Investigation on the Online-Offline Combined Instruction of Theoretical Mechanics

Xiaohong Wang(✉)

Department of Mechanics, School of Science, Beijing University of Civil Engineering and Architecture, No. 15 Yongyuan Rd., Daxing District, Beijing 102616, China
wangxiaohong@bucea.edu.cn

Abstract. Mechanics is an ancient discipline which deals with the state of rest or motion of bodies that are subjected to the action of forces. The rapid development of Internet and information technology has made it possible for college lecturers and professors from various fields to take advantage of the merits of the technology in their class teaching activities. A great deal of online learning platforms has emerged gradually and have been used in many universities. "Internet+ Education" attracted more and more attention and has been recognized in higher education. This work can be considered as a new exploration in teaching practice. We used Chaoxing Learning Platform as a teaching tool. Online-offline combined instruction of theoretical mechanics was made for a part of students in school of civil engineering. An overall plan of online-offline combined instruction was developed. Teaching evaluation was performed and compared with traditional offline teaching. We found that students chosen to be under the combined instruction showed more positive attitude and better academic performance. They also did better job in knowledge expansion and transfer after class.

Keywords: Theoretical mechanics · online-offline combined instruction · Leaning platform · Information technology · Internet

1 Introduction

Mechanics is an ancient discipline that has a history of more than 2000 years. It deals with the state of rest or motion of bodies that are subjected to the action of forces. Like most of the theories, mechanics has originated from practice and in turn serves our everyday live. The theory of mechanics is closely integrated with reality, well, at the same time highly systematic and logical. Therefore, it is extremely important for college students majored in engineering to spend much time and energy studying it. It is worth noting that some students find that it is very difficult to understand all the theories well.

The rapid development of Internet and information technology has made it possible for college lecturers and professors from various fields to take advantage of the merits of the technology in their class teaching activities. A great deal of online education and learning platforms have emerged gradually and have been used in many universities. The findings of present researchers showed that the internet-based educational platforms have

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brought better results in Engineering Education [1]. Zhao investigated online teaching in Guangdong-Hong Kong-Macao Greater Bay Area [2]. Based on artificial intelligence technology, Zhao et al. constructed the display education resource management system [3]. Li et al. presented a teaching practice of the application of Rain class platform in the teaching of systematic anatomy for undergraduate students [4]. Moreover, Wang et al. found that online-offline hybrid teaching could improve teaching effect significantly [5].

Chaoxing Learning Platform was recommended by Ministry of Education of China during the COVID-19 period. And then in the post-COVID-19 era, it has been used by more and more universities and colleges. It is designed as a professional terminal learning platform for smartphones, tablet computers as well as other mobile terminals users. "Internet+ Education" attracted more and more attention and has been recognized in higher education. This work can be considered as a new exploration in teaching practice. We used Chaoxing Learning Platform as a teaching tool. Online-offline combined instruction of theoretical mechanics was made for a part of students in school of civil engineering. An overall plan of online-offline combined instruction was developed. Teaching evaluation was performed and compared with traditional offline teaching. We found that students chosen to be under the combined instruction showed more positive attitude and better academic performance. They also did better job in knowledge expansion and transfer after class. The coming of information age is changing our education and learning models profoundly. We believe that the combined online-offline instruction model of theoretical courses like mechanics may promote a comprehensive development of students' abilities.

2 Methods and Tools

2.1 The Overall Plan of Online-Offline Combined Instruction

The final expectation of the teaching activity is to meet the regulations written in the teaching program. Therefore, no matter what type of instructions (online, offline or combined) is employed in the practice, university lecturers and professors should achieve the final goal. Online-offline combined instruction is not the simple integration of online courses and traditional classroom teaching. Rather, it is an organic and optimized combination of the two distinctive instructions. According to the advantages of the two distinctive instructions, and also based on the content of the course of theoretical mechanics, suitable and corresponding ways of instruction were employed and presented in this work in order to achieve maximum effect.

The overall plan of online-offline combined instruction flow chart is shown in Fig. 1. In order to construct a new space for teaching and learning, class hours should be divided rightly. The time assigned to online study and discussion is no less than 1/4 of the total class hours of the theoretical mechanics course. On one hand, the combined instruction let the students go into the classroom with online preview of the knowledge and questions. On the other hand, the instructors can adjust teaching progress, example selection, and difficulty level according to the students' feedback in time. Formative assessments as well as questionnaires were assigned during the semester. Quantitative feedback was obtained quickly. Effective interaction between teaching and learning can be achieved.

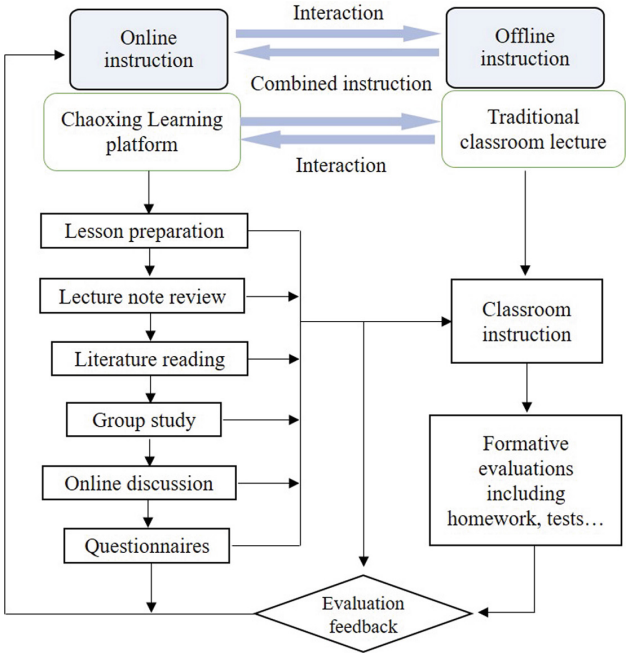

Fig. 1. Overall plan of online-offline combined instruction flow chart.

2.2 The Application of Online Learning Platform and Tools

Chaoxing learning platform was chosen to be the online teaching and learning medium. Users can carry out the preparation and review of the course. They can also look over the animations and short videos that revealed the general principles of theorical mechanics at their convenience. Moreover, the lecture notes of each chapter were uploaded to the learning platform for the students. Focus group discussions were conducted whenever and wherever possible. The instructors released tasks of each stage. Furthermore, the learning platform provided possibilities for students who had the abilities to learn more. They searched for digital resources, glanced over the latest information and literature metadata on theoretical mechanics, cultivating students' scientific spirit. Active participation in every segment of the combined instruction of this course were encouraged for the students. The total mark of a student involved in the combined instruction included many segments as shown in Fig. 2.

3 Results and Discussions

3.1 Online-Offline Combined Instruction Requires Comprehensive Quality of the Instructors

Obviously, the combined instruction altered many aspects of the traditional one. For example, students can glance over the digital resources on theoretical mechanics they are interested in anytime and anywhere. In addition, online study met the individual

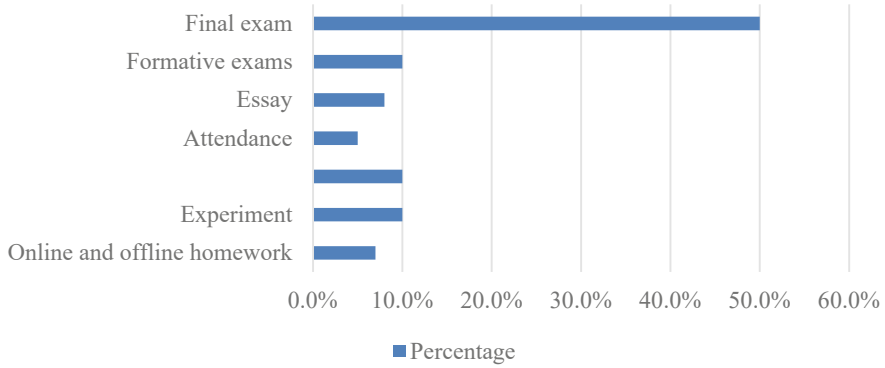

Fig. 2. Score allocation for online-offline combined instruction of theoretical mechanics course.

demand of the student to the utmost extent. Furthermore, the combined instruction made higher demands on the instructor's teaching skill, professional competence, ability of engineering practice and knowledge on information technology [6–10]. It meant more devotion for the instructors.

Most students prepared and reviewed their lessons, and participated in the discussions. Online and offline instructions have their respective merits. One of the distinguish advantages of traditional teaching is the instructors could see the students' real expression and feel their emotion in time. Online or combined instruction, in some degree, allowed students to progress at their own speed and interests, for it usually had rich content and repeatably after class. We had them combined, and made best use of them. Finally, we try to let students have the courage to solve specific mechanical problems in engineering as well as daily life in the future.

3.2 The Formative Assessment Results of Two Groups of Students in Different Stages of the Semester

The investigation showed that students involved in the combined instruction had marked difference in many aspects including on time submission rate of the assignments, attendance rate, mid-term exam pass rate, optional task participation rate and essay excellence rate compared with the other group of students. The corresponding data of the two groups of students were compared. The results were presented as histograms (See Fig. 3).

In this investigation, we also calculated and compared the sample variation of the two groups of students. The formation was defined as

$$S^2 = \frac{\sum_{i=1}^{n}\left(X_i - \overline{X}\right)^2}{n-1} \tag{1}$$

in which S^2 represented the sample variation of final score of two groups of students. X_i denoted random variable which was the final score of each student. $\overline{X}$ was the sample average. n was the total number of the cases. Results showed that combined instruction group had smaller sample variation than the other group. It implied that students in the

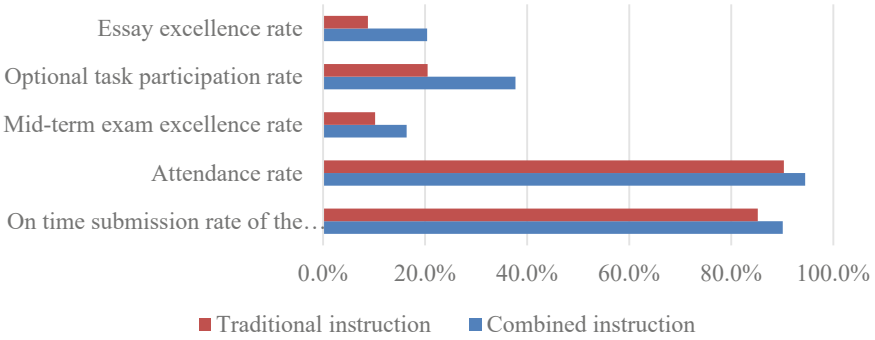

Fig. 3. Comparison of two groups of students in on time submission rate of the assignments, attendance rate, mid-term exam pass rate, optional task participation rate and essay excellence rate during one semester.

combined instruction group had smaller fluctuations in the final scores. It illustrated that students received online-offline combined instruction showed no trend of polarization.

4 Conclusion

The online-offline combined instruction emphasized on engineering practice and comprehensive ability of theorical mechanics. The combined instruction improved class participation rate of all students. Positive teacher-student interaction took place in online platform as well as offline classroom. What's more, the program contents, instruction methods could be recorded and adjusted according to the students' feedbacks. We believed that these data will be helpful to similar courses in the future.

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References

1. Martinez-Mediano, C., Rioperez Losada, N., (2017) "Internet-Based Performance Support Systems in Engineering Education," Revista Iberoamericana de Tecnologias del Aprendizaje, 12: 86-93. doi:https://doi.org/10.1109/RITA.2017.2697778.
2. Zhao, F., (2023) "Investigation and Analysis of Online Teaching in Guangdong-Hong Kong-Macao Greater Bay Area," 3rd International Conference on Intelligent Computing and Human-Computer Interaction, 2022, Guangzhou, China. 12509.
3. Zhao, H., Zhang, X., Wang, C., Yuan, W., (2022) "Classification Method of Aerobics Course Online Teaching Resources Based on Artificial Intelligence Technology," Wireless Communications and Mobile Computing, 2022. doi:https://doi.org/10.1155/2022/8915705.

4. Li, Q., Wu, Y., Jiang, H., Huang, W., Xuan, A., (2021) "The Application of Rain class in the Teaching of Systematic Anatomy of Undergraduate Students," 2nd Asia-Pacific Conference on Image Processing, Electronics and Computers, Dalian, China. 658-661. doi:https://doi.org/10.1145/3452446.3452606.
5. Wang, J., Lu, W., Zhang, W., Gu, C. (2022) "Exploration and Practice on the Reform of Online-online-offline Hybrid Teaching Mode under the Background of Informationization, " 3rd International Conference on Education, Knowledge and Information Management, Virtual, Online, China. 33-36. doi: https://doi.org/10.1109/ICEKIM55072.2022.00015.
6. Daling, L.M., Khoadei, S., Kalkofen, D., Thurner, S., Sieger, J., Shepel, T., Abdelrazeq, A., Ebner, M., Ebner, M., Isenhardt, I., (2022) "Evaluation of Mixed Reality Technologies in Remote Teaching, " Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics), 13329: LNCS, 24-37. doi:https://doi.org/10.1007/978-3-031-05675-8_3.
7. Lithoxoidou, A., Dimitriadou, C., (2021) "Teaching Strategies to Promote Critical Thinking Skills in an Online Learning Environment," 2nd International Conference on Technology and Innovation in Learning, Teaching and Education, TECH-EDU. Virtual, Online. doi: https://doi.org/10.1007/978-3-030-73988-1_13.
8. Lambie, I., Law, B., (2020) "Teaching online during a pandemic: Pedagogical skills transfer from face to face support to online synchronous support provision," 19th European Conference on e-Learning, ECEL, Berlin, Germany.270-277. doi:https://doi.org/10.34190/EEL.20.063.
9. Farkhadov, M., Vaskovsky, S., Nadeinsky, L., (2017) "Interactive online learning, E-education platform with multimedia computer technologies and internet-based laboratories," 5th International Conference on Control, Instrumentation, and Automation, ICCIA, Shiraz, Iran. 212-215. doi:https://doi.org/10.1109/ICCIAutom.2017.8258680.
10. Gao, Y., (2014) "The design for the framework of internet-based interactive distance education platform," 6th International Conference on Measuring Technology and Mechatronics Automation, ICMTMA 2014. Zhangjiajie, Hunan, China. 684-687. doi:https://doi.org/10.1109/ICMTMA.2014.169.2014.