended and dynamic stratified teaching model construction**

BSD teaching model as the development of blended teaching and stratified teaching model, its construction mainly includes three aspects: Optimization and integration of curriculum resources, designation of teaching process, and construction of multidimensional assessment system.

#### **4.1 Optimization and integration of curriculum resources**

Mathematics course content is abstract, logical, widely used, students have great difficulties in learning. In order to help students to establish solid knowledge foundation, expand the learning time and space, strengthen independent and innovative learning ability, BDS teaching model optimizes and integrates the content based on principle of combination of generality curriculum with specialty curriculum in premise of OBE.

##### **4.1.1 Enrich online teaching resources**

In the information age, students used to learning online flexibly with mobile devices. In order to cater to this learning habits, it is necessary to build good online teaching resources and make them supplement and extension of the offline classes to promote the achievement of teaching objectives. Of course, we could borrow other people's online resources to carry out our own teaching. However, the high-quality resources may not be suitable for the learning situation of our students.

So, the construction of curriculum resources in BDS teaching model include two sides as follow:

(1) *Choose quality resources*: For most knowledge points of advanced-math, such as limits, derivatives and other basic concepts, we choose high-quality online resources to apply in our teaching according to the orientation of university and curriculum syllabus. So as to save a lot of human resources and extend students' horizons.

(2) *Construct targeted resources*: According to the characteristics of running university, the advanced-math courses in different universities are different in depth and breadth of content' explanation. So targeted teaching resource must be constructed for every university based on the learning situation and professional needs. In BDS teaching model, the targeted resources mainly include micro-class videos using for flipped classrooms and after-class stratified tasks, such as professional background knowledge introduction, practical problem analysis and modeling, passing tests at different levels, etc. The ultimate goal of targeted resources construction is to stimulate learning interest, strengthen mathematical thinking and extend the development interface.

#### 4.1.2 Optimization of curriculum content

Sense of achievement is the key to motivating students to learn. In order to have a good sense of gain for each learner with individual differences and different needs, curriculum resources optimization follows the principle of "stratified classification, general professional integration". Firstly, under the premise of taking into account general education, the expansion module of profession is added according to the professional core courses' demands for advanced-math knowledge, and which as an effective supplement to the knowledge of mathematics, forming a characteristic knowledge system integrating learning and application. Secondly, in order to achieve the goal of effectively improving students' mathematical literacy and skills, the content is optimized into three modules: foundation, improvement and expansion. And the teaching goal of foundational module is mainly to make students master the basic concepts, principles and calculating skills; The improving module focuses on cultivating students' abstract thinking and logical reasoning ability; And the expanded module is to train students' practical ability to analyze and solve problems.

#### 4.2 Designation of teaching process

The online and offline blended teaching model is the mainstream of the current teaching reform, but it is not fully applicable to advanced-math with high abstraction and rigorous logical reasoning. So, for different teaching contents, the BDS teaching model designs multi-level teaching objectives according to the actual learning situation and carry out multi-dimensional blended and stratified teaching, such as "online+offline", "teacher+student", "theory+ practice". There are corresponding

three classroom types: lecturing classroom, blended classroom and live online classroom.

##### (1) Lecturing classroom

Lecturing classroom is mainly explained by teachers, which is applicable to abstract concepts, theories and methods, such as the concept of limit, the mean-value theorem, the differential element method, etc. This type classroom is based on the "teacher+student" mode. Before class, teacher releases the guidance plan to the students, and students preview independently with the help of online resources; During class, teachers guide students to think and discuss in the form of question-driven, situation creation, and heuristic; After class, according to the actual situation, two levels of assignments are implement: remedy and consolidation; intensify and expand.

##### (2) Blended classroom

The blended classroom is based on the mode of "online + offline", which is suitable for more simple concepts, theories and methods, such as the definition of derivative, the application of derivative, etc. Before class, students study independent online and self-test according to the learning plan guide. Teachers track and analyse students' learning status, and design the stratified learning objectives. During class, with the preview status and their wishes, students will be grouped to implement the stratified teaching: the main objectives of group with general learning situation are remedial, that is, the teacher sets questions on the key content, guides students to discuss and solve the problem, and timely gives targeted explanation to help the students internalize knowledge, learn to think and master skills, so as to consolidate the foundation and improve learning situation; The main objectives of group with better learning performance are supplement and expand, that is, the teacher sets questions with strong ideas and skills, guides students to communicate, discuss and collaborate explore in group, and expands the depth and breadth of students' understanding, so as to strengthen the ability of mathematical thinking, logical reasoning and problem solving. After class, corresponding stratified tasks are completed.

##### (3) Live online classroom

Live online classroom is based on the mode of "theory+ practice", which is suitable for the intensive training of simple calculation skills, and targeted expansion and improvement. Before class, students study independent and pass the test according to the relevant teaching resources distributed by the teacher. Teacher will prepare layered online courses according to the test results. During class, some students were selected for live online teaching, and other students independently finished the improved and expanded contents by peer learning. After class, students complete the corresponding improvement training and work display.

The implementation process of BDS teaching model is shown in Figure 1. Where, the letter "S" refers students, "T" refers teachers, and the symbol \* indicates stratification. Obviously, the stratification of lecturing classroom occurred after class, while blended and live online classroom occurred during and after class.

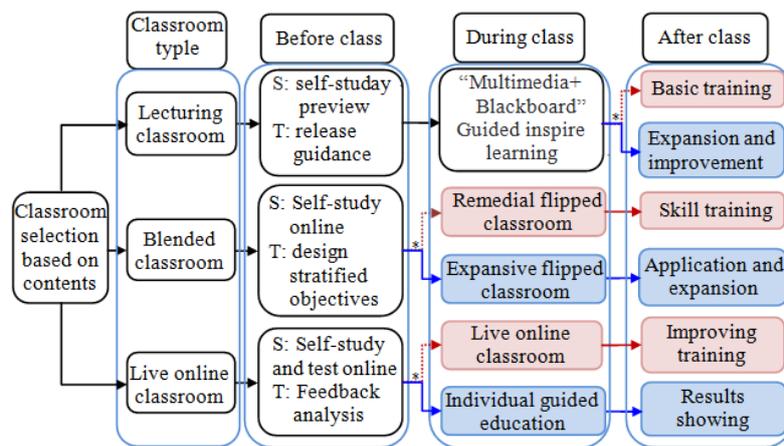


Figure 1. The implementation flow chart of BDS teaching model

### 4.3 Construction of multi-dimensional assessment system

In the examination of advance-math, the evaluation model of one volume for life has existed for a long time, and the test content focuses on calculation skills and ability, while the innovative application ability is often ignored. The immediate consequence of these is that the students do not actively think during class or actively apply practice after class, and their mathematical literacy and comprehensive ability cannot be improved corresponding. So, under the guidance of Outcomes-Based and Students-oriented teaching concept, our model establishes a multi-dimensional assessment system to stimulate students' learning enthusiasm, improve their mathematical literacy, and play the role of higher mathematics in profession development. The new assessment system includes eight competencies: self-discipline, concentration, understanding, analysis, collaboration, expression, calculation and application. And check contents accordingly are the preview, online self-study, classroom performance, group discussion, help learning, achievement display, after-class practice, data review, literature analysis, and expansion practice. In the end, students' performance in all aspects and final grades are integrated to get the final evaluation of students. Of course, in the process, teachers should timely formulate effective remedial measures according to the evaluation results, optimize and improve the implementation plan, evaluation standards and curriculum-related teaching materials.

## 5 The superiorities of blended and dynamic stratified teaching model

Different from the large-scale stratified teaching, the BDS teaching model is a temporary grouping based on the current learning situation and ensures that each student can have a good sense of learning through targeted assistance and personalized guidance. This model adheres to the principle of Outcomes-Based, Students-oriented, and integrates advanced technology, which is in line with the learning habits of college students in the new era. The new model has great

superiorities in the realization of teaching objectives and the improvement of students' comprehensive literacy.

### 5.1 Using targeted resources to promote the better fulfillment of teaching objectives

BDS teaching model is based on borrowing or building targeted online resources, which are convenient for student to use fragmented time to conduct in-depth discussion on a certain knowledge point. This caters to students' habit of flexible learning, and effectively solves the problem of large difference in the efficiency of knowledge internalization caused by the large content and strong logic in advance-math. And, the construction of online resources facilitates the extension of course content to professional issues within limited teaching hours. The introduction of professional problems and the solution of practical problems have strengthened students' mathematical thinking and knowledge application ability to a certain extent, improved the adaptability of higher mathematics courses, and achieved the purpose of improving the students' comprehensive ability.

### 5.2 Utilizing the stratified teaching to meet the needs of individual development

BDS teaching model emphasizes the effective connection between in and out of class. Targeted teaching objectives should be formulated and class stratification implemented based on the feedback of online independent learning, which can facilitate teachers to provide more personalized guidance and meet the needs of personalized development of undergraduates in the new era. The stratified exercises and professional development after class make up for the deficiency of the unified pace in class, which not only narrows individual differences, but also stimulates learning interest, promotes to gain sense of achievement and improves the knowledge application ability.

### 5.3 Dynamic teaching organization form reflected the principal position of students

In the implementation process of BDS teaching model, a variety of classroom types and teaching methods are integrated into lecturing classroom, which increases the interest and operability. In particular, the introduction of some professional problems sets the abstract mathematics into life and can effectively stimulate students' willingness to learn mathematics and use mathematics; And temporary group guidance according to the learning situation and student's willingness can stimulate learning interest in different periods, different levels "point by point", which not only reflects their principal position in learning, but also is conducive to form a good competitive learning environment.

## 6 Conclusion

We conducted a comparative experiment in two classes: one class has 119 students of Applied Physics and Opto-Electronics Information Science and Engineering, the BDS teaching model was implemented in this class. The other class has 126 students of Civil Engineering, which were taught by the same teacher in the normal teaching mode. Through a semester of practice, we found that students in the experimental class are more interested in learning and have a more harmonious relationship with their teacher than those in the non-experimental class. In the unified evaluation of the whole university, the average score of the experimental class was at least 80 points. While non-experimental class was about 65 which was basically same as other classes in the university.

The practice results show that the BDS teaching model is effective. Applying it into Higher Mathematics teaching not only injects vitality and passion into the traditional theoretical classroom, but also facilitates the cultivation of undergraduates' mathematical thinking and knowledge application ability, effectively improves the adaptability of the course, and realizes the deep learning with organic integration of knowledge, ability and quality<sup>[11]</sup>.

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