ISSN 1512-1801

ANALYSIS ON ADVANCED MATHEMATICS EDUCATION FOR CURRENT CHINESE UNDERGRADUATES

[1*]Bo Yu, [1]Ning Dong, [2]Wei Zhang, [3]Li Chen
[1]School of Science, Hunan University of Technology
[2]School of Engineering, Hunan University of Technology
[3]School of Language, Hunan University of Technology
(* the corresponding author, boyu_hut@126.com)

Abstract
Current Chinese undergraduates have some doubts in learning advanced mathematics. Instructors are also exposed to be lacked of the sensitivity to the new teaching methods. This paper conducts an investigation on 235 undergraduates in science and engineering majors and 23 advanced mathematics instructors, detailed reasons why both undergraduates and instructors bump into such a dilemma are analyzed based on the derived investigation data. Some suggestions are also proposed to improve the current teaching quality in advanced mathematics education.

Keywords: Undergraduates; Advanced mathematics; Inquiry learning

Introduction

Advanced mathematics is undoubtedly the cornerstone of constructing knowledge system for undergraduates specialized in vast majorities of science and engineering technology. It plays an important role for students not only in learning the subsequent courses, but also in cultivating students' creative ability in future. At present, with the rapid development of modernizing process and the large improvement of people's living standard in China, the scale of enrollments of students in Chinese universities has been expanded unceasingly in recent years. Such a leaped development in higher education is transforming the traditional "elite education" into a wide "popular education", which both aims at the quantitative expansion and the substantial change of the type in the higher education (Huai & Yang 2005, Wu et.al. 2007).

From a viewpoint of the international mainstream (Ercikan, McCreith & Lapointe 2005), it is advantageous that the large scale admission of undergraduates will greatly promote the input of resources in higher education, and definitely speed up the construction of the teaching facilities. On the other hand however, it is indisputable that the sharp increase of students in universities results in the huge admission of undergraduates with different knowledge level. Moreover, advanced mathematics teaching itself is now under the pressure of deceasing the corresponded class hours to provide more time for other specialized majors. This is in turn contradictory to the higher requirements of advanced mathematics in subsequent specialized curriculums (The guidance committee of mathematical curriculum for non-mathematical majors in universities, 2005). Therefore, it is urgent for university instructors to proactively pay more attention to the teaching quality in several relative short semesters and cultivate a large number of qualified students for conforming to the requirements of the society.

To analyze the statues quo of the advanced mathematics teaching in current local universities in China, we conducted an investigation on undergraduates from various majors and some university instructors teaching advanced mathematics. Based on the derived dada, we provide some suggestions.

ISSN 1512-1801

Descriptions of the Investigation

About 235 undergraduates in three majors including Information and Computation, Electric Engineering and Market Management, and 23 instructors of Department of Mathematics in Hunan University of Technology were participated in our investigation. The content was associated with the comprehensive understanding, interests and attitudes in learning, teaching contents and methods. The survey was based on questionnaires as well as informal discussions both for undergraduates and instructors. The obtained results are listed in Table 1 (undergraduates) and Table 2 (instructors) as below.

Table 1

Investigation for undergraduates

Is AM important ?		What is your attitude to AM ?	
Very important	30.4%	Very interesting	10.8%
Important	41.3%	Interesting	35.6%
It depends	15.7%	It depends	37.2%
Not important	12.6%	Not interesting	16.4%
Use of the multimedia in teaching		Teaching methods in the classroom	
Necessary	23.2%	Unnecessarily strict proof	29.1%
It depends	37.3%	Focus on practical value	57.3%
Unnecessary	39.5%	Instruct with exercises	13.6%

Note. "AM" represents the advanced mathematics.

Table 2

Investigation for instructors

What is your first consideration in preparing teaching AM ?		What do you most focus on ?	
Process of teaching materials	27.7%	Completion of teaching task	29.3%
Design of teaching methods	32.5%	Breakthrough of difficulties	30.5%
Application of teaching methods	28.9%	Students' status in learning	28.2%
Students' knowledge and potential	10.9%	Creation of math environment	12.0%
Do you know the inquiry learning?		Application of the inquiry learning	
Yes	10.5%	In classroom	3.0%
A little	22.1%	In exercises	11.9%
No	67.4%	In modeling activities	85.1%

Note. "AM" represents the advanced mathematics.

Analysis of Results

Students' present situation in learning advanced mathematics

● We can see from Table 1 that nearly 72% students think that learning mathematics is important, but only 46% of the investigated are interested in mathematics. This implies that the undergraduates are clear about the importance of mathematics in the upcoming disciplines, but only a few are fond of mathematics. The main reason we think, after some interviews with students, is from the following

ISSN 1512-1801

several aspects: (1) The lack of relatively solid foundation makes most undergraduates fearful of obstacles in learning mathematics; (2) The dull theorems and proofs in mathematics are hard to be understood by a lot of students; (3) The utilitarian attitude among undergraduates makes them think that the advanced mathematics is rarely used in their future work.

● There has been a trend in recent year that the multimedia teaching is very helpful for instructing students. But our survey showed that only 9.3% of undergraduates backed this viewpoint and the explicitly opposed were high to 39.5%.

We think several factors as below caused such a phenomenon. (1) Slides at present, no matter developed by any software tool, all take on a linear structure. Although some have branch structure or are designed of the function of jumping and linking, they are still mediocre. (2) The interactivity of slides is week. Instructing mathematics using black board and chalks seems fitter for the speed in students' thinking and easier to communicate with students. (3) Some courseware are not well targeted at students at different levels. This is because the development of courseware for different objects will cost huge expenses. (4) The limited demo screen space of slides only displays restricted information on one page. When the argument in descriptions of mathematical propositions is long, students are unavoidable to forget the previous conditions and statements that results in the incomprehension of the whole content. (5) Some courseware of course beat the traditional instruction methods in the presentation of graphics and tables. This is also the reason that some students (37.3%) put forward combining the multimedia with the blackboard.

● Some conclusions can be drawn from the teaching methods in the classroom. (1) Most students desire to improve teaching methods, which suggests that the current advanced mathematics teaching method is relatively in an old fashion and the force-feeding teaching makes students lacking of interests in mathematics. (2) Most instructors tend to finish the task as soon as possible since the given class-hours period in a semester is relatively limited. So it is required that the instructors should improve their teaching skills and the students should change the original learning method to adapt to the university study environment. (3) More than half of the investigated students (57%) put forward paying more attention to the practical application of advanced mathematics, which reflects that the curriculum content is not adapted to the request of the popularization of mathematical education.

● There are some undergraduates choose "It depends" for each question. This implies that only using new teaching method is hard to improve their learning enthusiasm. Therefore, it is necessary to strengthen an all-round ideological work to help them establish good learning attitude.

The reason caused such a result, we think, is from two aspects. One is the environment of current Chinese education system, i.e. exam-oriented education. An example is that a report from International Mathematical Olympiad (Kong & Zhang 2004) shows that the average time for Chinese students to learn mathematics in classroom is about 307 minutes (per week), but the corresponded one for other countries' students is about 217 minutes (per week),. Moreover, there are 37% of Chinese students spend more than 4 hours learning mathematics at their spare time while, the peers from most other countries spend 1 hour or less. It is obvious that the long-term overload of study that run out of some Chinese students' learning enthusiasm. Another reason is from the current management of most universities. At present, the policy in Chinese universities is strict in admission and loose in graduation. Some students feel unprecedentedly easy as long as they are enrolled to the university and rarely think they can not get the graduation certificate. Ultimately , these students form an idea that four years studies in the university is easy to getting through.

ISSN 1512-1801

Instructors' present situation in teaching advanced mathematics

● From Table 2 we can see that more than 60% instructors delve into teaching materials rather than take full consideration of students' original knowledge reservations and learning potential. The reason of this phenomenon we think, are from two aspects. (1) Under the influence of the traditional teaching mode, teachers always focus on teaching design. The lesson preparations are also based on the standard teaching materials and knowledge system. In other words, the teachers are dominant and the students are passive in the teaching activities. (2) To realize the standardized management in universities, instructors in departments and schools are required to prepare their lesson plans in a unified format. So the result is that all lesson plans are copied in a neat form, but lack distinct personality and characteristics.

● We can seen from the results of the investigation that nearly 60% focus on breakthrough of difficulties in teaching and completion of their teaching task. This is of course, an important target in teaching. But instructors are supposed to pay more attention to show the way to obtain mathematics knowledge rather than pour the knowledge to students since what we faced with are a group of energetic young men.

● Table 2 also shows that more than 67% instructors know nothing about the "inquiry learning" method. This concept was initially put forward by Shanghai Institute of Education Science at the beginning of 1999. Subsequently at 2000, the Chinese Ministry of Education issued a revised program to impose the "inquiry learning" method on the curriculums in ordinary middle school (Lv, 2004). This meant that the "inquiry learning" went into a substantial stage in the whole basic education as a formal specialized course. Although in current universities some teachers have made some helpful exploration in this area, there still are so many teachers do not know the concept of "inquiry learning", which implies that a lot of instructors are insensitivity to update their teaching methods.

● The investigated samples in the application of "inquiry learning" of Table 2 are taken from some instructors who are familiar with this concept. The result shows that the current inquiry learning activities are mainly focused on mathematical modeling outside classroom teaching, which is consistent with the current situation in all middle schools.

Countermeasures and Suggestions

In current teaching, the traditional method like "injection knowledge" still used by a lot of instructors (Weber, 2004), which only emphasizes getting the correct answers of mathematical problems rather than exploring the problem itself. Moreover, it concentrates on the calculation skills rather than the logical thinking ability. One feasible way to alternate this phenomenon is introducing a teaching pattern where the instructors are responsible for the studying directions and students for their own learning methods. Such an approach on one hand can cultivate students' creative ability and the spirit of solidarity and collaboration, and on the other hand can develop students' the potential and display their personality. This also meet the requirements of the modern quality-oriented education. In concrete, the several aspects we think are deserved effective implementation.

Emphasizing the purpose of learning mathematics to improve undergraduates' consciousness.

There exist a strong utilitarian among undergraduates nowadays to learn mathematics. What they most require is how to pass the exam and obtain the diplomas, but care nothing about learning mathematical knowledge. Also, there some students have doubts that whether it is important to learn mathematics and why to learn. So as a mathematics instructor, it is necessary to pay more attention to give a good

ISSN 1512-1801

introduction to students when taking the first class. In all, advanced mathematics in university education at least plays a role in the following three aspects.

● It is an essential tool for future specialized and professional courses;

● It is a good knowledge carrier to cultivate the rational thinking ability and scientific thinking method;

● It is an important approach to improve scientific aesthetic consciousness.

The exact representation language, the rationalism notion and the abstract and logical way of thinking in mathematical culture will bring great contribution to the quality for an individual's success in modern social.

Changing the traditional way for lesson preparations.

To change the students' way to learn mathematics, the instructors are supposed to implement a role transformation during the course of teaching. Obviously, the lesson preparations should be put in the first place. Teachers should design the teaching plan from the position of students and encourage them to devise "self-study" schemes according to individual's practical level. Instructors must have the consciousness to alternate the knowledge-oriented teaching approach to the ability-oriented and student-oriented ones to improve the comprehensive quality of students.

Reforming the existing teaching methods and introducing the "inquiry learning" .

Inquiry learning is a curiosity-driven and problem-oriented learning activity with students' high intelligence filling in (Ma, 2001). Compared with traditional learning approach, it is very good alternative for shifting from the lecturing prior to learning prior. So the roles between instructors and students during the study course will not be discriminated clearly and teaches are easier to construct a partner relationship with students. In specifics, we can concentrate on four aspects as below.

● Introducing "inquiry learning".

The current way of mathematics teaching is basically an injective teaching. The standard steps in each lesson are concluded as:

Review → Introducing new lesson →Teaching contents →Asking questions → Summary

It is, to a large extent, such a way that stifles students' creativity as there is only a repetition of the previous work, a kind of mechanical training to sacrifice students' different opinions. However in "inquiry learning" the teaching steps maybe designed as

Proposing problems → Analyzing and discussing → Drawing conclusion

↑ ↓

Putting forward new problems

It is seen that in inquiry learning activities, students themselves, under the guidance of the instructor, participate inquiry activities, explore process of solving problem and obtain the preliminary experiences of scientific research. Such a way is full of exploration, innovation and can stimulate the students' desire to analyze and solve problems. Moreover, it is helpful for students to form a habit of being fond of questioning, diligent in thinking and interested in solving problems. During the whole process, students also acquire good psychological quality which is useful in their future work.

ISSN 1512-1801

● Focusing both on logical reasoning and intuitional conjecture.

As the eventual representation of mathematical conclusions is derived from logical reasoning (Xu, 1990), students especially in study process, are hard to see the formation process of mathematical conceptions and theorems. This may result in the misunderstanding among students that there is no intuitional conjecture, suppositional speculation in mathematics but only strict rationality and abstractive deduction. This is one of the reasons that makes the students feel bored about mathematics. Therefore instructors, at the initial discussion stage, are supposed to encourage students to think and guess adventurously. Sometimes specious concepts and incorrect conjecture need to be proposed deliberately, accompanied by discussion with students to make them to have a more clear understanding.

● Making full use of network resources and computer technology.

One of the main characteristics in inquiry learning is the openness. The internet just provides the platform of communications and collaborations for students, where there exist a lot of mathematics websites offering a wide range of information. With the help of search engine, students are also able to find the relevant knowledge in inquiry learning and greatly save their learning time and improve the learning efficiency.

Establishing multivariate evaluation mechanism and changing the traditional examination way.

The current examination mode in Chinese universities is relatively simple. Two closed- book exams are respectively put in the middle and the end of a semester or only one at the end of a semester. The purpose of exams is mainly to test students mastery of basic knowledge and basic methods in advanced mathematics. So a lot of undergraduates only need to stay up all night cramming some mathematical formula to cope with the exam and once they pass it, they discard formula and knowledge. Such exams are contrary to our education goal and unfavorable to the cultivation of the students mathematical ability and innovative awareness. A possible alternative we think, is that the combination answering exam sheet in open-book form with closed-book form, together with the usual assignments completed independently or by group discussions. Besides, some special papers maybe submitted according to different students. In all, multi-level and diversification of examination modes are more appropriate for evaluation the students' mastery of the course knowledge and the ability to solve problems.

Introducing the hierarchical teaching plan.

Many Chinese universities have adopted a teaching approach based on the actual level of students. That is, the freshmen undergraduates are divided into different level of classes to be taught based on mathematical exams at the admission as well as the National College Entrance Examination. This approach solves the problem brought by the uneven mathematical foundation of undergraduates, but the use of the same teaching materials and the requirement to achieve the same teaching goal for students from various majors will also yield potential problems. Such problems become more obvious as the grade increase. A hierarchical teaching approach maybe used to cope with the above problem. As far as the advanced mathematics is concerned, three hierarchies could be divided. The first is the basic of mathematical culture which introduced the basic concepts, basic calculations and basic knowledge. This is a compulsory course for all science and engineering undergraduates. The second is the mathematical foundation for special majors, which focuses on reducing mathematical illation and strengthening theory application according to different majors. This is a compulsory course for most science and engineering majors that require medium degree of mathematics. The third hierarchy aims at a substantial improvement of advanced mathematical theory. This is a selective course for

ISSN 1512-1801

engineering majors and a compulsory course for several science majors. Such a hierarchical teaching plan can make the undergraduates' study objectives more clear, the instructors' concentration more prominent and, is ultimately helpful to improve the quality of advance mathematics.

Acknowledgement

This work is supported in part by a 2013 Educational Program of Hunan University of Technology.

References

1. Ercikan K., McCreith T. and Lapointe V. (2005) *Factors associated with mathematics achievement and participation in advanced mathematics courses: an examination of gender differences from an international perspective*. Science and Mathematics, 105,5-14.
2. Even R., (2011) *The relevance of advanced mathematics studies to expertise in secondary school mathematics teaching: practitioners' views*, ZDM, 43,941-950.
3. Huai Y., Yang Z. (2005) *Mathematical education method and the modern mathematics education* [In Chinese]. Journal of Mathematical Education, 14, 74-77.
4. Kong Q., Zhang X., (2004) *Analysis of the hot spot phenomenon in students learning "Mathematical Olympiad",* [In Chinese]. Global Education, 5, 70-72.
5. Lv L., (2004) *Three implementations of mathematics inquiry learning mode study* [In Chinese]. Journal of Mathematical Education, 2004, 13 (1) : 85-88.
6. Ma X. (2001), *Participation in advanced mathematics: Do expectation and influence of students, peers, teachers, and parents matter?* Contemporary Educational Psychology, 26,132-146.
7. The guidance committee of mathematical curriculum for non-mathematical majors in universities. (2005) *Status of current education in advanced mathematics and suggestions on improvement of the teaching quality* [In Chinese]. China University Teaching, 2, 9-11.
8. Weber K. (2004). *Traditional instruction in advanced mathematics courses: a case study of one professor's lectures and proofs in an introductory real analysis course,* The Journal of Mathematical Behavior, 23,115-133.
9. Wu J., Jiang S., Dai Z., Ge G. and Zhang J., *Investigation and Analysis on the Current University Mathematics Education*. [In Chinese]. Journal of Mathematical Education, 2007, 16, 36-39.
10. Xu L., (1990) *Mathematical methodology* [In Chinese]. Changsha: Hunan Science and Technology Press.

Article received: 2013-07-01