Mixed Classroom Teaching in Computer Mathematics for Undergraduate Students

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Abstract. The difficulties of computer mathematics in classroom teaching present in various aspects. The most important one in our experience is to ignite our students’ interests and active attitude. In this paper, we use mixed teaching modes to overcome the hardness of contents, and initiate our undergraduate students to follow useful instructions. Mixed classroom teaching modes use “new techniques and new resources, encouraging, heuristic, leading, from the shallower to the deeper”, to overcome the difficulties. By stimulating students learning desire, use step by step questions to lead and encourage them to overcome the psychological barriers. The mixed mode teaching focuses on students’ learning initiative, serves the happiness of successfully solving the problems to form active atmosphere of interactive classroom.

Introduction

The mathematical courses in computer science are very important to the specific major, but they are difficult to undergraduate students generally. The courses include ‘discrete mathematics’, ‘combinatorics’, ‘linear algebra’, etc. Our teaching group have experiences on these courses for over decades since 1990. The frequent situations we come through with cautious optimism are that our students were vulnerably keeping devotion on these courses. To improve the efficiency of classroom teaching, Cao etc. believe that the most urgent thing is to light the student learning interests and intentions [6].

As to ‘Discrete Mathematics’, undergraduate students in computer science worry about the difficulty to understand, to remember the various branches of concepts, lemmas, theorems, properties and the reasoning methods. As to ‘Linear Algebra’, the abstract outstands. In a given period, limited time length always in term, to remember and understand the particular contents brings more burst tasks to junior grade undergraduates. They are easy to fall into depression mood, just because they have not realized the importance while facing difficulties. In general, the student desire to learn knowledge, but their motivation to learn cannot spontaneously grow up. Without inner intention, some of them feel boring to learn these fundamental courses. The teachers have to find schemes or techniques to help their students cultivating interests and courage to overcome difficulties. Whatever helpful to the classes, the teachers should use to power the students. Then, we can take the advantages of MOOC, SPOC, and Micro Videos. As mentioned in [1], these new techniques bring us opportunities.

Facing the real situations, if only use traditional board writing, slide presentation, spoon-feed the contents, the students will definitely feel boring and sleepy in classroom. Unfortunately, some teachers may narrate factually and unimaginatively. As a result, without rhythm sensation of analyzing, positive and negative examples, they certainly experience failure to attract their student’s attention. By inserting flash or multimedia, history stories of famous applications, as well as basic exercises, the teacher will certainly change the rhythm and make the students feel a little exciting. Hence, teaching skills draw back the students’ attention.

However, how to improve the efficiency of classroom teaching seems no such a simple task. We should avoid monotonous introduction, keep screening the signals from student’s eyes or emoticon, from their faces or body languages. Do immediate communications with them to care their concerns.
The factors in classroom teaching are numerous, but we need to cover limited several critical aspects to improve our teaching efficiency. The critical techniques, combining the new mixed teaching modes, should focus the critical factors even in technical or practical classes [2]. Let alone the theoretical classes. Then, the basic critical factors jumps out naturally, in order to lead our students following the class process and contents. Finally, classroom teaching will improve their ability of thinking, ability of learning methods and logic description, technical terms, rigorous reasoning, etc. These considerations surround the goal of this paper for enlightening and encouraging the student’s activity and interests by mixed modes.

![Figure 1. Impact relations among critical elements in classroom teaching.](image)

Realizing the key factors of classroom teaching, the role of a teacher should cover contents and method by presentation, as well as initiate the learning desire of the students. In fact, the learning intention is depending on the teacher largely. Although, flipped classroom helps to improve the motivation of students [3], but they will soon get bored if every time is the same. Sometimes, use student assistants can show a good example in flipped class [4]. That means the teacher must make himself attractive, present the course interesting, encourage the motivation of the students with the mixed teaching mode.

**Guided Preview**

Preview is important to find personal difficult points in the following sections or chapters. Moreover, it provides more chances to repeat new contents. Hence, we arrange the preview tasks according to some questions appeared in the current class in order to lead our students to preview those corresponding sections. Question leading means the sections to preview may jump here and there sometimes, while often in sequence. Here, we emphasize the questions should be posed in predecessor class.

In fact, a proper preview can help our students to understand the relations among concepts. They can find the logic process from basic concepts to the further properties, even theorems. Sometimes, if the students successfully find the knowledge chain or concept mesh themselves, they will get more confidence to overcome difficult sections. Of course, it will help them to win power of thinking independently.

We encourage our students to preview by mentioning the motivations. With clear objectives, they are more proactive to follow the guidance. For an example, to discrete mathematics, we present possible usage in following other courses such as ‘trees’ serves a basic structure in Data Structure, ‘partition of set’ serves to categorize conditions in Program Designing, ‘character function’ serves logic truth-value in Logic Theory, ‘graph’ serves topologies in Network Analysis, etc.

Computer mathematics courses are critical to set up base of reasoning and fundamental knowledge to our students. In order to prepare our students, we use guided preview. The goal of the class training is to cultivate their ability to prove, to reason, to abstract, to summarize. In short, the guided preview is a necessary step to improve the thinking power of the students.

Guided preview is not aiming to solve all personal questions, but to find them in least the time cost. That is to say, the teacher tells the students to set up a proper goal, or easy task for preview. Most of our students just read and understand the global relation and find the position in the outline, some of them may read to let themselves feel the contents are a little familiar when we teach in class. They can answer some simple questions, for example, about concepts.
Mixed Process and Composition

In most cases, class teaching should present the easy contents first and difficult contents later. Generally, the textbooks are going in a proper way, considering the levels of difficulty and logical connections. If a teacher is good at the contents, considering the student behavior in class, he/she can easily insert interesting questions.

Design Class Process and Time Weight

Whatever a teacher takes in class, the most important thing is to serve a goal of stimulating the students’ willing and interest to learn. The mixed mode teaching may fit the textbook contents, but may have various adjustment actually. Hence, the process may not in a sequential way as the textbook.

Start from the Shallower

The new contents should be presented in the dependent stages: Preview to find what the section contains. Listen to find the answers for personal doubts. Excise some complicated cases to improve understand level. Any stage cannot be separated with the initiative participation of students. The class design should take care of how to encourage and stimulate the learning willing of students.

Let show the idea with an example in teaching propositional logic. Before present the contents in classroom, we give guided preview instructions as: Try to find the concepts of ‘quantifier’, ‘universal quantifier’, ‘existential quantifier’, ‘propositional formula’, ‘predicate formula’, ‘tautology’. Try to describe the difference between ‘propositional formula’ and ‘predicate formula’. You are expected to finish the two questions in 25 minutes.

Teaching in classroom, we usually start with a certain predesigned question—leading question. Specifically, to the logic topic, we use a statement “Not all the hens lay eggs, and also not all of the cock's crow”. We require our students to judge if this is a proposition first, if yes, write out the symbolized formula.

Along with Increasing Sophistication

After we checked the answers of the symbolized formula, we accessed a conclusion that students’ ideas form various kinds. Correct or incorrect, good or bad, even their description or explanation varied significantly. This revealed our students met obstacles in formalization or abstraction.

Here: we just list four typical answers, named AS1, AS2, AS3, AS4.

AS1: ¬∀x(H(x)→E(x)) ∨ ¬∀y(C(y)→S(y))
We use the selected answers to have a short discussion, in order to explain the point clear.

Our key comments to AS1: The student did not understand the attribute predicate; at least misunderstand how to use. It is not necessary to introduce two objects ‘x’ and ‘y’ to express the hens and the cocks. Hens and cocks are two kinds of chicken. Let ‘x’ stands for chicken, then, H(x) can stand for hen, and C(x) can stand for cock. Furthermore, the two statements “Not all the hens lay eggs, and also not all of the cock’s crow” should be coexisting. Then the conjunction symbol should be ‘∧’. It is not correct using ‘∨’ to connect the two statements in the final formula.

Our key comments to AS2: The parenthesis should be used to describe the range of individual variables. Here, the left parenthesis does not have its pair of right one. Moreover, the first quantifier does not have its individual variable here.

Key comments to AS3: Some students understood the question and realized their answers were typos. However, almost half of those with AS3 went against the rule of identity. They were unconscious what or why they changed ∀ to ∃ in the formula. We need to declare the difference of ∀ and ∃ again to the later.

Key comments to AS4: Correct answer. Of course, this is only a direct forward symbolization. Probably, we can deduce the formula to a simpler one.

We keep the example on white board until we repeatedly use it in semantic and logical truth. The example can act as an introduction to further logical truth “Exist a hen, it does not lay eggs”. We ask the class: Can you deduce a logical truth from formula AS4?

In most cases, there are students who can write out the following:

\[ \neg \forall x (H(x) \rightarrow E(x)) \land \neg \forall x (C(x) \rightarrow S(x)) \]

\[ \Rightarrow \neg \forall x (H(x) \rightarrow E(x)) \]

\[ \Rightarrow \exists x (\neg (\neg H(x) \lor E(x))) \]

\[ \Rightarrow \exists x (H(x) \land \neg E(x)) \]

The final formula has clear semantic: “Exist a hen, it does not lay eggs”.

Class with Mixed Modes

Mixed modes include various methods and techniques to conduct classroom teaching. Occasionally, some contents may originally get through internet, like video and audio material from MOOC. Sometimes, we can combine flipped classroom under the teacher’s guidance. There are reports on using student assistants to improve the flipped class efficiency [5]. A class with mixed modes makes the contents presenting with multiple forms. Hence, such classes are more likely to achieve higher teaching efficiency. We use course website to expand the teaching activity [7].

The slides are still a useful method to give basic clue and to present important materials in class. Although, some students may feel boring to look at the slides all the way. To change this situation, we can intentionally design some errors to ask the students, or to test if they are with the teacher. If they can find or correct the errors, they will feel successful and exciting to focus on the class.

It is time to assign a practical exercise if the students are losing their attention. This simple inserted exercise can help to draw their attention back and review the contents in the hour. However, the most important function is to awaken the students in time. We should keep an interval every 20 minutes of new content displaying. Inserting a simple exercise can also check the effects of class teaching.

As to the time ratio of different style in a class with 45 minutes, we try various combinations. One pattern is more acceptable considering the feeling of both the teacher and the students. It is illustrated in Figure 3.
Summary
We introduce an effective pattern of classroom teaching based on our experience. It may not fit all possible situations. The specific cases must consider the students, the course, the textbook, the teacher, the device in classroom, and the evaluation scheme. The teacher acts as the major role to a greater extent. The mixed class should be processed in a depending way considering the critical aspects, such as the students, the classroom equipment, the course, and the management requirements, etc. Mixed modes are helpful to maintain the intention and important to initiate the class motivation.

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References