Influences of Problem-Based Online Learning on the Learning Outcomes of Learners

https://doi.org/10.3991/ijet.v18i01.36705

Chi Zhang(✉)
School of Economics and Management, Huanghuai University, Zhuamdian, China
20121261@huanghuai.edu.cn

Abstract—Influenced by the COVID-19 pandemic, online learning has become a major learning mode for most university students in China. For high-quality online teaching, teachers must optimize the teaching mode and strengthen the enthusiasm of students in classroom learning. In this study, a comparative experiment was carried out based on the course *Cross-border E-commerce Customer Services* for sophomore E-commerce majors at Huanghuai University in Zhumadian City, Henan Province, China. In the experiment, the teaching effect of the problem-based learning (PBL) mode in higher education was verified and gender differences in learning outcomes of learners who accepted PBL were analyzed. Results showed a significant difference at the 0.01 level between pre- and post-test results of the experimental group ($t = -11.367$, $p = 0.000$), proving the teaching effect of PBL. The academic performances of the experimental class are significantly better compared with those of the control class, indicating that PBL is more beneficial to improve learning outcomes of students than traditional teaching methods. Gender has significant influences on post-test results at the 0.01 level ($p = 0.002 < 0.01$). The median of final exam scores of male students is obviously higher than that of female students. Research conclusions can provide important references to test the effectiveness of PBL in learning outcomes of a specific subject, construct a PBL mode that can promote deep learning, and facilitate development of university teaching from knowledge teaching to core quality training of students.

Keywords—online teaching, teaching mode, learning outcome, paired sample T-test, independent sample T-test

1 Introduction

The updating and development speeds of knowledge are far higher than the acceptance speed of people. Internalizing and applying knowledge in a short period is often difficult for learners. Given that life is surrounded by various types of fragmented and entertainment information, gaining a deep understanding of knowledge is even more difficult for the student group. Most students only have a superficial understanding. To develop good self-study habits through independent learning, university students need to use diversified learning strategies positively under the effective guidance of teachers, develop complete critical thinking and problem solving ability, train the

consciousness of cooperation and exchange, and emphasize individual enthusiasm in reconstruction of new and old knowledge, thereby developing learning habits with high-order thinking ability and achieving deep understanding and effective migration. However, the traditional simple exam-oriented education mode can no longer meet students' needs for life and comprehensive quality improvement. The traditional teaching modes have long been centered on teachers, so that they have been put in a passive learning position. Teachers have single teaching methods instead of providing effective teaching according to the learning needs of learners, and they pour teaching contents into students repeatedly. How to make students develop and improve their independent learning ability truly is key to current teaching reform in disciplines in universities. One important university teaching goal and requirement is to further develop and improve the independent learning ability and learning outcomes of students.

PBL is a mode that is centered on learners and guided by problems. Introducing PBL into teaching activities in universities is critical for its many obvious advantages compared with traditional teaching methods. PBL advocates that students focus on problems during learning activities. Students can collect relevant information, review, screen, and discuss the collected information in a group, and finally develop solutions to their problem. PBL is more conducive to developing the independent learning enthusiasm of students fully. PBL is centered on problems and students are asked to think about the problem and discuss it with a group. Students may take the initiative to seek solutions in this process, thus strengthening their learning interests and increasing their learning initiation. Through the scenarios of well-designed practical life problems, PBL helps learners in ways and methods to find solutions during self-study from perspectives such as guess hypothesis, scheme design, experimental exploration, data analysis, summarization and exchange, and reflection. Moreover, the goal and philosophy of PBL are highly consistent with deep learning. Therefore, a series of targeted measures to improve teaching activities in universities and suggestions to improve independent learning ability of university students were proposed based on comparative analysis of the teaching effect of the PBL mode, enabling an increase in the overall teaching level of universities.

2 Theoretical basis and hypotheses development

2.1 Theoretical basis

PBL theory was proposed by Hmelo-Silver, C. E [1], who believed that PBL mainly includes teachers' careful selection and design of problems, learners solving the problem through critical thinking, and developing independent learning ability and team cooperation skills. PBL is viewed as a teaching method that can help learners to acquire methods, thinking, and ability to solve problems in the learning process. PBL combines the problem-based teaching of teachers and problem-based learning of students and views problems as the source of learning. Students cooperate, explore, and complete learning contents independently. A PBL mode that can improve students' ability is different from traditional teaching. PBL is a teaching mode based on problems, centered on students, and implemented by group cooperation. PBL highlights the dominant role

of students, while teachers are responsible for supervising and facilitating learning of students as guiders and organizers of students' learning activities, and they play an important role in stimulating the enthusiasm of students in learning. PBL also emphasizes putting learning in complicated and meaningful real problem scenarios, in which students find the learned contents and choose and use knowledge and methods of multiple aspects to solve the practical problem, thereby establishing the knowledge system successfully. In the teaching process, PBL advocates group cooperation positively and makes reasonable grouping according to students' requirements for individual development. Given the ability and interests of students, PBL assures consistent inter-group level and encourages team members to communicate and discuss mutually, exhibit and report on the lesson, and finally make summaries and evaluations. PBL stimulates students to explore and innovate around problems continuously by setting the problem scenarios, thereby causing obvious influences on deep learning of learners.

2.2 Hypotheses development

PBL plays a very important role in the international education and teaching field. The primary effect of PBL is that it helps students in strengthening their thinking about structural problems. Based on this thinking process, students solve existing problems using divergent thinking and previously learned knowledge. Studies on how PBL influences the learning outcomes, motivation, and learning strategies of learners are introduced as follows. Qomariyah, S. N [2] carried out a comparative study on 80 students from two classes by using a quasi-experiment. Results showed that PBL and traditional modes had some influences on learning outcomes, but the influences of the former were significant. Belland, B. R et al. [3] analyzed results of PBL in 33 empirical studies and found that whether PBL influenced learning outcomes was related with sample size and experimental method to a certain extent. Distlehorst, L. H et al. [4] carried out comparative experiments of students from nine graduating classes in the School of Medicine, Southern Illinois University, and found that PBL teaching helped students to obtain better clinical performances and caused significant differences in medical knowledge accumulation, clinical reasoning, and non-cognitive behaviors. Preeti, B et al. [5] believed that PBL is an effective, coherent, comprehensive, and concentrated education approach. He implemented a questionnaire survey to 72 medical students from Ludhianada Dayanand Medical College and hospital. Results showed that PBL could facilitate independent subject learning and guaranteed a better ability in practice learning and interest in innovation. Wong, D. K. P et al. [6] carried out a comparative experiment on 132 sophomores majoring in social work who attended social work theory and practice and skill laboratory core courses under PBL. Results demonstrated that PBL teaching could improve students' cognition of social work knowledge, skills, and values. Steele, D. J et al. [7] carried out a comparative analysis of influences of Web-based PBL teaching on learning outcomes of students. Results showed that using PBL technology had positive effects on academic performances of students. Mulyanto, H et al. [8] carried out an experimental study on 309 students and found significant differences in math learning outcomes among students using PBL and the traditional learning mode. Prosser, M [9] pointed out that differences among students in cognition

and understanding of PBL are vital to their learning methods and outcomes. Timor, A. R et al. [10] carried out a comparative experimental study on 29 medical students and found that PBL had very obvious influences on learning outcomes and learning motivation. Dupri, D et al. [11] found that PBL could increase cooperation among students obviously and also improved learning outcomes significantly. The comparative experimental results of Khusaini, K et al. [12] showed that learning outcomes of students using PBL had significant differences from those of students using traditional method. PBL increased learning motivation of students. Reinsini, C. E et al. [13] pointed out that using PBL could significantly improve learning outcomes of students in basic repairing ability of a braking system. Based on at least 20 studies since 1990, Albanese, M. A et al. [14] introduced how PBL influences learning outcomes of students majoring in a medical department. Stentoft, D [15] pointed out that PBL is a teaching method that fully supports interdisciplinary learning in higher education, and it is conducive to improve students' potentials in interdisciplinary learning. Khatiban, M et al. [16] compared effects of PBL and traditional clinical education. Results showed that comprehensive ability and unique ability of students using PBL were improved significantly more compared with students in the control group. PBL trained ability, attitude, and performances of nursing students. Goni, A. M et al. [17] analyzed influences of PBL on learning outcomes of Grade 4 students. Results showed that after PBL teaching, math learning outcomes of students were improved obviously. Miller, S. K [18] analyzed differences in performances and satisfaction of pharmacological students who adopted PBL compared with traditional teaching mode. Results showed that both modes might be course teaching methods with the same effectiveness. Aslam, L. K et al. [19] concluded that PBL could obviously facilitate improvement of skills of learners. Utami, I et al. [20] applied PBL to teaching basic skills of volleyball passing, finding that in the first cycle, PBL increased the number of students skilled in passing. Winning, T et al. [21] found that PBL can provide an incentive learning environment, promote comprehensive learning, encourage systematic patient management methods, and develop independent learning skills. AlHaqwi, A. I [22] conducted a questionnaire survey of 174 undergraduates in medical school and found that PBL had positive effects on the development of their cognitive, individual, and team cooperation abilities. Teachers were recommended to be equipped with professional knowledge about contents and process, so that learners can easily obtain the best outcomes from PBL. Dharma, I. M. A et al. [23] conducted a comparative analysis of 68 students from two schools by using one-way analysis of variance (ANOVA) and multivariate ANOVA analysis. Test results indicated that PBL improved students' ability in understanding the theme easily and quickly during the learning process and it had some influences on learning outcomes in social studies and critical thinking ability of students. Hmelo-Silver, C. E et al. [24] found that PBL could decrease cognitive loads of learners and allow students to improve their content knowledge, cognitive practices, cooperation, and independent learning ability in complicated fields. McPhee, A. D [25] introduced the development of PBL and some of its applications and introduced possible uses of PBL in this field.

Our literature review indicates that the procedure of PBL has been extensively approved and used in developed countries, such as those in Europe and America. A consensus shows that PBL not only achieves good teaching effect but also improves independent learning ability of students significantly and trains creativity, practice

ability, cooperative spirit, and communication ability of students, and finally improving their academic performances obviously. Additional studies have proved through comparative experiments that PBL is an excellent teaching method and has outstanding teaching effects. Given that PBL emphasizes the dominant role of students in learning activities compared with the traditional learning mode, the classroom is returned to students and it fully motivates the subjective initiative of students, so that students improve their comprehensive quality in analyzing and solving problems. Using PBL in specific subjects can facilitate learning of students effectively. However, comparative experiments about PBL and learning outcomes might arrive at different research conclusions in different subjects (e.g., physics, chemistry, geography, Chinese, history, and biology).

3 Methodology

3.1 Experimental objects

To test the effects of PBL on learning outcomes of learners, an experiment of *Cross-border E-commerce Customer Services* for sophomore E-commerce majors was carried out. Two groups were set: the experimental group that used PBL and the control group that used the traditional teaching method. Students of both groups were collected from Huanghuai University in Zhumadian City, Henan Province, with an average age of 20.3. There were 28 males and 12 females. To assure an average homogeneous level of students in these two groups, all students had a mid-term exam in *Cross-border E-commerce Customer Services* before the official implementation of the experiment. Male and female students were grouped uniformly according to test results. The experimental group (one class) and control group (one class) each had 20 students. The differences between the experimental group and the control group in terms of means of various items did not reach statistical significance. Both groups were homogenous. This experiment eliminated influences of physical and psychological conditions of students and assured authenticity and reliability of experimental results.

3.2 Experimental steps

First, two classes were grouped. The mid-term exam scores (covering weeks 1–8 of the course) were used as pre-test results for an independent sample-T test. Pre-test results showed no significant difference. In other words, the classes with equilibrium levels were used as experimental and control classes thus determining the experimental and control groups, respectively. In the second half of the learning period (weeks 9–16), teachers adopted PBL officially with the experimental group, while the control group continued to use the traditional teaching method. Subsequently, all students had a final exam and their final exam scores were used as the representative of learning outcome measurement. Later, a statistical analysis was conducted and a comparison test between the experimental group and the control group was implemented. The final exam scores were used as the post-test results for independent sample-T test, whose results were used to verify the effectiveness of PBL. To assure accuracy of experimental results, the author controlled disturbance factors that may influence experimental effects uniformly before the experiment, such as teachers, teaching duration, and homework.

4 Results analysis

4.1 Comparison of pre-test results between experimental and control groups

The author set experimental and control groups, on which the PBL and traditional teaching modes were applied, respectively. This requires students of two groups to maintain a homogenous independent learning ability before the experiment to eliminate influences of students' differences in experimental results. The pre-test results (mid-term exam scores, weeks 1–8) of students were compared before the experiment.

Table 1. Pre-test T-test

	Groups (mean ± standard deviation)		t	p
	Experimental Group (n = 20)	Control Group (n = 20)		
Pre-test results	65.75±2.79	64.75±3.13	1.067	0.293

Note: *p < 0.05, **p < 0.01.

Table 1 shows that differences between the experimental group and the control group in terms of mean of various items not reaching reached statistical significance according to the T-test of pre-test results. In other words, the P value was higher than 0.05. Both groups were homogenous, enabling the elimination of disturbances of physical and psychological conditions of students on experimental results. This laid a solid foundation to guarantee objectivity of experimental results.

4.2 Pre-test and post-test paired sample T-test

Table 2. Paired sample T-test results

Name	Pairing (mean ± standard deviation)		Difference (Pair 1 − Pair 2)	t	p
	Pair 1	Pair 2			
Pre-test results of experimental group + post-test results of experimental group	64.35 ± 2.52	81.30 ± 6.04	−16.95	−11.367	0.000**
Pre-test results of control group + post-test results of control group	65.85 ± 2.68	74.85 ± 4.32	−9	−9.096	0.000**

Note: *p < 0.05, **p < 0.01.

Table 3. Effect size indexes of paired sample-T test

Name	Mean Difference	Difference 95% CI	d*f*	Difference Standard Deviation
Pre-test results of experimental group + post-test results of experimental group	−16.95	−20.071–−13.829	19	6.669
Pre-test results of control group + post-test results of control group	−9	−11.071– −6.929	19	4.425

Generally, differences in experimental data were investigated by paired T-test. Tables 2 and 3 show that the paired T-tests between the pre-test results and post-test results of the experimental group all indicated differences ($p < 0.05$). The difference between pre-test results and post-test results of the experimental group was significant on the 0.01 level ($t = -11.367$, $p = 0.000$). According to a detailed comparison of differences, the mean pre-test result of the experimental group (64.35) was significantly lower than the post-test result (81.30). Paired data all presented differences, indicating that PBL improved final-exam scores of the experimental group significantly. This is mainly because PBL increased the real effective teachers–students interaction and students–students interaction in the online classroom. PBL also brought diversified teaching methods for online teaching and stimulated learning efficacy of students. Students can show more active, positive, and engaged learning state than in a traditional classroom, and their learning outcomes are relatively obvious.

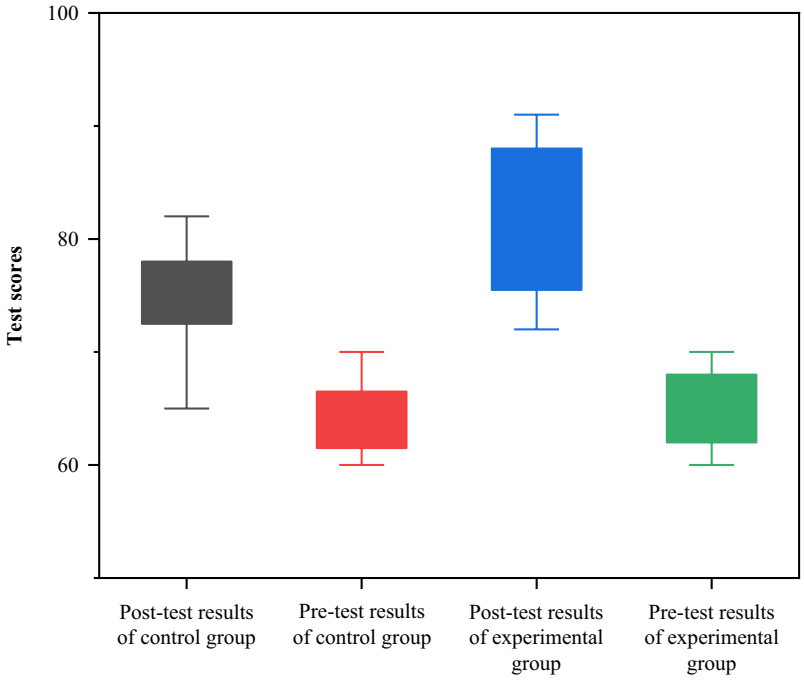

Fig. 1. End-of-term scores of the experimental group were compared before and after

Figure 1 shows that after the final-exam scores of the experimental group were compared with the mid-term results, the average scores improved significantly. This indicated that PBL is an effective teaching method and it at least assured no negative effects on final-exam scores of students. On this basis, horizontal comparison of final-exam scores between the experimental and control groups was further carried out. The final-exam scores of the former were higher than those of the latter, but such a difference did not show statistical significance. This might be because teachers have used PBL for a short period (only for a half-semester, from weeks 9 to 16), thereby failing to develop

its effects fully. The positive effect of PBL mode on academic performances of students is also influenced by other extra variables. PBL could effectively facilitate the independent learning ability of students. Such improvement in independent learning ability is not directly equal to improvement in academic performances. The academic performances of students are obviously influenced by extra student factors such as individual knowledge basis, intelligence conditions, and degree of preparation for the exam.

4.3 Covariance test

Table 4. Covariance analysis results

Difference Source	Quadratic Sum	d*f*	Mean Square	F	p
Intercept	33627.992	1	33627.992	1804.997	0.000**
Groups	476.1	1	476.1	25.555	0.000**
Gender	394.971	1	394.971	21.2	0.000**
Residual	689.329	37	18.631		

Note: *p < 0.05, **p < 0.01.

Table 4 shows that gender was included in the model as a covariable for the covariance analysis to study the influences of PBL on post-test results and prevent disturbances of other factors on the model. Obviously, gender has influences on academic performances. This might be because male students are more interested in professional knowledge requiring manual operation when learning E-commerce, making them significantly better than female students.

Table 5. Non-parameteric test results

	Gender, Median M (P25, P75)		Mann–Whitney Test Statistical U-Value	Mann–Whitney Test Statistical z-Value	p
	Males (n = 28)	Females (n = 12)			
Post-test results	80.000 (75.0,86.0)	73.500 (72.0,76.8)	64.5	−3.067	0.002**

Note: *p < 0.05, **p < 0.01.

Gender differences in one item of post-test results were investigated by a non-parametric test. Table 5 shows that the Mann–Whitney statistical analysis was used investigate differences between two gender groups (1.0, 2.0). Different gender samples all showed significantly different post-test results ($p < 0.05$). According to specific analysis, p value of gender to post-test results was significant at the 0.01 level ($p = 0.002 < 0.01$). According to a specific comparison of median differences, the median of final-exam scores of male students (80.000) was far higher than that of female students (73.500). According to the summary and analysis, Mann–Whitney statistical analysis was applied. Results showed that different gender samples showed significant differences in post-test results. This might be because learning efficacy of female students in the course was poor and they easily accumulated learning fatigue. This conclusion also inspires university teachers to consider gender differences for

relatively difficult subjects and even explore teaching reform of "one student, one scheme" to improve learning outcomes of female students in engineering courses.

5 Discussions

In this study, the influences of PBL on academic performances of students were investigated through comparative analysis between pre- and post-test results of the experimental group. Results showed that PBL improved academic performances of the experimental group significantly. This is enough to prove that such a new teaching mode can improve the academic performances of students significantly. Possible reasons for this ability are as follows. PBL emphasizes the dominant role of students and stimulates their learning enthusiasm. Teaching E-commerce for undergraduates has long applied the cramming teaching mode. Such a traditional teaching model often centers on teachers. It starts with teachers in the teaching process and controls each link of the teaching process but puts students in the role of passive knowledge receivers. Psychological states of students, such as initiative and enthusiasm, are not the core problems of concern in the whole teaching activity. The primary task of the teaching process is to realize the teaching objective. The spirits of exploration and curiosity students are compressed and ignored. PBL mode changes such a situation. Students again become the subject of teaching activities. They are supported and encouraged to learn positively and actively and develop their own ability to solve learning problems that teachers set for them. In this process, the enthusiasm and initiative of students are respected highly. By solving pre-setting problems, students show their ability in problem solving, experience realization of individual values, further stimulate their interests in independent problem solving, and extend such emotions consciously to activities out of the classroom. Thus, space is created to further develop the independent learning ability of students. Final-exam scores of students are also an important index to measure the teaching effect of a new teaching method. In this experiment, the average academic performances of the experimental group have been improved significantly, indicating that PBL is an effective teaching method. The researcher further carried out a horizontal comparison of academic performances between the experimental and control groups and found that the final-exam scores of the former were higher than those of the latter. However, such a difference did not reach the statistical significance level possibly because the external validity of research conclusions was relatively low due to the small sample size. The PBL mode was also used for a short period (only for a half-semester) and the teaching effect of PBL mode had not yet been developed fully. However, academic performances of students are obviously influenced by extra student factors such as individual knowledge basis, intelligence conditions, and degree of preparation for exams. These variables will be considered and controlled in future studies.

6 Conclusions

China's higher education is facing opportunities and challenges of online learning in the background of the COVID-19 epidemic. Owing to rapid scientific and technological development, teachers are empowered to make innovations in education mode, drive changes in classroom teaching, and update philosophies of education and

teaching modes. These are important directions to improve online teaching effects. PBL establishes the corresponding learning scenario based on real-world experience and advocates student-oriented teaching. PBL is a way to provide teaching activities around core problems. It can effectively solve the physical spatial separation problem between teaching and learning in online learning and improve the learning efficacy of learners. In this study, a comparative experiment was carried out based on the course *Cross-border E-commerce Customer Services* for sophomore E-commerce majors at Huanghuai University in Zhumadian City, Henan Province, China. Results show the following. (1) The difference between pre- and post-test results of the experimental group is significant at the 0.01 level ($t = -11.367$, $p = 0.000$). (2) Academic performances of the experimental group are significantly better than those of the control group, indicating that PBL is more beneficial to improve learning outcomes of students than traditional teaching methods. (3) Significant gender differences are observed in post-test results ($p = 0.002 < 0.01$). The median of final-exam scores of male students is far higher than that of female students. Suggestions for future researchers include expanding the research scope, research levels, and research object types of PBL teaching experiments.

7 Acknowledgment

This study was supported by the Key Scientific Research Projects of Henan Province Colleges and Universities (23A630036).

8 References

[1] Hmelo-Silver, C. E. (2004). Problem-based learning: What and how do students learn?. Educational Psychology Review, 16(3): 235–266. https://doi.org/10.1023/B:EDPR.0000034022.16470.f3

[2] Qomariyah, S. N. (2019). Effect of problem based learning model to improve student learning outcomes. International Journal of Educational Research Review, 4(2): 217–222. https://doi.org/10.24331/ijere.518056

[3] Belland, B. R., French, B. F., & Ertmer, P. A. (2009). Validity and problem-based learning research: A review of instruments used to assess intended learning outcomes. Interdisciplinary. Journal of Problem-based Learning, 3(1): 59–89. https://doi.org/10.7771/1541-5015.1059

[4] Distlehorst, L. H., Dawson, E., Robbs, R. S., & Barrows, H. S. (2005). Problem-based learning outcomes: the glass half-full. Academic Medicine, 80(3): 294–299. https://doi.org/10.1097/00001888-200503000-00020

[5] Preeti, B., Ashish, A., & Shriram, G. (2013). Problem based learning (PBL)-an effective approach to improve learning outcomes in medical teaching. Journal of Clinical and Diagnostic Research, 7(12): 2896–2897. https://doi.org/10.7860/JCDR/2013/7339.3787

[6] Wong, D. K. P., & Lam, D. O. B. (2007). Problem-based learning in social work: A study of student learning outcomes. Research on Social Work Practice, 17(1): 55–65. https://doi.org/10.1177/1049731506293364

[7] Steele, D. J., Medder, J. D., & Turner, P. (2000). A comparison of learning outcomes and attitudes in student-versus faculty-led problem-based learning: An experimental study. Medical Education, 34(1): 23–29. https://doi.org/10.1046/j.1365-2923.2000.00460.x

[8] Mulyanto, H., Gunarhadi, G., & Indriayu, M. (2018). The effect of problem based learning model on student mathematics learning outcomes viewed from critical thinking skills. International Journal of Educational Research Review, 3(2): 37–45. https://doi.org/10.24331/ijere.408454

[9] Prosser, M. (2004). A student learning perspective on teaching and learning, with implications for problem-based learning. European Journal of Dental Education, 8(2): 51–58. https://doi.org/10.1111/j.1600-0579.2003.00336.x

[10] Timor, A. R., Ambiyar, A., Dakhi, O., Verawadina, U., & Zagoto, M. M. (2021). Effectiveness of problem-based model learning on learning outcomes and student learning motivation in basic electronic subjects. International Journal of Multi Science, 1(10): 1–8.

[11] Dupri, D., Candra, O., Candra, A., & Suryani, D. A. (2020). The implementation of problem based learning model in improving cooperation and learning outcomes in physical education. Jurnal Pendidikan Jasmani Dan Olahraga, 5(1): 87–90. https://doi.org/10.17509/jpjo.v5i1.22531

[12] Khusaini, K., Lestari, S., & Agustin, N. A. (2018). The application of problem-based learning methods to improve economic learning outcomes and motivation. Dinamika Pendidikan, 13(2): 218–227. https://doi.org/10.15294/dp.v13i2.16634

[13] Reinsini, C. E., Susila, I. W., & Cholik, M. (2021). Application of problem-based learning to enhance students learning outcomes in basic competencies of maintaining brake systems. International Journal for Educational and Vocational Studies, 3(2): 139–145. https://doi.org/10.29103/ijevs.v3i2.3470

[14] Albanese, M. A., & Dast, L. (2014). Problem-based learning: Outcomes evidence from the health professions. Journal on Excellence in College Teaching, 25(3/4): 239–252.

[15] Stentoft, D. (2017). From saying to doing interdisciplinary learning: Is problem-based learning the answer?. Active Learning in Higher Education, 18(1): 51–61. https://doi.org/10.1177/1469787417693510

[16] Khatiban, M., & Sangestani, G. (2014). The effects of using problem-based learning in the clinical nursing education on the students' outcomes in Iran: A quasi-experimental study. Nurse Education in Practice, 14(6): 698–703. https://doi.org/10.1016/j.nepr.2014.10.002

[17] Goni, A. M., Tumurang, H., & Ester, K. (2022). Problem Based Learning (PBL) Model and Mathematics Learning Outcomes Students. Specialusis Ugdymas, 1(43): 8277–8284.

[18] Miller, S. K. (2003). A comparison of student outcomes following problem-based learning instruction versus traditional lecture learning in a graduate pharmacology course. Journal of the American Academy of Nurse Practitioners, 15(12): 550–556. https://doi.org/10.1111/j.1745-7599.2003.tb00347.x

[19] Aslam, L. K., Suparji, S., & Rijanto, T. (2021). The effect of problem based learning model on learning outcomes in the vocational high school students. International Journal for Educational and Vocational Studies, 3(4): 264–267. https://doi.org/10.29103/ijevs.v3i4.3958

[20] Utami, I., Burhanuddin, S., & Sahabuddin, S. (2022). Implementation of a scientific approach using Problem Based Learning (PBL) models to improve learning outcomes of overhand pass in volleyball game. Competitor: Jurnal Pendidikan Kepelatihan Olahraga, 14(1): 115–134. https://doi.org/10.26858/cjpko.v14i1.32521

[21] Winning, T., Skinner, V., Townsend, G., Drummond, B., & Kieser, J. (2004). Developing problem-based learning packages internationally: An evaluation of outcomes. Innovations in Education and Teaching International, 41(2): 125–144. https://doi.org/10.1080/1470329042000208666

[22] AlHaqwi, A. I. (2014). Learning outcomes and tutoring in problem based-learning: How do undergraduate medical students perceive them?. International Journal of Health Sciences, 8(2): 125–132. https://doi.org/10.12816/0006078

[23] Dharma, I. M. A., & Lestari, N. A. P. (2022). The impact of problem-based learning models on social studies learning outcomes and critical thinking skills for fifth grade elementary school students. Jurnal Ilmiah Sekolah Dasar, 6(2): 263–269. https://doi.org/10.23887/jisd.v6i2.46140

[24] Hmelo-Silver, C. E., Duncan, R. G., & Chinn, C. A. (2007). Scaffolding and achievement in problem-based and inquiry learning: A response to Kirschner, Sweller, and Educational Psychologist, 42(2): 99–107. https://doi.org/10.1080/00461520701263368

[25] McPhee, A. D. (2002). Problem-based learning in initial teacher education: Taking the agenda forward. The Journal of Educational Enquiry, 3(1): 60–78.

9 Author

Chi Zhang, Master's degree, is a lecturer at School of Economics and Management, Huanghuai University. Her research interests focus on E-commerce and Teaching Research. (email: 20121261@huanghuai.edu.cn).

Article submitted 2022-10-08. Resubmitted 2022-12-07. Final acceptance 2022-12-09. Final version published as submitted by the authors.