

The Application of PBL English Teaching in Engineering Universities

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ABSTRACT

This paper is a literature review which aims to discuss and summarize the experiences and cases of Problem-Based Learning (PBL) applied in engineering universities. The authors first reviewed the historical developments of PBL. After that, based on the experience of PBL teaching in engineering colleges in various countries, the authors summarized the operation process of PBL before and after class in engineering schools. For these studies, we evaluated the effectiveness of PBL. This review found that although there were very few previous studies related to English PBL teaching, it was an effective method for science and technology students to improve personal achievement, including personal ability, cooperation awareness, and English study motivations. This implied that PBL has a huge potential for implementation in English courses to enhance the learners' English skills. Also, some improvements and limitations are discussed.

Keywords: PBL, English Teaching Method, Engineering and Science Universities

1. INTRODUCTION

In traditional English teaching courses, the teachers are the center of the course, who constantly impart knowledge to the students. Students often lose interests in this kind of course because of the dull learning process. Especially in engineering univerrisites, they do not pay enough attention to English learning. In addition, it is difficult to combine the students' professional courses and English courses. Traditional English teaching methods can hardly meet the needs of students in engineering schools to learn English.

In the 1960s, McMaster School of Medicine proposed The Problem-Based Learning (PBL) method for the first time. This method is student-centered and problem-based, which had greatly improved students' interest in learning and learning effects. It is widely admitted by students and promoted to all stages, different types of schools, and disciplines, which includes teaching English in engineering schools through PBL.

Among engineering universities in various countries, many teachers and professors have written papers to introduce examples of PBL English courses in their schools. However, the authors of this paper found that there are very few studies on summarizing the experience

of PBL English courses in those engineering schools, which is a research gap.

This paper first introduces the historical origin and development of PBL, and then reviews the general course of PBL English teaching based on several engineering schools that use PBL to teach English. The authors of this paper found that using PBL as an approach to teach English in engineering schools is very effective in improving students' personal skills and learning motivations. However, there are still some problems in the practical application of PBL teaching method due to the lack of well-trained teachers and suitable textbooks.

Accroding to the above information, PBL is an effective and promising teaching method in teaching English in engineering universities. This paper aims to summarize the previous teaching experience of a school as a case study about how did it carry out PBL, which might inspire future teachers who intend to change the traditional teaching method and improve students' English learning.

2. THE ORIGINS AND DEVELOPMENTS OF PBL

Project Based Learning (PBL) is a teaching method

in which students gain knowledge and skills by working for an extended period of time to investigate and respond to an authentic, engaging, and complex question, problem, or challenge [1]. In traditional education methods, teachers are always the center of the class. The teachers are in control of the learning goals and learning progress. However, unlike traditional education methods, PBL encourages teachers to put students to the center of the class. Teachers provide authentic questions, and students try to solve them by themselves through group discussions and experiments. With PBL, teachers are only assisting for students to study independently who guide students when necessary. PBL requires critical thinkings, problem solving, collaborations, and various forms of communication. To answer a driving question and create high-quality work, students need to do much more than just memorizing words. They need to use critical thinking skills and learn to work as a team.

In the 1960s, McMaster School of Medicine in Ontario, Canada found that the connection between teaching and the authentic situations which students faced in the workplace was not close. And the traditional teaching mode was seriously challenged. In 1966, the Faculty of Medicine established experts headed by American neurology professor Holder Barrows. The group abandoned the "standard" practice of setting courses centered on subjects and formulated a "Three-year plan", which marked the birth of PBL. After the 1980s, it has developed rapidly in North America and was gradually adopted and accepted by other schools. In the 1990s, some medical schools in Europe began to experiment with this model, and PBL became the mainstream trend of medical education reform and development. At present, PBL has been extended to the teaching of other majors such as education, psychology, and law. Since the 1990s, PBL has been practically used in the teaching of English courses in many Western country and has achieved good results [2].

In North America, PBL is widely used in various subjects all over the world. Taking China as an example, after Shanghai Second Medical University and Xi'an Medical University introducing the PBL teaching method in 1986, PBL has been widely used in the teaching of science and engineering, foreign languages, law, physical education and other subjects in Chinese universities.

3. THE PROCESS AND REQUIREMENTS OF PBL DEVELOPMENT IN ENGINEERING COLLEGES

3.1. The Particularity of English Proficiency of Science and Engineering Students

Due to the background and speciality of the major of science and engineering students, there are also some

differences between science students and other students in English learning.

First of all, the general English courses of science and engineering students are not well integrated with professional courses, and the courses learned in university classrooms are difficult to meet the needs of work. Science and engineering graduates need to read English technical materials, English-Chinese or Chinese-English technical materials, write English technical reports, oral communication of professional technical content, and daily life communication. As a technician, the primary use of English is as a tool to solve problems in professional technical work. Basically, college basic English education, which is now consuming a lot of teaching resources, is quite lacking in the training of students in this area [3].

Second, the students of science and engineering's English foundation is not good enough. For example, in terms of vocabulary, science and engineering students are obviously inadequate. Li from Luoyang Institute of Technology conducted a vocabulary test on 133 students of a science and engineering department and found that nearly half of the students' vocabulary did not reach the 2000 words required by the syllabus [4]. Duan and Fu from Hebei University of Science and Technology found through investigations that what students have. There is a big gap between English vocabulary and professional vocabulary necessary for professional and technical personnel [5].

Overall, English courses in China are divided into public English and professional English, and their emphases are different. On the one hand, public English enables students to master basic English knowledge so that students can read and understand English books and literature, with a certain degree of language communication skills [6]. On the other hand, professional English contains vocabulary terms and sentence styles associated with the major to help learners to understand, master, and apply the expressions and communications of English in their major [7]. Below is a proposal of PBL class in engineering schools.

3.2. Before the Class

3.2.1. Grouping

An important teaching goal of PBL teaching method is to cultivate students' teamwork ability. In PBL teaching, group discussions, group presentations, after-class evaluations, and others are all acted through the form of small groups. Therefore, it can be argued that the group is the basis of PBL teaching. Before class, the teachers are required to divide the students into groups based on the class size with around five to six students in each group. Because in engineering colleges, students might not have a good foundation in English, and there

are fewer students who are better at English. The teachers should arrange these students with a good English foundation in each group, and try to ensure that each group has a good English foundation and a strong sense of responsibility to be the group leader. The group leader should try to promote the discussion of the whole group, especially the students with relatively low English level to participate in the discussion. The teachers need to tell the students: the tasks assigned during and after the class need to be completed by all group members. The score of the class depends on the group work. Hence, each member of the group must join the discussion[8].

3.2.2. Pre-class Preview and Problems Raised

3.2.2.1. The Pre-class Preview

The PBL teaching method has high requirements for pre-class preparation. When the teachers assign pre-class preparation homework, they cannot just focus on the literal meaning of the text, and ask students to read the text word by word and master the grammar points of the text. This will separate the students' understanding of the text from the connotation of the author's writing. Instead, teachers should encourage students to focus on the writing background of the article, cultural connotation, and the story behind the text content, which can not only help students have an overall grasp of the article, but also create an immersive feeling for students and strengthens students' sense of participation and involvement. Li, a teacher in Yunnan Water Resources and Hydropower Vocational, arrange for students to collect, organize, and describe Jobs' biographical information, and summarize Jobs' important choices of his life [9]. This will make students study the text with general ideas and respect for the character Steve Jobs in the text, which is easier for students to understand the whole meaning of the text.

3.2.2.2. The Problems Raised

PBL means "Project-Based Learning", in which problems teachers raised are the most important element of PBL. Teachers need to design questions according to the context of the curriculum before class and ask students to consider based on the questions, to research for the information, and to prepare for group discussions and group reports in class. Therefore, PBL has very high requirements on the problems set by teachers.

Students in engineering schools often have a weak foundation in English. They lack interests in English learning because they feel a sense of separation between professional courses and English courses. Therefore, when setting pre-class questions, teachers should consider the particularities of students in engineering colleges and try to increase their interest in English learning. Teachers can integrate the appropriate content of the textbook with the students' professional courses so that students can feel that English is utilized in the

authentic contexts of their engineering fields. For example, when Hu used PBL to teach bilingual engineering electrical courses, he combined the "How" and "what if" sentence structures-such as: "How to imthth prove 'nature' pf", "What if C is serial with the load how to improve pf?" with the connection of electrical equipment [10]. Through this interesting way, students can learn new grammatical sentence patterns while consolidating their engineering expertise. In addition, teachers can also raise questions that are open enough and have no fixed answers. In this way, all members of the group will be attracted to discuss these questions from the very beginning and to operate as a team [11]. The questions can be such as: "What are the four major types of organic reactions? Please give some examples of each type."; "What are oxidation reactions? What are the differences between the oxidation reactions of alkenes and those of alkanes?" [12]

3.3. During the Class

3.3.1. Group Discussion and Group Presentation

If the pre-class preparation is well prepared, students should have their understandings of the problems raised by the teachers. During class, the teachers should let the members of the same group sit together so that they can express their opinions and explore their views and opinions on the questions raised by the teachers. Finally, the group leader and group members finalize or summarize the group's views on the problems raised by the teachers. Later, the teachers randomly select one person from each group and present the group's views and discussion results to the class. During the presentation, other students can ask questions to the student on display, and all other students in this group can answer. Through this way, a second discussion of the whole class can be formed. After the group presentation, the teachers can invite several students randomly to comment on the presentation just now and talk about whether they agree with the group's views. Then, they make a comprehensive comment on the group report. During the class, the teachers should not interfere excessively and interrupt the students' autonomous learning process, nor should they allow them to discuss and demonstrate without restrictions. During the discussion of the group, teachers should observe each group, and encourage some introverted students in the group to actively participate in the discussion. During group presentations, students who speak on stage should also provide help from the aspects of vocabulary, grammar, etc.

3.3.2. Class Speech

Although PBL teaching is student-centered, teachers also need to explain the courses programmatically.

First, teachers should carry out and analyze the supplementary problems in class, such as summarizing various methods of students and further explaining some of the problems raised by students. Second, teachers should correct the student's remittance English expressions for telling the time, guiding students to use blackboards, gestures, and facial expressions. Third, teachers should introduce students' skills of face-to-face communication and the control of emotions to make the teaching atmosphere better [10].

4. THE EFFECT OF PBL ENGLISH TEACHING ON SCIENCE AND TECHNOLOGY STUDENTS

There are many previous studies that have proved that the PBL teaching model in science and technology students' English classes can enhance their many abilities [12, 13, 15, 16]. In recent years, as English teaching based on PBL method has been widely used, there is been a growing number of related studies and investigations. The authors will review literature, focusing on summarizing the implications of PBL English teaching method on college student's personal skills, cooperation ability, learning motivation.

4.1. PBL's Effectiveness in Personal skills

Through many researchers' studies, we could see that PBL English teaching in science and technology universities can, to some extent, improve students' problem-solving ability, critical thinking, and research ability, etc.

According to Chen, Hung, and Yeh's study, they carried out an experience for using PBL teaching method in College English. It indicates that PBL can strongly enhance students' problem-solving ability through many evaluation indicators [12]. It uses a lot of statistical formulas to ensure their experimental whether accurate and rigorous or not. But this experience lacks generalisability, as they test most of the good English level students sampling without science and engineering students. GNA and Ny's demonstration of the way to use PBL learning in English for a specific purpose is beneficial to students to overcome difficult problems through collaborating and interpreting feedbacks [13]. Thus, using PBL method in English class is vitally important to students' problem-solving ability. Through this way, students who learn English can not only make progress in this course also master various ways of dealing with problems. Although the second experiment's sampling seems quite convincible and generable, it lacks sufficient data to support, meaning that the authors' subjective judgments may not necessarily be suitable for most occasions.

In terms of research ability, Zhu and Jin's observation that an excellent PBL English teaching class can improve

students' ability to search English literature and comprehensively deal with problems has been supported by a number of other scholars [14]. Similar to the formal one, this paper also lacks enough data analysis, which is not easy to convince. Li and Du's research explained why this happens. But only 43% of students in this research approve that PBL English class improve their writing skills [15]. He refers that writing skill is a comprehensive reflection of the level of English language and it is a long way to improve it. In other words, writing skills cannot be improved in just a few months or a single course [15]. Therefore, one of the challenges could be the data collection for researchers in this domain.

4.2. PBL's Effectiveness in Cooperation

According to many pieces of research related to English teaching among engineering and science students, we could draw a conclusion that students' ability of cooperation and creation has largely enhanced through the join in PBL class. Zhang and Yang refer that in the bilingual teaching mixed with PBL method on engineering students, their communications and cooperation ability between the group members who do not approach PBL method have an increasing improvement [16]. As PBL gives students the opportunity to present in class, presentation is based on teamwork. Thus they have to collaborate with each other. If they do not share their views in their groups or they just merely receive the knowledge taught in the teacher's classroom, the ability to work together and discuss in teams does not work out. Through this way, everyone participates in this project and everyone shares their views, no matter how influential of their view, it can really boost students' teamwork awareness.

Based on Zhang and yang's study, Amira and kaouthar argue that students have stronger confidence and willingness to speak English after carrying out an English course on engineering students with PBL teaching method [17]. And it also shows that PBL English teaching approach develops students' reciprocity and cooperation ability, which is according to the feedbacks from the students who attend this course. The reason why students become collaborative is mainly that all the problems and solutions come out themselves rather than teachers or textbooks. This gives them enough discussion and communication chances which gradually enable students to gain knowledge in a group-problem-solving environment. Different from Amira's study, Sukerti and Yuliantini use research method to analyze students' attitudes on PBL English learning for specific purposes [13]. The study also shows that students hold a positive attitude in this project and it helps them to acquire collaborative skills such as working together to complete the outline. Although the two studies' analyses seem reasonable, both of them are lacking adequate data analysis or evaluation metrics, which means that we can

only get feedbacks from participants but not effective and direct numbers. In a word, PBL is still effective in English teaching at engineering and technology universities.

4.3. PBL's Effectiveness in Motivation

In addition to the function of improving students' cooperating ability, previous research has also examined the effectiveness of the PBL teaching model on improving students' English learning motivation. Through a PBL teaching experiment in China University of Political Science and Law in one semester, Li and Du's demonstration of the link between learning motivation and PBL teaching method is interesting. The data related to students' feedback of this course found 72% of students believe that this PBL model is conducive to learning motivation [15]. On the one hand, through solving different kinds of problems, students can gain a sense of accomplishments in the English learning process and then turn into a learning motivation. On the other hand, since PBL's problem comes from the real situation and students are willing to adapt to the future working environment, they would be more engaged in the learning process [12][16]. Even if this effectiveness may be limited by a short of an experiment, it can still give some inspirations to PBL English teaching in science and technology universities.

Zhang argues that PBL can mobilize learners' interests and stimulate their motivations, initiatives, and agency in her PBL teaching design [18]. In the process of re-constructing knowledge, students are not passively accepting knowledge, but actively acquiring knowledge. It effectively enables students to complete the transition from passive reception mode to active discovery mode [19]. However, this is why PBL method can promote students' motivation. Although the result seems convincing and reliable, it still lacks sufficient data to explain his opinion.

5. THE REFLECTION OF PBL ENGLISH TEACHING

PBL produces better results compared with teacher-led language education. This teaching method should be highly implemented in the English education system, as it brings plenty of benefits to both students and teachers. However, there are still some problems when practicing PBL English teaching method. They are mainly divided into three aspects.

5.1. External and Internal Factors of Students' Learning

Many studies show that PBL requires students to devote much time and energy outside of class and arrange their time properly [11][21][20]. The reason why is that,

for one thing, PBL teaching method is not the same traditional one. In traditional teaching, the level of mastery and comprehension of English knowledge is relatively irrelevant to students' pre-class preview, as the teacher will teach knowledge from head to toe in class. But in PBL class, if students do not take the initiative to learn before and after class, it is difficult for them to achieve the expected teaching results and goals. For another thing, as self-learning, guidance, and evaluation are the innovation of PBL teaching, it is natural for students to maintain their learning status after class, and timely learning assessment. Therefore, Li and Du argue that PBL learning is a time-consuming process[15].

For the internal factor of students' learning, Self-efficacy is also an important point, which means the students who hold a higher level of self-learning would gain more in this class. Several researchers carried out a PBL English course in order to test students' study levels [17]. He argues that PBL teaching method requires self-learning ability, otherwise students would not have been able to learn knowledge in class. Similar to their study, Qing, Hong and Lang also mention that lack of awareness of independent learning, learning is more passive [20]. Therefore, the problem that troubled PBL teaching designer is that as the students are accustomed to traditional teaching methods, passive learning has become their pattern of learning. Future research is suggested to explore the solution of passive study under PBL teaching.

5.2. Teachers' Teaching and Management Skills

Apart from these problems in the implementation of PBL English teaching among students, there are still some drawbacks with teachers that need to improve.

First, teachers lack perfect and effective results evaluation. Yang and Zhang hold the view that the language, means, and evaluation subjects of evaluation are relatively poor and monotonous in the implementation of PBL teaching [16]. The reason is that the PBL English teaching method is a new way of teaching method introduced in Chinese universities. Owing to unfamiliarity with this method, teachers are just simply pursuing the lively scene of the classroom, but not giving students a timely evaluation in class or only giving a very general evaluation. These evaluations will not promote students' future English teaching. In other words, these evaluations are just letting students know the teacher is paying attention to them. In the future, teachers' evaluations should focus more on the process so that students can be evaluated in various different aspects. For example, making an evaluation scale can effectively evaluate students' learning levels in many aspects that the teacher wants to evaluate.

Second, PBL textbooks are underdeveloped. Qing, Hong, and Lang suggest that designing and integrating PBL content in future textbooks can, to some extent, reduce teachers' burdens [20]. However, the study is limited because of the time of curriculum development competencies. Developing a complete textbook not only has to consider students' needs, clarify the objectives of textbook writing, study the characteristics of textbooks, determine the principles of textbook writing and composition of textbooks [21]. It might be difficult for university English teachers to develop a textbook instead of teaching in class. It should be highly noted that the development of teaching materials needs to be adapted to local conditions. In other words, if the textbooks are too standardized, it will lead to a lack of innovation in PBL class. Thus, teachers should find ways to improve PBL teaching method to avoid teaching problems caused by excessive standardization of textbooks.

Thirdly, grouping ought to be reasonable. Zhang and Yang remark that unreasonable grouping such as a group with very top students and extremely low-level students will be unbalanced, which is disadvantageous for students' developments [16]. In practice, we found that students have different personalities and different problem-handling skills, if we categorize the students with the same competitive personality, it is easier to fight in this group than arranging both silent and competitive ones in a group.

6. CONCLUSION

The purpose of this paper is to review previous research about the application of PBL teaching method in science and technology universities. From a historical perspective, it seems that PBL has not been so widely adopted in the field of science and technology majored in English education, but it can be quite efficient through current research due to its creative processes.

The paper is divided into four sections: the first section is to give a brief introduction about the origins and development of PBL teaching method. The second section reviews a large quantity of literature on the implementation of PBL English teaching method in order to organize the proper way of this method, which factorizes into 3 steps. The third part makes a review of previous articles and experimental data to illustrate the effectiveness of PBL English teaching and the results show that it can largely enhance students' cooperation, motivation, and personal skills in English learning. The final section demonstrates the potential problems existing between teachers and students when conducting a PBL English class. And it is mainly because of students' inner personalities and teachers' teaching skills.

In a word, PBL English teaching method in science and engineering universities has great potential, even if researches in this field are relatively less now. Future

research is needed to confirm this novel finding in order to apply this method in more disciplines.

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