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Feasibility of Flipped Classroom in Engineering Teaching

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Abstract: Information technology has greatly changed people's way of life and learning, and also posed a challenge to the existing classroom teaching model. Therefore, flipped classroom emerged at the right moment. Flipped classroom is a new educational pattern that adopts technology to influence and promote education, which has been promoted in many foreign schools and achieved excellent results. This paper introduces the principle, advantages and disadvantages of flipped classroom, and the feasibility of flipped classroom in science and technology teaching. Flipped classroom can not only cultivate students' self-directed learning ability, but also respect students' individual differences. It can be found that flipped classroom mode is actually a revolution brought by the development of technology to education. It meets the needs of students and will revolutionize classroom teaching.

1. Introduction

The concept of flipped classroom (FC) can be traced back to 2000 [1], but FC method became popular around 2012 with the work of Bergmann and Sams [2], as shown in Figure 1.

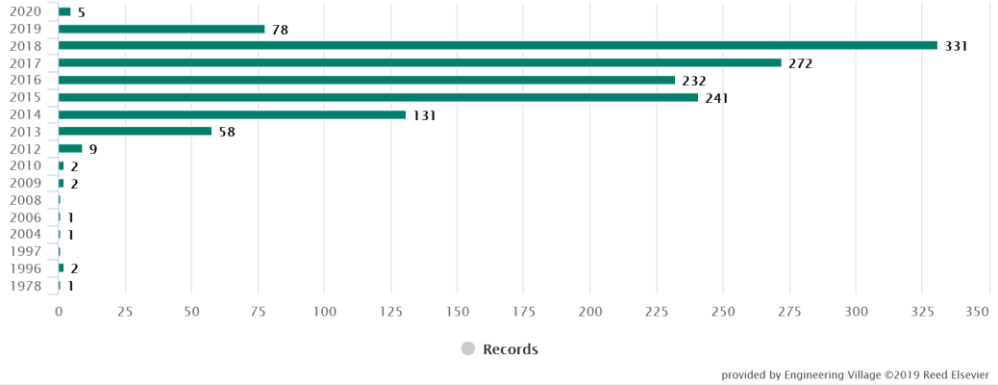

Figure 1: Since 1978, the keyword flipped classroom has been searched in Engineering Village (EI) database

It can be believed that the major reason for the FC model's widespread adoption is the novel technologies' availability in daily life, for instance, smart phones and high-speed Internet connection anytime and anywhere, which makes video lectures and other content easy to access [3].

With the worldwide implementation of FC and the rise of entering higher education institutions (for example, universities), the number of research papers on the FC model's success also increases, as shown in Figure 2.

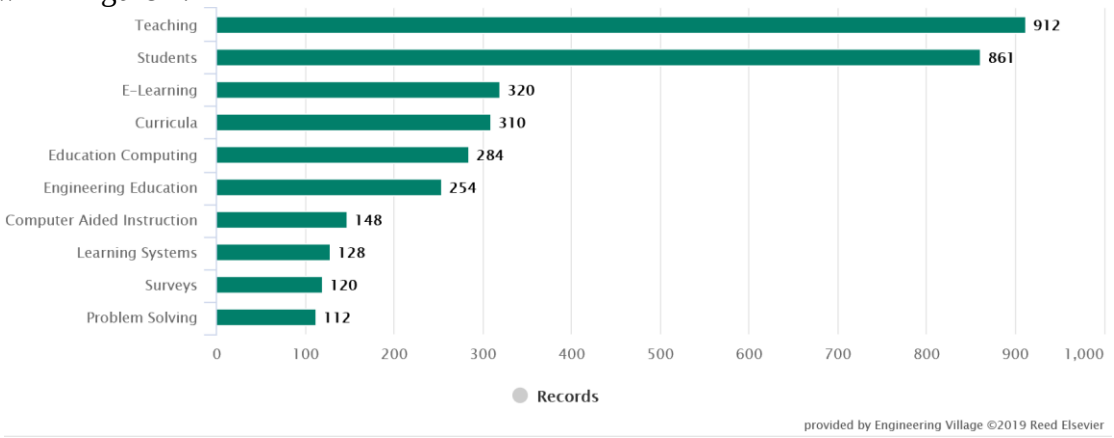

Figure 2: Number of papers related to FC published in past years

This paper focuses on the feasibility of FC in engineering teaching. Although there are few empirical studies related to engineering, existing studies have shown that the implementation of FC is successful. For instance, research conducted in computer networking courses for engineering seniors [4-6] showed that the number of students in the experimental group who achieved the targeted application level of Bloom's classification [7] was significantly higher than that in the control group who achieved only memory level. In the same study, a majority of students said they liked FC activities. It is found in literature [8] that the average score of the test group students is higher, reaching 4%, and the scores of most students are better in the comprehensive questions, which indicates that they have the ability to apply what they have learned into practice. In addition, the students themselves reported improvements in their ability to solve new problems, express themselves and work in teams. [9] Pointed out that the comparison between the two sets of students adopting FC and conventional classroom shows that the FC has a superior overall score, with a difference of about 20%.

The rest of this article is organized as follows. The following section describes the principles and pros and cons of FC. The third section verifies the feasibility of FC in science and technology teaching. Finally, the fourth part is the conclusion of the thesis.

2. The Principles and Pros of FC

2.1. The Principles of FC

FC is a hybrid learning mode based on digital resources. Teachers attend classes during the day and students do homework at home, which is the opposite of the traditional way of teaching. On KNEWY's official website, it gives a fairly detailed explanation of the chart. Students' knowledge learning and internalization is not through 45 minutes of class, but through extra-curricular digital resources into autonomous learning. In the precious class time, teachers try their best to understand students deeply, answer students' questions in a personalized way, and guide students to use the knowledge they have learned to carry out practical activities [10]. This teaching model makes full use of the advantages of education technology under the rapid development, and creates learning

opportunities for students in the environment and activities. Digital resources that reverse the learning environment and time inject new vitality into the education revolution and digitalization. The principle is shown in Figure 3 [9].

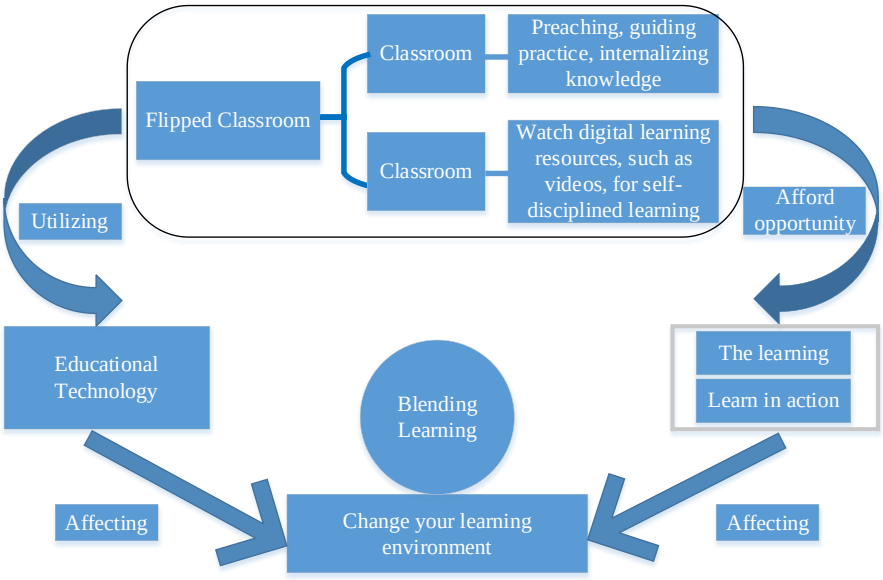

Figure 3: The principles of FC

On the surface, the model provides some suggestions and experiences for teachers and students who adopt FC, but actually reflects the essence of FC. FC is a mixed learning mode. It can be clearly seen from Figure 3: Firstly, FC is not a simple online teaching, but a mixed teaching mode through computers. Secondly, FC is not equal to online video teaching. There are so many digital resources that are the basis of FC, such as advanced game simulation, audio and web pages. As long as it is conducive to learning, it can be a textbook for FC. What's more, FC learning is not just about doing homework and answering questions. It creates personalized learning space. Students can discuss with teachers the difficulties they can't understand; Finally, FC does not only exist in the static learning phase. With the development of technology and the convenience of mobile learning, interactive teaching is happening all the time and digital learning is everywhere.

2.2. The Pros of FC

Some relevant works have concluded that the FC model has many advantages [6]. Here's what's relevant to our research:

- Anyway, the students act at their own pace;
- Costing more time meeting students leads to more interaction and helps clarify difficulties;
- Teachers can customize lessons more readily-easily;
- Anyway, classrooms are adopted in effect and in a creative way;
- Technology's application works flexibly and appropriately in current environment;
- Anyway, students can share their knowledge in class, which helps consolidate what they learn;
- A short video class engages students more than a long one.

Of course, the FC model also has some disadvantages [5-6], such as:

- Anyway, students may not be prepared for class and therefore can't actively participate.
- Prepare material, for example, video lectures and reading materials, to make it fun and festinating. This needs teachers' extra time and energy;
- Anyway, it's tough to carry out FC according to university standards, which are part of a government program;

▪ Sino class size; Adapting FC technology to a required course for a few hundred students is much harder than adapting it to a small class;

▪ According to a student's personality, it’s impossible to accommodate everyone, for example a shy student might not like to show results publicly.

While this is not a universal shortcoming, we would like to raise another potential problem with implementing the FC model, and that is the age of students. Studies have shown that junior high school students are more willing to learn using the FC model than first-year students. Readiness to engage and accept this learning approach plays an important role in the overall achievement outcome. This discovery, along with class size, is the main reason we decided to implement FC only for science and engineering classes.

2.3. The Feasibility of Flipped Teaching in Science and Technology Teaching

FC is a kind of classroom teaching mode that transforms teaching methods. Learning activities that usually take place in the classroom and learning activities that students take place outside the classroom. The idea is to subvert normal teaching methods, meaning that what used to be taught in the classroom can now be used at home (complete with video) and before the actual lecture. Therefore, the classroom becomes a place for students to solve problems, ask questions and actively participate. Figure 4 [10] shows a FC problem System to encourage students to actively participate in FC.

In view of the idea of FC, the first step in the process will be for students to watch videos. In the usual process, after watching the video (or in the process of watching), students should write down their questions about the content explained, so that they can ask teacher questions in the following lecture process. Thus, at the starting of the procedure, students view one or more videos (for instance, suppose there is only one video) before listening to the seminar. Afterwards, they talk over the content of these videos in class. The difference from traditional methods is that in our scenario, students anonymously recorded their issues through an online tool (the teacher was unaware of the identity of the student asking the questions). Teachers can then use the tool to ask questions. In this way, students don't have to ask such questions in front of their teachers and classmates in the classroom.

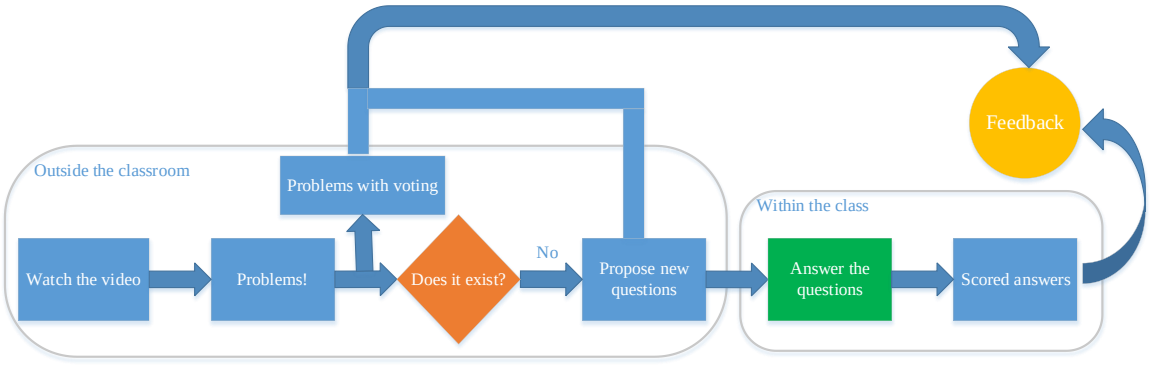

Figure 4: Process flow chart

In this manner, once in the classroom, the teacher answers the question he/she has chosen among the tools. During this time in class (or later if the teacher wishes), the tool will be turned back on, but in this occasion just a grading system will be enabled. This grading system allows students to rate the answers to each question given by the teacher, which reflects how much they like (or dislike) the answers and explanations given by the teacher.

Once this process is implemented, teachers get valuable feedback from students. There are two related aspects to this feedback:

▪ By means of the questions provided in the system after students watch the video, teachers can extract which parts of the video may be unclear and which contents need to be improved;

▪ Teachers can also improve them with grades and explanations in class, in case their scores are low.

3. Conclusions

Engineering course is a practical course, its essence is practical experience and cooperative work. It's also a rapidly evolving field with new technologies that students need to familiarize themselves with to be ready for the job market.

Flipped classroom (FC) is a new teaching mode that realizes “information transfer” before class. The classroom is a place for interaction between teachers and students. FC subverts the traditional teaching mode in terms of teaching concept, teaching mode, teaching environment and student orientation. It can improve students' interest in learning and teaching effect. Practice has proved that it is necessary to improve the quality and effect of teaching and promote students' learning and growth mode. It is believed that the teaching mode and concept of “flipped classroom” will gradually spread and be open to application in more classroom teaching

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