Hybrid Task-Driven and SPOC in Enhancing Students’ Computational Thinking

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**Abstract.** Computational thinking has been a unique capability in the era of artificial intelligence. Computer programming course is the most direct and operational platform to cultivate students’ ability of computational thinking. This paper integrates task-driven and SPOC teaching modes together to help students to develop their computational thinking. Students' programming practice activities are at the core with task-driven mode and students can get assistance and support with SPOC when they are confronted with difficulties and problems.

1 Introduction

With the booming development of information technology, computational thinking has been widely concerned in the field of international education. Computational thinking is regarded as an important skill to solve problems, considered to be one of the basic qualities necessary for the self-development of contemporary learners like reading, writing and computing. It also is a unique capability in the era of artificial intelligence.

In 2018, STE and the Computer Science Teachers Association (CSTA) jointly put forward the operational definition of computational thinking, which is defined as the process of problem-solving using computing tools to organize and analyze data logically. Computational Thinking Competences Standards for Educators was issued by STE in 2018, in which it clearly stated that educators should cultivate their own and students' computational thinking ability as the roles of “learner”, “leader”, “collaborator”, “designer” and “facilitator”\cite{1}.

The course of computer programming is the most direct and operational platform for the cultivation of students' ability of computational thinking. This paper integrates the task-driven and SPOC teaching modes together in C programming course to help students to develop their computational thinking ability in the role of leader, collaborator, designer and facilitator.

2 Task-driven mode

The main teaching goal of programming course is to improve students' programming ability and problem-solving ability, which requires students to do a lot of programming practice. As the leading role in the whole teaching process, if the students' interest int learning and enthusiasm for programming cannot be stimulated, it is impossible to achieve the teaching goal at all.

In the task driven teaching method, students are oriented with programming tasks which hides the corresponding theoretical knowledge points. By completing the tasks, students master the theoretical knowledge points independently. And in this process, students are full of sense of achievement and gratification, which greatly and continually inspire them to learn deeply.

The task driven teaching mode has changed the traditional teaching mode of "teacher speaking, student listening", into the multi-dimensional interactive teaching mode of solving problems and completing tasks\cite{2}. It guides and maintains learners' learning interests and motivation by exploring problems, so that students have the initiative to learn, so that students' learning is not only knowledge from outside The internal transfer and transfer is the process of actively building their own knowledge and experience, so as to cultivate students' ability to analyze and solve problems, and improve students' ability to learn independently and cooperate with others.
To play the role of these three roles well in task driven teaching, we should have an inspiring task driven implementation platform and design all the tasks at first.

2.1 Task design
In task driven teaching, teaching objectives are embodied in each specific task. Therefore, the most important job of task driven teaching is to design scientific and practical tasks. The following problems should be paid attention to when designing tasks:

1. The overall learning objectives should be divided into small objectives, and small objectives should be refined to tasks that are practical and specific. It's a top-down process.

2. When designing tasks, we should also consider to promote students' autonomous learning. Instead of telling students directly how to solve the problems, teachers may provide students with relevant clues to solve the problems, such as what information is needed and where to get it, emphasizing the development of students' ability of independent learning.

Tasks with reasonable difficulty gradient distribution should be designed to adapt to different types of students to respectively achieve basic objectives, development objectives and open objectives. All students are required to complete the basic objectives. The students with learning ideas and interests then required to complete the next development objective with efforts, and those talented students can continue to complete the later open tasks.

2.2 Task driven implementation platform
A good implementation platform is essential after teachers have designed tasks which dissolved all the knowledge points. A good implementation platform can make students feel interesting and stimulate their sustained devotion in programming. We use online judge system to test whether students’ submitted codes are correct or not in real time. Immediate feedback can greatly inspire students’ desire to win, keep mobilizing students' enthusiasm in learning. At the same time, full and comprehensive test data will also greatly improve the comprehensiveness of students' consideration of problems and the ability of debugging programs.

The implementation platform we adopted is PTA(Programming Teaching Assist), which adopts B/S structure. Students submit the program source code with the web browser, the server receives the source code and compiles it, and returns the corresponding compilation and execution results to the students. The platform also integrates performance statistics, ranking and the other functions.

On one hand, PTA provides a competitive incentive mechanism to further stimulate students' learning interest and interest in programming. On the other hand, the platform may also offer teachers an opportunity to find out whether students not working hard or exactly having trouble in learning which led to low ranking through analysing students’ submission history.

3 SPOC
MOOC (Mass Open Online Course), characterized as "fragmented" learning mode with "short video" as basic teaching unit began from 2012. Since then, MOOC has grown rapidly in the world. MOOC provides more people with free access to quality education. But there are difficulties for MOOC to maintain learners' learning motivation and improve the completion rate of learners. And most MOOCs can only guarantee learners to complete the step of receiving information. But it’s not sufficient in higher education especially in the kind of programming courses which needs students to think, integrate information, do a lot of practice and ultimately form students’ own understanding and computational thinking.

Compared with MOOC, SPOC is a hybrid learning mode combining classroom teaching and online teaching[3][4]. It can use MOOC's lecture video to implement flipped classroom teaching. Programming courses emphasize students' programming ability, which cannot be mastered only through reading or attending lectures. We should put students' programming practice activities at the core with task-driven mode, and simultaneously using SPOC to supply assistance and support for students when they are confronted with difficulties and problems.
SPOC website is designed to support students to better complete the central task of programming training. The resources on the SPOC website are all built or collected to assist students. The core components of SPOC website are short videos (self-made or quoted) of all knowledge points of the course and forums for students to ask questions, discuss and exchange.

3.1 Video resources

Video resources can be used to help students to acquire relevant knowledge before or during doing the tasks. At present, there are many excellent courses of programming on MOOC website, and correspondingly there are many helpful course videos. In our SPOC website, teachers recommend these excellent videos to students. In addition, the teacher team also have recorded short videos of knowledge points for this course to link with students’ weekly programming tasks.

We keep our own unique characteristics when recording short videos, that is, taking programming as the driving force, organizing short videos around students' programming activities, using the minimalist teaching method to enable students to start programming activities as soon as possible, and combining teaching short videos with students' weekly programming tasks closely. Till now, we have recorded about 500 minutes of short video.

3.2 SPOC learning community

Even if the students' programming task list has been linked with the corresponding video resources, students will still have various personality problems in the process of solving problems. If these questions are not answered in time, it will frustrate them and it will cause problems to pile up, which will lead to the difficulties of understanding the subsequent knowledge points.

Therefore, we have built SPOC learning community. SPOC learning community is composed of learners, senior teaching assistants and teachers. They often communicate, exchange and share various learning resources in the learning process, and establish cooperative learning mode. The existence of these communication channels can not only break the loneliness of students' learning emotion, but also eliminate the helplessness in time when they encounter problems, and stimulate students' to actively participate in SPOC courses.

In addition, the teacher will also record short videos on the forum according to the interaction with students to explain the programming problems that students have common problems, and analyze the thinking of solving problems to penetrate the cultivation of computational thinking.

3.3 Flipped classroom

With the task-driven and SPOC mode together, teachers now change from a pure knowledge imparter to a tutor who guides and helps students to learn. They no longer focus on what to teach and how to teach from the perspective of teachers, instead focus on how students want to learn (learning process) and how students learn (learning effect). The main task of teachers is no longer to supervise and judge students' learning results, but to help students to get better learning effect and learning experience.

With the video resources of SPOC to explain theoretical knowledge points, and students have taken the main learning task as the main body of learning, the role of teachers in the classroom has changed a lot. Teachers can focus on analyzing and explaining the problems happened in students' programming, and they can also invite students who have completed their tasks to explain their ideas and carry out a classroom communication and discussion. The atmosphere in such classroom is more active.

4 Evaluation and teaching effect

The goal of the course is to cultivate students' computational thinking and to improve their ability of software programming, so we take the programming ability of students as the core assessment. In addition to daily practice, students have monthly test, computer room test, mid-term test and final exam. Finally, the course score is evaluated as: 10% (attendance + homework) + 20%
monthly test + 30% mid-term test + 40% final exam. Daily practice, monthly test, computer room test and mid-term test are all composed of programming questions, only in final exam there are 15% of the questions are not the programming questions.

In this semester of 2019-2020 academic year, students in 8 classes of 2 majors (Computer Science, Information Computing and Science) took part in the mid-term computer test of C language programming. There are 12 programming questions in the mid-term computer test. Students can choose 10 from 12 questions to complete. Each question is equipped with multiple test points and students can get corresponding scores only if when they pass the test of the test points. The results of the mid-term test are shown in the table below. By and large, the test reflects the programming ability of students which is greatly improved compared with that before the teaching reform.

There are still differences in test scores between majors and classes. However, the test scores are positively related to the amount of daily programming training of students. Those classes with lower average scores and those who failed are just those with less programming training. We believe that the differences can be eliminated by increasing programming practice in the second half in the semester.

| No. | Class No. | Total students | Average score | Failed students |
|-----|-----------|----------------|---------------|----------------|
| 1   | CS191     | 28             | 89.75         | 3              |
| 2   | CS192     | 26             | 98.64         | 0              |
| 3   | CS193     | 26             | 91.62         | 2              |
| 4   | CS194     | 27             | 96.26         | 1              |
| 5   | CS195     | 27             | 91.22         | 2              |
| 6   | CS196     | 26             | 84.07         | 2              |
| 7   | ICS191    | 20             | 78.95         | 4              |
| 8   | ICS192    | 19             | 69.5          | 6              |

5 Conclusion

The main teaching goal of programming course is to improve students' programming ability and cultivate their computational thinking, which requires students to do a lot of programming practice. We adopted task-driven mode to motivate students to devote to programming, and simultaneously equipped with SPOC to support their activities. Midterm test reflects that this mode can greatly improve the programming ability of students. How to better stimulate and maintain students' interest in learning and provide personalized and intelligent learning services is our later research focus.

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