

Discussion on the Student-Centered Teaching of College Mathematics

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Abstract

College mathematics is the core course of science and engineering. The importance of the course lies in its wide application, whereas many students are frustrated by learning the course. Commonly, each subject of college mathematics such as advanced mathematics, linear algebra, probability and statistics, has a high rate of failure. As a result, college mathematics is known as very difficult to learn. There are three factors involved: the characteristics of college mathematics, the learning habits of students, and the teaching of college mathematics. In practice, the student's learning effects may be not directly concerned with the teacher's classroom teaching, and the omissions in each teaching aspect will affect the student's learning. In this paper, some problems in current teaching of college mathematics are enumerated. Based on the student-centered idea, several specific measures are proposed for the improvement of teaching. The SPOC mode of blended learning is recommended for the teaching of college mathematics, for it is quite flexible to combine the advantages of traditional teaching and online teaching in practice. The construction of a good learning environment for the students is emphasized. Namely, the key is that the teaching of college mathematics should meet the student's current level, and be focused their learning needs whether the teaching is online or in the classroom.

Keywords

Student-Centered, Blended-Learning, Mathematics, SPOC, MOOCs

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1. Introduction

As the foundation of science, college mathematics is the core course for all the students majored in science and engineering. Although different majors have different requirements for college mathematics, at least the three subjects: advanced mathematics, linear algebra, probability and mathematical statistics are required for most students. Commonly, each subject of college mathematics has a high rate of failure, so that college mathematics is known as very difficult to learn. To overcome the problem, teaching reforms in college mathematics have never been stopped. There are six developing trends in higher education as pointed out in [1]. Some of them are turning into realities, such as the increasing

use of blended-learning, the proliferation of open educational resources, and so on. A large number of MOOCs (massive open online courses) of college mathematics have been run online, and more are in construction. For example, according to the plan of Ministry of Education, there will be about 3000 MOOCs in China to be identified as national excellent online courses by 2020 [2]. Although the evaluation of MOOCs is mixed and disputed, it is positive as an alternative choice of learning because students may have different preferences in learning. Compared to the face-to-face model, effective learning online requires more participation of the students [3]. Those students who are absent from the discussions in classroom because of shyness may be willing to take part in the discussions online. For all the students' online activities can be easily recorded, this provides teachers with timely and

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comprehensive information on teaching. By the analysis of online data it is possible to know the problems of each student in learning, and then to provide personalized instructions for them. A successful example is reported in [4], where the so called adaptive learning for advanced math has gotten good results in practice by the design of personal adaptive work. Briefly, it is not enough to construct a MOOC and then to let it run automatically. Students' learning online with MOOCs needs suitable learning environments and well-directed conceptions, which is also a great challenge for both teachers and universities. In fact, online learning and classroom teaching have their own advantages respectively. The combination of online learning with classroom teaching is the mode so called blended learning. Therein, the flipped classroom and SPOCs (small private online courses) are the most famous styles of blended learning. The former converts the role of teachers and students in teaching, and it is more dependent on the students' autonomous Learning. However, flipped classroom in college mathematics is still not popular, owing to the difficulty of the course. The most popular teaching style of college mathematics is SPOCs, where the online course is restricted to a specified group of people, such as a class in the university. Generally, the group is restricted small and the learners are selected to have roughly the same level. Thus, activities both online and in classroom can be arranged more pertinently and effectively. The style of SPOCs overcomes the limitation of MOOCs and has more advantages [5]. Overall, teaching either online or face-to face is for the learning of the students. A good teaching is the one that meets the needs of students and makes learning effective. As pointed by Prof. Boettcher: "No matter where teaching and learning take place, the importance of the faculty member being there and being mentally present with the students is the most important thing they can do" [3], which is essentially the idea of student-centered teaching.

The rest of this paper is organized as follows. First, it is the interpretation of student centered teaching, and it is followed by the analysis of several problems in current college mathematics teaching. Then, some measures for the improvement of teaching in college mathematics are proposed. Finally, it is a summary of the full text.

2. Student-Centered Teaching

The idea of student-centered teaching can be traced back to the American educator John Dewey's book "the school and society" in 1900, and was developed by many educators such as Carl Rogers etc. The expression of student-centered teaching may have different meanings in usage. Generally, it refers to the emphasis of students' subjective role in teaching, so the term is also used as student-centered learning. In this

sense, maybe no teacher will admit that his or her teaching is not student centered. It is natural to pay more attention to the students in teaching, but it is difficult to balance in practice when combined with the guidance role of teachers. It is necessary to hold the theoretical principles of the idea. The basis of student-centered teaching is the theory of constructive learning, which emphasizes the student's critical role in constructing meaning from new information and prior experience. By the theory, learning is an active process, or as pointed by Rogers "A person cannot teach another person directly; a person can only facilitate another's learning". That is, no matter how to teach, it can only take effect through the student's learning. Thereby, all teaching activities should be designed and performed in the interest of student's learning, rather than the course content or something else. Maryellen Weimer, the author of book "learner-centered teaching", summarizes the five characteristics of student-centered teaching as follows [6]:

- 1 Student-centered teaching engages students in the hard, messy work of learning;
- 2 Student-centered teaching includes explicit skill instructions on how to think, solve problems, evaluate evidence, analyze arguments, and generate hypotheses;
- 3 Student-centered teaching encourages students to reflect on what they are learning and how they are learning it;
- 4 Student-centered teaching motivates students by giving them some control over learning processes;
- 5 Student-centered teaching encourages collaboration.

Based on Weimer's work, there are great differences between the student-centered teaching and the traditional teacher-centered teaching in practice, which were explicated with examples in [7]. The most critical difference is the teaching's evaluation. For the central concern of student-centered teaching is the students' learning, it typically involves more formative assessment and less summative assessment overall. In view of the student-centered teaching, the content of the course is only one aspect of the learning assessment rather than the purpose of evaluation. According to Bloom's taxonomy, the learning objectives are classified into six levels in order: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating. The mastery of course knowledge just corresponds to the lower levels of evaluation, whereas the student-centered teaching is in favor of the higher levels of learning objectives. That is, with student centered teaching, it does not mean that students can make less efforts. On the contrary, they will meet more challenges and have to do more themselves. The student centered teaching also puts forward higher requirements to teachers. It is not enough for them to be only good at giving

lectures in classroom, and all the changes in teaching which can facilitate more active learning are expected.

3. Problems in College Mathematics Teaching

A survey by Prof. Liu shows that the teaching in universities is generally lack of interactions, and about half of the students are not active in the classroom [8]. The phenomenon is not a rare case in universities, and may be more serious in the teaching of college mathematics for the difficulty of the course. The students who are majored in science and engineering have to spend at least four semesters to learn college mathematics, but many of them are frustrated by the course. As a result, college mathematics is known as very difficult to learn. Although the teaching reforms in college mathematics have never ceased all the time, the main mode is still classroom teaching and it is far from student-centered in china. For the improvement of teaching, the problems in common are analyzed as follows.

First of all, except for a few talented students mathematics is indeed not easy to most students, which is owing to the characteristics of the course, i.e. logicality, abstractness, and preciseness. Different from people's everyday language, the expressions of mathematics are highly refined for the purpose of preciseness. Generally, students cannot understand the expressions fully and correctly without the process of conscientious thinking. Moreover, the contents of mathematics are usually coherent in logic. It is almost impossible to go down when the front contents are not well understood. However, the difficulty of mathematics results mainly from its abstractness. The knowledge of mathematics is not about specific things, it is generalized by abstracting. As a result, mathematics has a wide range of applications, while it is hard to understand.

Secondly, there is a great span between college mathematics and high school mathematics in depth and breadth. The high school mathematics is relatively simple, and students in high school have to do lots of excises because of the college entrance examination. Thereby, most students can understand high school mathematics well. The main differences of high school students in mathematics learning depend on their proficiency and skills of problem solving. However, college mathematics is more difficulty, and there are much more contents being taught in a lecture. As a result, many freshmen cannot keep up with the math teaching in college. Some of them cannot understand the math lectures at all. Many students are not adapted to the college mathematics learning, whereas they can seldom get proper guidance on how to learn.

Thirdly, it is quite common that university teachers are

focused their concentration on scientific research, for the assessment or promotion of university teachers are mainly based on their performances in research, rather than in teaching. Even if some university teachers are willing to spend more time in teaching, it is very limited. On the whole, students can get less concern in learning from university teachers than they got from high school teachers. The problem is that for most students it is difficult to learn college mathematics by themselves, for the mathematics textbooks are generally written according to the logic of contents, rather than the consideration of good understandings.

Finally, as the compulsory basic course, the teaching of college mathematics is usually in large classes. It is common in china that there are over 100 students in a college mathematics class. Therefore, the communications between teachers and students can not be fully guaranteed in this case. For there are too many students in a class, it is impossible to take into account the feedbacks from each student in classroom teaching. Overall, the teaching of college mathematics in china is still teacher centered.

4. Discussion on College Mathematics Teaching

The SPOC mode is relatively suitable for college mathematics teaching, because it is flexible in practice, and combines the advantages of traditional teaching and online teaching. More importantly, this mode facilitates students' discussion online and is convenient to get students' feedbacks in learning. In fact, the technical means can only promote teaching but never the decisive factor in teaching. No matter with what kind of teaching mode, the good teaching of college mathematics is inseparable from the devotions of teachers. It is essential in mathematics teaching, to know students and be good at motivating students to learn. For college mathematics teaching, the first consideration of instructional design is to make students learning it easy, which is precisely the difficulty of college mathematics teaching. Although the course contents are important and necessary, organizing teaching according to the contents will always deviate from the student centered thinking, and may lead to undesirable teaching effect. For example, if we teach a lot, but students learn very little, we fail in teaching.

Teaching of college mathematics concerns naturally with the purpose of mathematics education. College mathematics is not only the tools for problem solving, but also a way of observing, thinking and communicating. As reported in [9], the reason for teaching mathematics is that mathematics provides a powerful, concise and accurate means of information communicating. That is, it is biased to pay too much attention to the impartment of course knowledge in teaching. In fact, it is a

remarkable feature of mathematics teaching in China, to attach importance to the teaching and training of basic knowledge. Maybe that is effective in the sense of knowledge imparting. However, when the learning process turns out to be just listening and doing, the learning is far from active.

For the sake of active learning, teachers should manage to create suitable learning conditions for the students in college mathematics teaching. A good lecture is an important aspect of teaching, which is the foundation for students' follow-up study. When students understand lectures very little, they are frustrated and have no motivation to continue the course. For some incomprehensible contents of college mathematics, it is very difficult to make students understand easily. Moreover, the lectures suitable for these students may not be suitable for others. Generally, different interpretations on a knowledge point will always have different effects, and the desired interpretations are the more understandable ones. As shown in Figure 1, the lectures of teachers are to make clear to the students what the knowledge point wants to express in natural language. For the teaching of a theorem as example, if the process of deducing is explained step by step according to the logical relationship, this is only equivalent to showing the students that the theorem is correct. In this case, students may not understand the theorem so thoroughly that they can re-prove it themselves, because the idea of theorem proving is not explained in teaching. A way to make mathematical lectures easy to understand is to make clear the key ideas of a knowledge point in teaching.

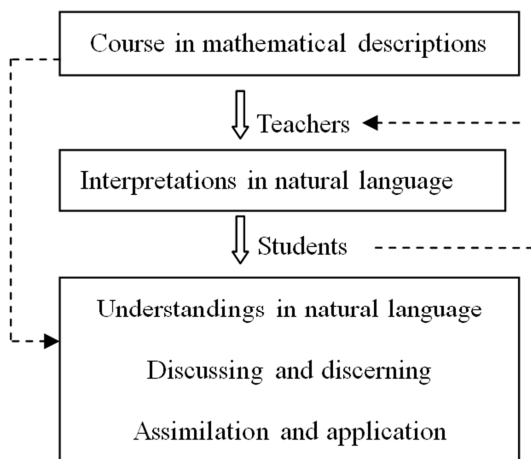


Figure 1. Process of mathematics learning.

Students' understanding of mathematical knowledge is a gradual process with discussing and discerning. They communicate with each other according to their own understandings and can easily get the right views from classmates to revise their original understandings. Sometimes, the discussion between students is more effective than teachers' instruction. If the discussion is online, it can be recorded and analyzed automatically for the improvement of

teaching. It is found in practice that students' online discussions are not uniform. The students' online discussions are mainly focused on the problems of assignments, rather than the lectures. The problems that can attract students to discuss in depth are those with moderate difficulty. The online participation of course probability and statistics is shown in Figure 2, where there are about one-quarter of the students taken part in the discussion. The peak of discussion on June 25th indicates that the difficulty of the problem under discussed is quite moderate.

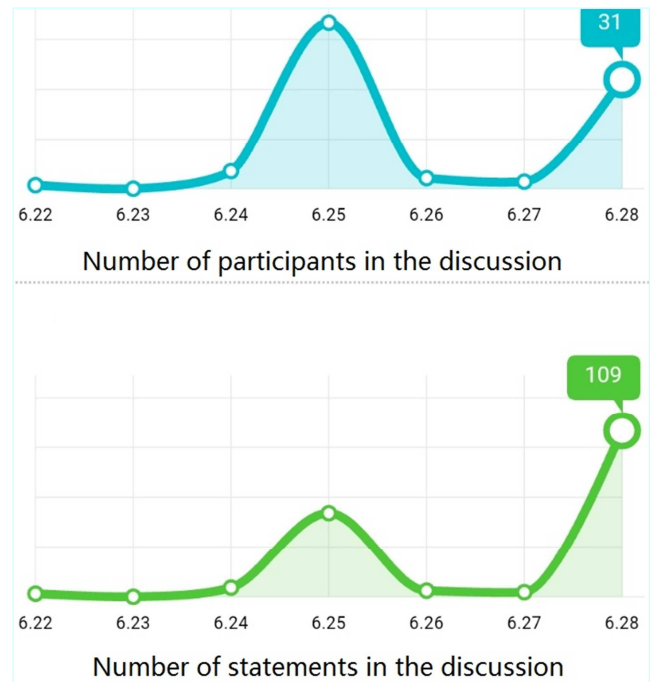


Figure 2. Course online discussion in a week.

In general, the scores for the problems of moderate difficulty are normal distributed. When the scores of exercises are positive or negative skew distributed, it's reasonable to confirm that the assignment is too easy or too difficult. From the feedbacks of assignments, teachers can check students' assimilation and find the deficiencies in teaching. That is, the good teaching can only be constantly improved in practice.

5. Conclusion

The teaching of college mathematics is relatively complicated in comparison with other courses for the difficulty of the course. To overcome the difficulty, the teaching of college mathematics should be student centered, and make the students' learning active. Without good cooperation between teachers and students, only one side's efforts will be ineffective. Besides the lectures, teachers should also motivate students in learning, create good learning conditions for them, and pay attention to their feedbacks in learning. In fact, there may no best teaching of college mathematics exist for all

students, but all the teaching can be improved in practice according to the feedbacks of students.

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