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# PBL-Based Vocational Education Blended Learning Activity Design Research

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**Abstract:** There are disparities between vocational education personnel training and industrial development. The purpose of this research is to develop a PBL-based blended learning activity design aligned with vocational education talent training goals, leveraging the benefits of project-based and mixed learning approaches. The design encompasses problem clarification, goal determination, problem design, problem-solving, results display and evaluation, and summary activities. Employing a quasi-experimental research methodology, this study was conducted in the core course "Software Development Technology" within the software technology major of Vocational College X. Through comparative data analysis between the experimental and control groups, it was observed that students in the experimental group demonstrated varying degrees of improvement in their abilities related to demand analysis, software design, software development, and software testing in the field of software development technology. This finding affirms that PBL-based blended learning activities can effectively enhance students' technical skills by extending learning opportunities in both space and time, thereby offering practical insights for vocational education talent training research.

**Keywords:** Blended learning; E-learning; Information technology

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## 1. Introduction

Vocational education, an integral component of the education system, is tasked with the mission of cultivating a diverse workforce. China's latest Vocational Education Law explicitly emphasizes the equal importance of vocational education alongside general education. Presently, vocational education not only offers a wide array of specializations but also demonstrates increasing sophistication across secondary, advanced, and undergraduate levels. However, there appears to be a discrepancy between vocational education and the societal demand for skilled labor, failing to adequately fulfill enterprises' requirements for vocational talents. This issue stems from a lack of true implementation of vocational education personnel training objectives in the educational process. This neglect is evident in the continued reliance on traditional classroom lectures supplemented by practical training and internships, with curriculum assessments primarily relying on exams and tests.

In essence, vocational education aims to equip individuals with the vocational knowledge, skills, and cultural understanding required for high-quality technical and skilled personnel in specific occupations [1]. Thus, innovating teaching modes and methods to enhance teaching quality is paramount for the successful execution of high-quality technical skills personnel training in vocational education.

This study harnesses the omnipresence of online learning and the collaborative nature of extracurricular learning in vocational education to propose blended learning based on Problem-Based Learning (PBL). It merges the attributes of PBL and blended learning, leveraging the advantages of both online and offline, and in-class and extracurricular learning. By guiding vocational education to identify real-world problems in teaching and learning, this approach emphasizes core knowledge themes and facilitates collaborative problem analysis and exploration within groups. Learning outcomes are showcased and evaluated through works, culminating in a teaching and learning endeavor that nurtures technical talent in vocational education.

Through the implementation and evaluation of blended learning activities in vocational education grounded in PBL, this study seeks to introduce fresh perspectives and chart new pathways for cultivating high-quality technical and skilled talent in vocational education. It also aims to foster synergistic development between vocational education and industry.

## 2. PBL-based blended learning activity design for vocational education

### 2.1. Design basis

PBL centers on real-world problem inquiry, wherein students, organized into teams, undertake a series of activities including design, planning, problem-solving, decision-making, creation, and presentation of results. This approach aims at fostering knowledge construction and enhancing abilities [2]. The model aligns with Jerome Seymour Bruner's theory of discovery learning, John Dewy's pragmatic theory of education, and Robert Jeffrey Sternberg's constructivist theory of learning. Its focus on real-world problems and unique teaching methods align well with the demand for talent in the new era and the developmental trajectory of vocational education toward nurturing high-quality technical and skilled talents [3].

Blended learning, also known as "fusion learning," encompasses various perspectives in the 21st century's rapidly evolving digital landscape. Reed *et al.* argued that blended learning involves the strategic utilization of appropriate learning methods, media, timing, and content to maximize learning efficiency [4]. Picciano defined blended learning as the integration of multimedia technology with traditional classroom practices [5]. British scholar Thorne suggested that blended learning integrates digital and traditional teaching methods, catering to students' personalities and needs [6]. Bonk and Graham, in the "Handbook of Blended Learning: Global Perspectives, Local Designs," described blended learning as a fusion of face-to-face instruction and online teaching, requiring teachers to adapt to diverse teaching contexts, environments, and student needs, while crafting instructional designs [7].

Hence, the scientifically and systematically designed blended learning activities based on PBL hold significant practical importance for innovating teaching modes and methods and implementing high-quality technical and skilled personnel training. Whether it involves discovering, analyzing, and resolving real-world problems in vocational education or collaborating to complete learning outcomes and evaluate displays, blended learning grounded in PBL fosters immersive problem-solving experiences within group settings. Consequently, theories such as discovery learning, pragmatism in education, and constructivism in learning offer valuable foundations and perspectives for the design of blended learning activities based on PBL.

### 2.2. Activity design

A learning activity encompasses the collective actions of both teachers and students aimed at accomplishing designated learning objectives [8]. The design of blended learning activities based on PBL in vocational education entails comprehensive planning of the teaching and learning process, serving as the foundation and assurance for subsequent activity implementation. Aligned with the goals of vocational education talent cultivation and PBL characteristics, the process of PBL-based vocational education blended learning activities is illustrated in **Figure 1**. This process involves identifying the theme, defining objectives, formulating a plan, problem-solving, communicating results, and evaluating and summarizing outcomes. The specific execution of these activities can take various forms, including entirely face-to-face instruction, fully online instruction, or a blend of online and offline modalities [9]. However, it necessitates support from online learning resources such as Massive Open Online Courses (MOOCs) and online teaching platforms, as well as network technologies like 5G, augmented reality (AR), and virtual reality (VR) technologies.

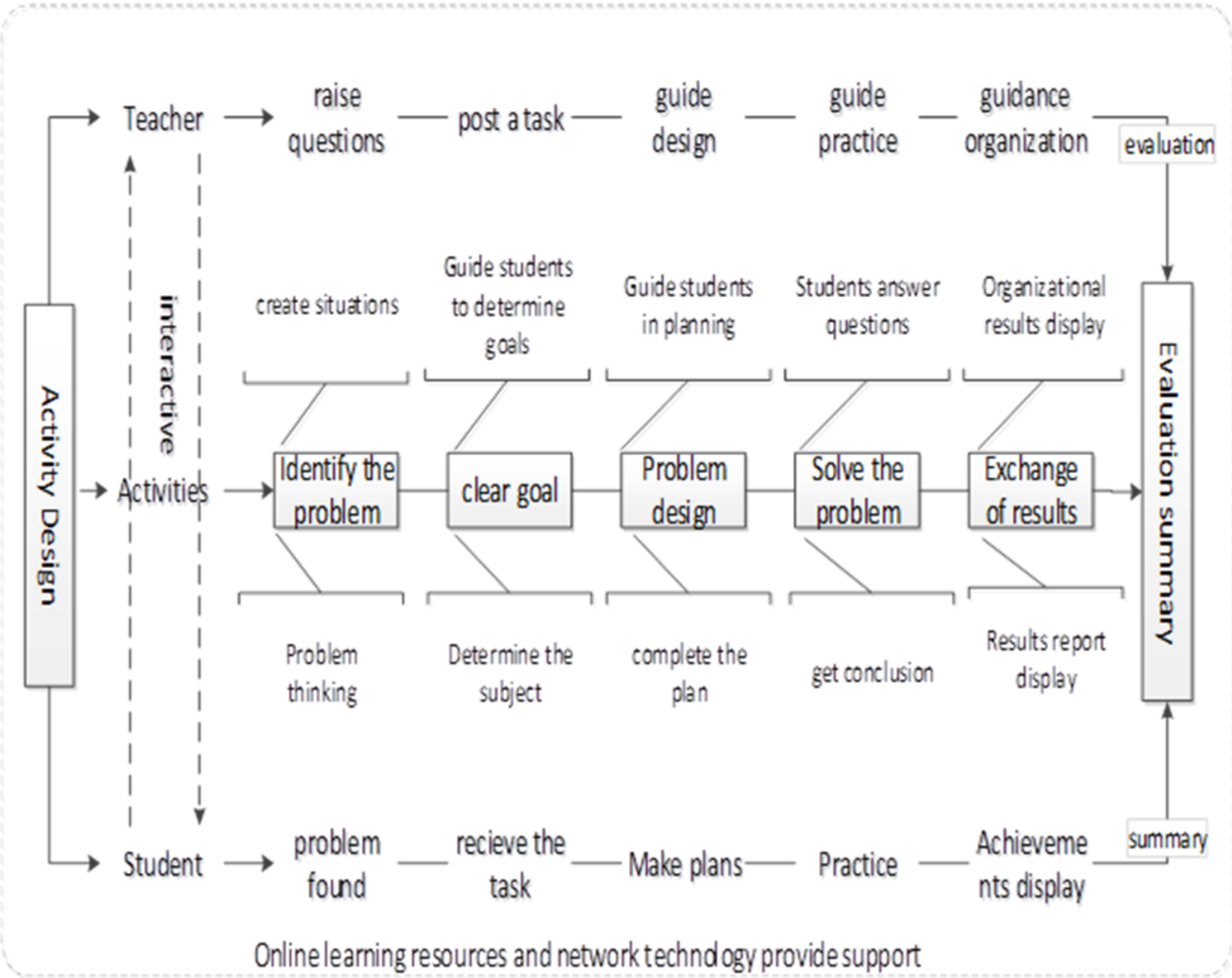


**Figure 1.** BPL-based blended learning activity design for vocational education

## 3. Applied practice of blended learning activity design based on PBL

To ascertain the effectiveness of PBL-based blended learning activity design in vocational education, this study was conducted during the spring semester of 2023, implementing the core course "Software Development Technology" in the software technology program at Vocational College X.

## 3.1. Study design

Experimental subject: The experimental group comprised the students of Big Data Technology Class 1, Grade 2021, while Big Data Technology Class 1, Grade 2020, served as the control group. It was anticipated that the professional skills of the experimental group would improve in their core course of "Software Development Technology" during the second semester of the software technology major following the implementation of blended learning activities based on PBL.

Experimental design: This study employed a quasi-experimental research method, utilizing post-tests for both the control and experimental groups to analyze whether students' professional knowledge, skills, and professionalism improved, thus validating the effectiveness of blended learning activities based on PBL. The independent variable was PBL-based blended learning activities, while the dependent variable was software development technical skills in the software technology program. Each group consisted of 50 students, and both groups were instructed by the same teacher. The independent variable was applied to the experimental group to facilitate the analysis of differences between the two groups' software technology students regarding software development technical skills.

Before the course commenced, a questionnaire was administered to collect data on the software development technical skills of students in the control group. Four project-based learning activities – requirements analysis, software coding, software development, and software testing – were incorporated into the teaching of the experimental group, as outlined in **Table 1**. The course adopted a format of offline face-to-face instruction for 2 hours per week, supplemented by online learning services through the "Super Star" cloud classroom outside of class. Random interviews were conducted at the conclusion of each project, and questionnaires were employed to assess and analyze the experimental group's students' skills in software development technology at the end of the course. Finally, the effectiveness of PBL-based blended learning activities in enhancing the software development technical skills of software technology students was verified through a comparison of questionnaire survey results between the experimental and control groups, alongside an analysis of interview content and completion of project activities by the experimental group.

**Table 1.** Design of the course project

| Project name | Project goal | Project result demand |
|---|---|---|
| Requirements analysis | Solve the problem of "what to do", that is, analyzing and organizing the information described in the user requirements to form a complete, clear, and standardized description of the document. | Be able to fully identify user requirements and standardize the preparation of the "User Requirements Specification." |
| Software design | Solve the problem of "how to", that is, obtaining a feasible, high-quality software solution that meets the needs of the software. | Be able to standardize the preparation of "the Outline Design Specification" and "Detailed Specification." |
| Software coding | Solve the problem of "how to deal", that is, completing the program design and code writing of the software. | Be able to develop software that is consistent with the description in the User Requirements Specification (URS). |
| Software testing | Solve the problem of "how is it done", that is, completing the testing of the software. | Be able to standardize the preparation of the "Test Report." |

Measuring tools: Questionnaires were developed for both the experimental and control groups to assess their technical skills in software development. The content tailored for the experimental group specifically emphasized the four programs, including the Student Outcome Assessment Scale (SOSA).

## 3.2. Study results

Through qualitative analysis of the interviews and course outcomes of students in the experimental group, along with quantitative comparative analysis of questionnaire data from the control group, this study found that the software development technical skills of students in the software technology major within the experimental group have improved to varying degrees. The specific changes are as follows:

### 3.2.1. Firming of professional belief in software development

In post-course interviews, Student A remarked, “PBL-based blended learning makes the software development technology course engaging and enriching, strengthening my confidence and determination to pursue a career in software development after graduation.” Student B commented, “The four projects provided me with a more comprehensive understanding of software development work, and I truly appreciate the effectiveness of PBL.” Student C stated, “Software development is inherently a collaborative endeavor. Through project presentations and evaluations, I have gained a deeper understanding of the importance of communication and collaboration in team development processes.” The survey and qualitative analysis of software development technology learning outcomes revealed that “technology,” “ability,” and “communication” were the most prominent aspects. This suggests that students majoring in software technology have acquired a more comprehensive mastery of software development technology skills through this course.

### 3.2.2. Enhanced professional knowledge in software development

According to the system development cycle theory, software development typically involves four stages: requirements analysis, software design, software coding, and software testing [10]. Building upon this framework, the study conducted a mean value analysis of expertise mastery using questionnaire and evaluation data from both experimental and control groups, as illustrated in **Table 2**. The analysis indicates that students in the experimental group exhibited positive changes in all four dimensions of software development expertise mastery.

**Table 2.** Test difference in software development knowledge

| | Experimental group | | Control group | | *P*-value |
|---|---|---|---|---|---|
| | Mean | Std dev | Mean | Std dev | |
| Requirements analysis | 8.32 | 1.085 | 7.54 | 1.299 | 0.002 |
| Software design | 8.2 | 1.131 | 7.32 | 1.849 | 0.005 |
| Software coding | 8.14 | 1.183 | 7.52 | 1.723 | 0.041 |
| Software testing | 8.28 | 1.184 | 7.62 | 1.528 | 0.010 |

To further comprehend the significance of the four knowledge changes, this study conducted a difference test on the two sets of data. Among them, the *P*-value for the requirements analysis dimension was found to be 0.002. This indicates that through blended learning based on PBL, the requirements analysis knowledge of students in the experimental group has been significantly enhanced, while the improvement in software coding knowledge is also notable. The primary reason for the relatively less significant change in software coding knowledge is that the design of software coding activities necessitates students to possess a certain level of prior knowledge, thus the changes through blended learning activities based on PBL are comparatively moderate. Software requirements analysis is intricately linked to the teaching of software development technology courses. Within the course, students encounter numerous opportunities to engage with design examples from information technology courses and undertake innovative designs, hence leading to a significant improvement in software requirements analysis. Software testing, being closely associated with the preceding three activities, benefits from the plethora of reference resources provided by the online teaching platform, resulting in noticeable improvements in software testing.

### 3.2.3. Enhanced professional competence in software development

In accordance with the professional ability requirements of software development roles, individuals are expected to possess technical ability, problem-solving ability, independent learning ability, and communication and collaboration skills [11]. Based on this premise, the study analyzed the self-evaluation mean values of the four professional competencies, as depicted in **Table 3**. The mean values of competencies such as technical ability, problem-solving ability, and independent learning ability have all increased to varying degrees.

**Table 2.** Test of difference in software development knowledge

| | Experimental group | | Control group | | *P*-value |
|---|---|---|---|---|---|
| | Mean | Std dev | Mean | Std dev | |
| Technical ability | 8.58 | 1.234 | 8.02 | 1.490 | 0.045 |
| Problem-solving ability | 8.32 | 1.207 | 7.56 | 1.899 | 0.019 |
| Independent learning ability | 8.72 | 1.078 | 7.7 | 1.735 | 0.001 |
| Communication ability | 8.46 | 1.203 | 7.76 | 1.594 | 0.008 |

Based on the mean values of self-assessment for the four professional competencies, this study conducted a difference test between the experimental and control group data for each competency to further analyze the significance of the changes. The *P*-values for students' technical competence, problem-solving competence, independent learning competence, communication competence, and software development competence as a whole were found to be 0.045, 0.019, 0.001, 0.008, and 0.18, respectively. These results indicate a significant improvement in these four competencies among the students.

Through the course, PBL-based blended learning practices were employed, providing students with access to a wide range of online learning resources for software development, including targeted and self-directed selective learning and software development case references. Additionally, class discussion groups and forums were established within the "Super Star" cloud classroom platform, with students' participation frequency in discussions being one of the evaluation criteria for the course assessment. As a result, noticeable improvements were observed in students' technical skills, problem-solving abilities, independent learning capabilities, and communication and collaboration skills.

### 3.2.4. Expanded learning time and space for software development

PBL-based blended learning encourages students to engage in activities such as problem clarification, team division of labor, problem design, investigation, and results presentation through the "Super Star" cloud classroom platform, both inside and outside the classroom. This approach fully leverages the advantages of "online + offline" learning, departing from the limitations of traditional teaching where teacher-student interactions are confined to the classroom. Consequently, learning time and space have been effectively extended. Therefore, the ability to independently learn from online resources is deemed essential for students' professional competencies. Furthermore, through interviews with students in the experimental group, it was revealed that the majority found blended learning activities, both online and offline, to make their learning experience more convenient.

In summary, the analysis of experimental results indicates that the students in the experimental group have demonstrated varying degrees of improvement in their software development technology, specifically in requirements analysis, software design, software coding, and software testing abilities. Thus, it can be concluded that the implementation of blended learning activities based on PBL enhances students' technical skills by breaking through traditional constraints in learning time and space.

## 4. Conclusion

Innovation in teaching methods and approaches within vocational education is not only essential to meet the inherent demand for talent training but also crucial for the advancement of vocational education in nurturing technical and skilled individuals. This study validates the effectiveness of PBL-based blended learning activities in enhancing the technical skills of vocational personnel. It is important to note that prior to conducting these activities, suitable online learning resources and technologies are necessary to provide teaching support. Throughout the activities, leveraging the course assessment and evaluation mechanism is imperative to incentivize student engagement in course learning and group collaboration and communication during extracurricular time. Following the conclusion of these activities, teachers can guide students in optimizing or improving course outcomes, encouraging active participation in relevant skills competitions or social practice activities to further solidify their professional knowledge and enhance their professional and technical skills.

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## Author contributions

Conceptualization: Hailang Chen
Investigation: Hailang Chen
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Writing – original draft: Jianhua Huang
Writing – review & editing: Hailang Chen, Jianhua Huang

## References

[1] Dumschat M, Stetter R, Rottmann J, 2019, 2019 IEEE 11th International Conference on Engineering Education (ICEED), November 6–7, 2019: Lead Example Interlinked Curriculum for Action Oriented Teaching and Learning. ICEED, Kanazawa, 245–250. https://doi.org/10.1109/ICEED47294.2019.8994953

[2] Ye L, 2022, Research on Design and Practice of PBL Teaching Model Based on STEM Education Concept. e-Education Research, 43(2): 95–101. https://doi.org/10.13811/j.cnki.eer.2022.02.013

[3] Pi J, Liao Y, 2022, On Four-Dimension Ability Cultivation of Engineering Talents in Universities under the

Background of Industry 4.0 – PBL Mode of Aalborg University in Denmark. Research in Higher Education of Engineering, 2022(4): 194–200.
[4] Reed SM, Hughes DB, Singh RN, 1987, Backfill Settlement of Restored Strip Mine Sites – Case Histories. International Journal of Mining and Geological Engineering, 5: 161–169. https://doi.org/10.1007/BF01560875
[5] Panarelli F, 2010, S. Maria di Picciano (MT) E Gli Ultimi Sovrani Della Dinastia Altavilla [S. Maria di Picciano (MT) and the Last Sovereigns of the Altavilla Dynasty]. Quellen und Forschungen aus italienischen Archiven Bibliotheken, 90: 66–86.
[6] Thorne K, 2003, Blended Learning: How to Integrate Online & Traditional Learning. Kogan Page Publishers, London.
[7] Bonk CJ, Graham CR, 2006, The Handbook of Blended Learning: Global Perspectives, Local Designs. Wiley, New Jersey.
[8] Su Q, Zhang W, Wang H, et al., 2022, Research on Project-Based Learning of Information Technology Curriculum for Cultivating Senior High School Students' Computational Thinking. e-Education Research, 2022(8): 109–115 + 122. https://doi.org/10.13811/j.cnki.eer.2022.08.014
[9] Chen H, He Z, 2020, 2020 International Conference on Modern Education and Information Management (ICMEIM), September 25–27, 2020: Blended Learning Design and Praxis for the Coordinated Development of Theory and Practice – Take Vocational Education as an Example. ICMEIM, Dalian, 671–675. https://doi.org/10.1109/ICMEIM51375.2020.00151
[10] Wester R, Koster J, 2015, The Software behind Moore's Law. IEEE Software, 32(2): 37–40. https://doi.org/10.1109/MS.2015.53
[11] Heck P, Zaidman A, 2014, Horizontal Traceability for Just-in-Time Requirements: The Case for Open Source Feature Requests. Journal of Software: Evolution and Process, 26(12): 1280–1296. https://doi.org/10.1002/smr.1678