Research Trends of Blended Learning
for Engineering Disciplines in China and Abroad

Wei Zhang[(✉)]

Capital Engineering Education Research Center, Beijing University of Technology, Beijing,
China
weizhang@bjut.edu.cn

Abstract. Blended learning is developing rapidly in China and worldwide recently especially after the COVID-19 appeared. A lot of research has been conducted on blended learning, whereas it is still unclear for the research status of blended learning for engineering disciplines in China and abroad. Therefore, this paper has conducted the literature review on blended learning for engineering disciplines in China and abroad in order to provide references for the future research. The paper has also provided some discussions and suggestions for the future research in this field.

Keywords: Research trends · blended learning · engineering disciplines · China and Abroad

1 Introduction

Blended learning has been developed at a high rate of speed in recent years especially after the COVID-19 appeared in China and abroad. In engineering disciplines, blended learning has also been adopted to fit with the current situation and trends. This paper will explore the research trends in this field to provide references and suggestions. First of all, the core concepts will be introduced in this section.

1.1 Engineering Disciplines

According to the list of first-class disciplines published by the Ministry of education, excluding the engineering disciplines (such as nuclear science) with a small number of schools offering the discipline, the following disciplines are counted: Chemical Engineering, materials, environment, bio-medicine, machinery, instruments, optical engineering, power, mechanics, civil engineering, water conservancy, construction, electrical engineering, electronics, communication, control, and computer, with a total of 17 disciplines.

1.2 Blended Learning

There are many definitions available in the literature. In this research we apply the definition by the famous Chinese researcher He [1]: The so-called blended learning is to combine the advantages of traditional learning methods with the advantages of online learning, that is, it is necessary to give full play to the leading role of teachers in guiding, inspiring and monitoring the teaching process, and fully reflect the initiative, enthusiasm and creativity of students as the main body of the learning process.

2 Research of Blended Learning for Engineering Disciplines in China

According to the relevant research found on CNKI, the research on blended learning has appeared in China since the beginning of the 21st century. However, the research on blended learning for engineering has only begun to rise in recent years (2018–2022), most of which are the exploration and application research of blended learning in the context of engineering (such as Xie et al. [2]; Zhu et al. [3]; Xue et al. [4]; Wu et al. [5]; Zhang et al. [6]; Wang [7]). Research on blended learning of engineering disciplines in China could be divided into the following categories:

2.1 Introduction to the Blended Learning Mode Under the Background of Engineering

Such studies generally briefly introduce and analyze the advantages and disadvantages of blended learning used in the engineering environment. For instance, Huang et al. [8] studied blended learning mode driven by new engineering project immersion and competition. Song [9] examined blended learning of engineering majors under the MOOC background. Meng et al. [10] conducted research on online and offline blended learning mode of Engineering Mathematics under the big data background. Tu et al. [11] conducted research on blended learning of traditional practical training courses in engineering, etc.

2.2 Exploration and Application of Blended Learning Mode Under the Background of Engineering

This kind of research accounts for the vast majority of the existing research in this area: including the exploration, application and practice of the blended learning mode under the background of engineering disciplines. For example, Xu et al. [12] applied practice of blended learning in medical engineering courses. Xue et al. [4] explored blended learning in electrical and electronic technology courses under the new engineering background. Zhang et al. [6] applied blended learning in engineering professional courses under the MOOC background, and Wu et al. [5] explored and applied the reform of blended learning mode in microcomputer courses under the new engineering environment. Wang [7] conducted the "research and practice on blended learning mode of programming courses in application-oriented undergraduate colleges under the background of new engineering environment", etc.

2.3 Research on the Reform of Blended Learning Mode Under the Background of Engineering

This kind of research emphasizes the reform of the existing learning mode under the background of engineering, and introduces blended learning into the field of engineering from the perspective of reform. For example, Zhu et al. [3] conducted the research on blended learning reform based on OBE concept in the context of new engineering. Wang et al. [13] conducted the research on blended learning mode reform of "3D printing" engineering training course. Wu et al. [5] studied the learning reform of compilation principle course based on blended learning in the context of new engineering, etc.

3 Research on Blended Learning for Engineering Disciplines Abroad

Research on blended abroad began in the 1990s. As Frieden [14] *said, "blended learning"* has emerged with the emergence and development of the Internet since the 1990s. There has been a lot of research since the beginning of the 21st century. Research on blended learning of engineering also began at the beginning of the 21st century. These studies are mainly divided into the following categories:

3.1 Research on the Design of Blended Learning Under the Background of Engineering

Such research is mainly aimed at the design of blended learning in the field of engineering, such as Méndez & González's [15] designed the blended learning mode for control engineering course. Chiba et al. [16] designed the blended learning for embedded system engineering course, etc.

3.2 Research on the Application of Blended Learning in the Background of Engineering

This kind of research actually applies the blended learning mode and method to the engineering environment. For example, Cortizo et al. [17] applied the blended learning to the research and learning of engineering machinery coupling. Sivakumar et al. [18] applied the blended learning mode to engineering undergraduates, etc.

3.3 Evaluation on the Effect of the Blended Learning Under the Background of Engineering

There have been a lot of studies available on the evaluation of the effect of the blended learning in engineering abroad, such as the study of engineering courses by Szeto [19] which tested the effect of blended learning: comparing the experiences of online and face-to-face students and teachers, and the study of engineering graphics courses by Szeto [20] which explored community model as a teaching method: the effect of teaching, society and cognitive presences in blended learning, etc.

4   Discussions and Suggestions

To sum up, the research in China on blended learning of engineering is mostly about exploration and application, but there is still a lack of research in three aspects. First, there is a lack of evaluation and counter-measure research on the effect of blended learning of engineering. Second, there is a lack of the theoretical support in the relevant research. Third, there is a lack of research on comparative studies. Therefore, it is suggested that the future research can be carried out for the effect evaluation and counter-measure research on the blended learning of engineering, looking for sufficient theoretical basis in the research, finding problems and putting forward counter-measures, and filling the lack of comparative research in this field. Specifically, the future work in this area could be as follows.

4.1   Evaluation and Countermeasures Research of the Blended Learning Effect of Engineering

From the above literature review, it can be seen that there is still a lack of evaluation and countermeasure research on the effect of blended learning for engineering in China. Therefore, future research can make some preliminary exploration in this regard, and comprehensively evaluate and countermeasure research on the effect of blended learning for engineering from the subjective and objective perspectives. It can provide theoretical and empirical basis for relevant research academically. In practical application, it can provide guidance and reference for the development of blended learning for engineering in colleges and universities.

4.2   Sufficient and Innovative Theoretical Basis

It is suggested that more theories should be studied and applied in the future research. For example, according to the effect factor model of Shachar & Neumann [21], effect evaluation and countermeasure research should be carried out from four aspects: learning results, satisfaction, attitude and teaching evaluation. According to the "community inquiry model" initiated by Garrison et al. [22] and innovated and developed by the applicants, the research could also be conducted from the following three aspects: social presence, cognitive presence, and teaching presence. According to the "seven principles of high-quality undergraduate teaching" of Chickering & Gamson [23], the research could be carried out from seven aspects: enthusiasm, expectation, cooperation, interaction, feedback, diversity and time.

4.3   Comparative Studies Between China and Other Countries

Although many research has been conducted concerning the blended learning for engineering disciplines, there is still a lack of comparative research between China and other countries. The comparative studies will be beneficial because both China and abroad have their advantages and could be utilized by each other. There are more practices in China because nearly all the Chinese schools including primary school, middle school,

colleges and universities have utilized blended learning or online learning especially after 2020 when the COVID-19 disease appeared. However, there are more theoretical researches available concerning blended learning abroad. For example, one of the most popular theories for blended learning has been developed for more than 20 years since its first proposed by Garrison et al. [22], that is the Community of Inquiry Model. However, the research about Community of Inquiry Model has been just started in recent years in China. Therefore, the author would suggest to study the blended learning in Chinese practices based on the international theories, which could be a prospective research direction.

5   Conclusions

This paper has reported the research of blended learning for engineering disciplines in China and abroad. In conclusion, the research in China mainly lies in three aspects: introduction to the blended learning mode under the background of engineering, exploration and application of blended learning mode under the background of engineering, and research on the reform of blended learning mode under the background of engineering. And the research abroad mainly lies in: research on the design of blended learning under the background of engineering, research on the application of blended learning in the background of engineering, and evaluation on the effect of the blended learning under the background of engineering.

The discussions of the research and the suggestions for future research are provided in the paper as well, with the most frequently mentioned suggestions in conclusion: To apply the international mature theories into the Chinese practices so that the China-oriented theory is developed and the future practices are optimized. It is hoped that this study could be taken as a reference for the future research in this field.

Although there are still limitations of this research such as there are too many research in this field, for which the paper could not examine all the research available, whereas the paper could definitely provide some references and it is hoped that the suggestions of the author could be employed and achieved in the near future.

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