Training Students’ Innovative and Critical Thinking Capabilities via Flipped Classroom Strategy—The Courses of General Chemistry as Examples

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Abstract. In this work, a systematic approach to develop the teaching of general education courses via flipped classroom strategy is discussed. A series course of general chemistry is taken as examples for discussion. A conceptual framework for organizing and executing three-in-one combination teaching and studying systems, i.e., in-out class studying, on-off line studying, theoretical-practical studying, is presented. Problem based learning (PBL) and cooperative learning (CL) methods are applied. Overall, a student-centered environment is proposed which aims to train students’ innovative and critical thinking capabilities.

Introduction

General Education, also known as liberal education, originated from Liberal Education in the ancient Greece [1]. In the mid-20’s century, the Education Committee of Harvard University published a special report—“General Education in a Liberal Society”, which listed off a wave of time for General Education and linked it to the higher education. The report illustrated the significance of General Education in college education, indicating only General Education can bless people with the endowments like knowledge, capabilities and refinement that are requisite to people’s life, with which before setting foot in the society, university students can take possession of the “critical capabilities” [2]. Several strategies for carrying out general education courses in Chinese universities can be found in the literatures [3-5]. However, due to their characteristics as “optional courses”, general education courses have been normally marked the stamps of "unimportant courses". Students pay little attention to those courses. Moreover, in China, traditionally, teaching and learning of courses are carried out using a didactic approach, i.e. the teachers deliver formal lectures to convey knowledge. In this case, the students receive it passively and then are expected to reproduce the information accurately in examinations. This teacher-centered teaching and learning approach may be easy and effective in terms of time for the teachers but it does not provide an active learning environment for students. As a consequence, the learning outcomes are not effectively delivered and the feedback from the students is not satisfactory. In order to realize the aim of training students’ innovative and critical thinking capabilities via general education courses, a systematic approach via flipped classroom strategy is discussed. A series course of general chemistry is taken as examples for discussion. A three-in-one teaching-studying system with student-centered environment is presented. Problem based learning (PBL) and cooperative learning (CL) methods are applied.

Flipped Classroom Strategy

Flipped classroom is an instructional strategy and a type of blended learning that reverses the traditional learning environment by delivering instructional content, often online, outside of the classroom. It moves activities, including those that may have traditionally been considered homework, into the classroom. In a flipped classroom, students watch online lectures, collaborate in
online discussions, or carry out research at home and engage in concepts in the classroom with the guidance of a mentor. As early as 551 B.C., Confucius had stated, “I hear and I forget, I see and I remember, I do and I understand.” By introducing flipped classroom strategy to the general education courses might inspire the students' interest and motivate their active learning. The overall flipped classroom strategy was shown in Figure 1.

![Figure 1. Framework of Flipped Classroom Strategy.](image)

As shown in Figure 1, the core content to be mastered in the course is not simply introduced by teachers via a monologue. Some active learning pedagogy, such as PBL, question-based comparison, team-working, presentation, reports are also undertaken. By recalling this prior knowledge, not only is the prior and successive knowledge connected effectively but students will also value knowledge and technology they have been taught previously. This may stimulate their interest and reinforce their self-confidence.

During the lecture hour in-class, current hot topics were introduced by teachers to inspire their learning experience and link the theory with real-life events. Such topics are also given as problem based learning (PBL) projects out-of-class, including a one semester long problem solving project and several small problem solving projects. The whole class is also divided into groups with an average size of four to six students per group. Most of the in-class discussion and out-of-class problem solving is performed in these groups.

**Successful Example**

Under the framework of flipped classroom strategy, a series course of general chemistry, including the course of “A bite of chemistry”, “Chemistry and Human Dream”, “Chemistry and Social Development”, “Chemistry in Daily Life”, is taken as examples for discussion. In these courses, a conceptual framework for organizing and executing three-in-one combination teaching and studying systems, i.e., in-out class studying, on-off line studying, theoretical-practical studying, is presented. Problem based learning (PBL) and cooperative learning (CL) methods are applied.

For example, in the course of “A bite of chemistry” and “Chemistry and Human Dream”, before class students organize a team for PBL project assigned by teachers. Applying PBL means that
students are given relatively little information on how to problem solve. Students must read beyond their textbooks to gain more knowledge by examining other resources, thereby engaging students in active learning and necessitating that they make their own decisions and choices. Cooperative learning involves students working in groups and, therefore, allows them to share knowledge and explain concepts to their peers. Since it is difficult to provide a tutor for each group, we employed the method described by Woods whereby the groups are empowered to run without a tutor and thus enable the students to learn skills in facilitating group tasks, problem solving and the learning process [6]. They are asked to give a presentation and submit a report for the group project at the end of the semester. The final assessment of the PBL performance is given based on students peer assessment (both evaluation of the group members (inter-group) (30%) and evaluation of the group as a whole (intra-group) (30%)) and evaluation by the instructors (40%). The PBL projects account for 30% of the student’s overall course grade while the final examination (on-line exam, in which the trial balloon was established by the students as well. The test paper was formed randomly for individuals) accounts for 30% of the mark. The rest 40% of the mark covers the on-line study and practices. In class, several kinds of pedagogical methods, such as class discussion, demonstration, presentation, debate competition, quiz show, etc, have been used to enhance student-centered active learning. In addition, the plan, organization of the demonstrations, presentations, competitions are accomplished by the students. Overall, a student-centered environment is proposed which aims to cultivate the students’ practical abilities and individual talent. After class, feedback of the students about the online and offline studying, out-class social practice training from the students are collected for the critical rethinking of both the teachers and the students. Typical pedagogies for realizing the flipped classroom strategy are shown in Figure 2. Some of the PBL projects outputs (self-made soap and leaf veins bookmarks) and pictures for presentation and debates are shown in Figure 3 and 4.

Figure 2. Typical Pedagogies for Realizing the Flipped Classroom Strategy.

Figure 3. Some of the PBL Projects Outputs.
Conclusion

Flipped classroom strategy offers students opportunities to learn practical knowledge, to gain working experience, and, most importantly, to train and gain innovative and critical thinking capabilities. Under the conceptual framework for organizing and executing three-in-one combination teaching and studying systems, i.e., in-out class studying, on-off line studying, theoretical-practical studying, a systematic approach for teaching general education courses via flipped classroom strategy have been successfully carried out. Problem based learning (PBL) and cooperative learning (CL) methods are applied. The use of systematic approach for general education courses should be promulgated widely.

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References