Educational Administration: Theory and Practice
2024, 30(6), 4266 - 4279
ISSN: 2148-2403
https://kuey.net/
Research Article

Technology-supported Blended Problem-based Learning Model for Problem-Solving and Autonomous Learning

Li Wang[1], Jirarat Sitthiworachart[2*], John Morris[3]

[1]King Mongkut's Institute of Technology Ladkrabang, Thailand, Email: 64603084@kmitl.ac.th
[2*]King Mongkut's Institute of Technology Ladkrabang, Thailand, Email: jirarat.si@kmitl.ac.th
[3]King Mongkut's Institute of Technology Ladkrabang, Thailand, Email: john.mo@kmitl.ac.th

***Corresponding Author:** Jirarat Sitthiworachart*

Citation: Li Wang.et al (2024), Technology-supported Blended Problem-based Learning Model for Problem-Solving and Autonomous Learning *Educational Administration: Theory and Practice, 30(6), 4266 - 4279*
Doi: 10.53555/kuey.v30i6.6228

ARTICLE INFO

ABSTRACT

Problem-solving skills and autonomous learning are crucial abilities for 21st-century students. Yet, due to work and family obligations, mature students face time constraints for education. This study developed an online course platform and mind mapping technology-supported blended problem-based learning (Tech-Blended PBL) model to investigate how it affects mature students' achievement, problem-solving skills and autonomous learning. A pre-post test design tested the model effect, using 70 students, randomly assigned to similarly sized experimental and control groups. Data analysis, using MANOVA and t-tests, confirmed that there were significant differences in all three aspects: the average scores of the experimental vs control groups for course achievement were 85% vs 74%, for problem-solving abilities were 83% vs 72% and for autonomous learning 86% vs 75% (Sig. < 0.05). Overall, the Tech-Blended PBL model had a positive impact on all three aspects. A questionnaire answered by students in the experimental class showed that they were satisfied with the new model.

Keywords: Problem-based learning (PBL), Tech-Blended PBL Model, Problem-Solving ability, Autonomous learning, Mind-mapping

1. Introduction

1.1 Research Background

In today's education system, the significance of developing problem-solving abilities and fostering autonomous learning is well accepted (Fiore et al., 2018). These skills are crucial for preparing students to navigate the complexities of the 21st-century world (Pellegrino & Hilton, 2012). In lifelong education, for mature students in particular, problem-solving skills and autonomous learning are important, the problem-solving ability of mature students is an essential skill that they develop and refine throughout their educational journey (Surur et al., 2020).

Following Heagney and Benson (2017), in this study, a mature student is someone who pursues higher education at a later stage in life, usually beyond the traditional tertiary age range of 18-23 years.

Shogren and Wehmeyer (2017) reported that problem-solving was a crucial skill in both personal and professional contexts. Moreover, problem-solving skills are transferable across domains and can be used in different areas of life (Anwar, 2021). Also, employers increasingly value candidates who can think critically, adapt to new situations, and solve problems independently (Brewer, 2013). Therefore, teaching students a problem-solving approach equips them with valuable skills, that can be applied not only in academic study but also in future careers and daily lives.

Autonomous learning is also important. Studies indicated that students who exhibit a strong capacity for autonomous learning generally achieved higher academic performance than those dependent on teacher guidance (W. Zhang et al., 2017). Furthermore, autonomous learning is of great importance for students as it fosters self-directed learning, encourages independent problem-solving and promotes lifelong learning habits (Lee & Kwon,2022)

According to Charnley (2016), working-age mature students now tend to have shorter tenures in multiple jobs throughout their careers, as lifelong jobs have largely disappeared. This underscores the necessity of continuous re-skilling and up-skilling, given the integration of new technology that transforms our work environments.

Mature students contribute positively to the economy, as they are more likely to be employed, while pursuing their studies and typically have higher earning potential upon graduation (Busher & James, 2019). However, mature learners often face the challenge between educational pursuits and responsibilities such as work and family (Baharudin et al., 2013). Another challenge is adapting to new learning environments and technologies, especially for those who have been out of education for a significant period (Ho & Lim, 2020). Another challenge is juggling multiple roles and responsibilities, which can make time management and prioritization difficult (D. Lee, 2000). Hence, the traditional "teacher-centred" approach hinders student engagement and is not conducive to enhancing course achievement, problem-solving skills, and autonomous learning.

To overcome these challenges, mature students need flexible learning methods (Kara et al., 2019). As an educator, implementing teaching strategies to support them in balancing education with work and family commitments is essential (Bengo, 2020). For instance, they use online articles and various educational materials in problem-based learning approaches to enhance understanding (C. Zhang & Zheng, 2013). Mature students seek social circle support to manage time efficiently and balance education with other commitments (Kasworm, 2008).

In today's rapidly evolving world, students also need to use technology to enrich their learning. Häkkinen et al. (2020) noted that by incorporating technology into Problem-Based Learning (PBL), students were able to enhance problem-solving abilities and autonomous learning. Liu et al. (2021) reported that implementing technology enriched problem-based learning and improved learning motivation and problem-solving abilities. Social security plays a crucial role in the lives of individuals and communities. While taking these courses on it, students solve real-life health insurance issues (Reno, 2016), that help in the lives of mature students. Therefore, this study selected the "Social Security" course (社会保障 in Chinese) at Shandong Open University as the basis for the experiment.

1.2 Research Questions

We constructed a new Tech-Blended PBL model and ran experiments in the "Social Security" course to address these questions:

1. What are the differences in course achievement using traditional or Tech-Blended PBL learning models?
2. What are the differences in problem-solving abilities between the two models?
3.What are the differences in autonomous learning between the two models?

2. Literature review

2.1 Theoretical foundation

2.1.1 Knowles's adult theory

Knowles (1978) made six assumptions regarding adult learners:

1. They need to know why they are learning;
2. They need self-direction;
3. They bring a wealth of experience connected to their identities;
4. Their willingness to learn is related to their “need to know”;
5. They assume a "problem-centered" orientation to learning and
6. They are primarily motivated internally rather than externally.

D. Lee (2000) highlighted that Knowles' theory acknowledged the varied nature of mature learners, enabling the provision of customized learning experiences tailored to individual needs, preferences and learning styles. Mahan and Stein (2014) noted that mature learners tended to demonstrate higher motivation and engagement when they connected instructional content with their personal experiences and objectives. Therefore, Knowles' theory provided references for instructional design and the characteristics of the teaching objectives should be fully considered.

2.1.2 Self-directed learning theory

Self-directed learning theory constitutes a fundamental construct in the realm of adult education. It is a learning approach that emphasizes learner autonomy and responsibility in education (Loeng, 2020).

Self-directed learning theory has led to the development of more student-centred teaching models. Educators have shifted their focus from traditional instruction to creating environments that foster self-directed learning (Yarbrough, 2018). Based on this theory, the integration of technology and diverse learning resources provided the basis for diversified learning methods (Solichin et al., 2021). Therefore, instructional *designers should* strive to create flexible learning environments that accommodate individual learning paces and preferences, thereby promoting the development of autonomous learning abilities.

2.2 Effects of Blended PBL on Achievement, Problem-solving Ability and Autonomous Learning

2.2.1 Course achievement

Course achievement refers to the level of success that students attain in a course. It can be measured by various indicators, such as grades, test scores, participation and overall mastery of course content and objectives (He, 2020). Erickson (1999) showed that students using PBL outperformed those in traditional classrooms on national examinations and exhibited superior professional skills.

Shu and Gu (2018) mentioned that the blended PBL approach (BPBL) contributed to knowledge acquisition and the cultivation of desirable skills and attitudes. Moreover, Aisyah, Mustaji & Arsana (2022) showed that students who received blended problem-based learning achieved better course grades than students who learnt traditionally.

2.2.2 Problem-solving Ability

Problem-solving ability is a valuable skill that students must master as they enter the real world. Barbey and Barsalou (2009) mentioned that problem-solving involves reasoning, analyzing and finding solutions. Gorghiu et al. (2015) showed the combination of problem-solving strategies and disciplinary knowledge in BPBL leads to improved problem-solving abilities. Suryanata and Wuryandani (2019) reported that by actively engaging in problem-solving activities, students applied their knowledge in practical and real-world scenarios.

Rasheed et al. (2020) mentioned that BPBL substantially enhanced problem-solving skills by fostering an innovative learning environment that encouraged collaborative learning and analytical abilities. Moreover, Amin et al. (2021) confirmed that integrating technology into BPBL enhanced problem-solving skills.

2.2.3 Autonomous Learning

Holec (1981) defined autonomous learning as the ability to take charge of one's learning. Nunan (1997) underscored that autonomous learning allowed one to set their own goals to create opportunities and essentially achieve autonomy.

Autonomous learning implies a higher degree of independence and decision-making than self-directed learning: autonomous learners are expected to be more self-regulated and less dependent on external sources for guidance or direction (Lee & Kwon, 2022).

Blended problem-based learning enhances autonomous learning by offering learners opportunities to take charge of their learning (Boelens et al., 2017). Also by integrating technology into BPBL, students could access a wider range of resources and tools to tackle real-world problems and engage in autonomous learning (Rasheed et al., 2020). Evensen et al. (2000) argued participation in PBL not only improved knowledge but also proficiency in problem-solving and autonomous learning.

2.3 Mind mapping achievement, problem-solving ability and autonomous learning

'Mind mapping' was coined by Tony Buzan, a British brain researcher who invented this method in the 1970s (Buzan, 2002). It is a powerful technique. that allowed individuals to visually organize and connect information. Sulastri (2019) reported that students using mind mapping not only enhanced academic achievements but also cultivated problem-solving abilities and became more autonomous learners.

Moreover, the use of mind mapping was effective in enhancing problem-solving skills as it allowed students to grasp the broader perspective and identify potential solutions more efficiently (Ritchie et al., 2013). Stokhof et al. (2020) mentioned using mind maps enabled students to manage their learning journey and promoted autonomous learning. Fauzi and Metroyadi (2020) suggested by visually organizing information and making connections between different ideas, students remembered and understood concepts more easily and further demonstrated that mind mapping can also promote effective collaboration and communication among students.

2.4 Conceptual framework

This paper integrated the China Open University online learning platform (OUCHN, http://one.ouchn.cn/) (Huang et al., 2020) and mind mapping (Wu & Chen, 2018) with BPBL, used Knowles's adult theory and self-directed learning theory and developed a new Tech-Blended PBL model.

Fig.1 shows the conceptual framework, including the independent variables (Tech- Blended PBL model and Traditional teaching method) and dependent variables (Course achievement, Problem-solving ability and Autonomous learning).

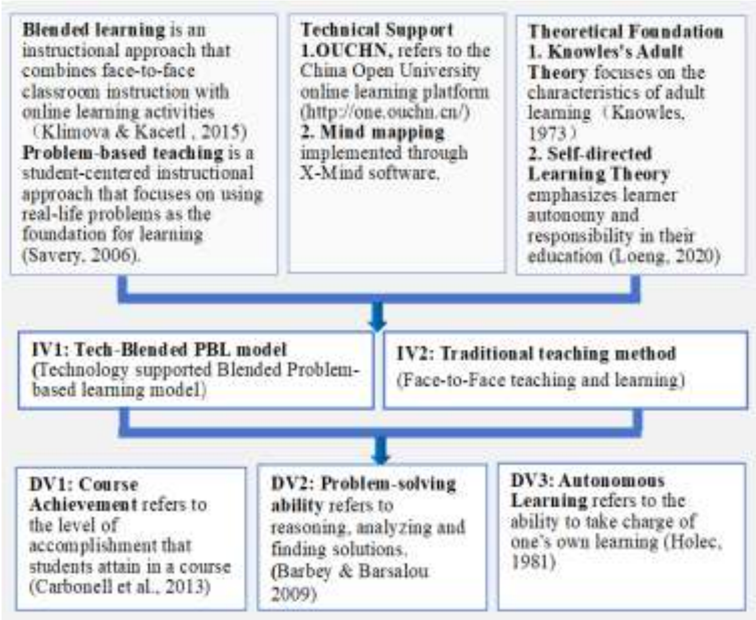


Fig1. Conceptual framework for this study

3. Development of a Tech-Blended PBL instructional model

Ibrahim et al. (2015) concentrated on incorporating technology into autonomous learning and devised a BPBL model to enhance higher-order thinking skills; Woltering et al.(2009) considered the application of PBL in blended learning and developed the BPBL model; Dwiyogo (2018) designed a BPBL model using analysis, design and evaluation; Hamzah et al .(2021) developed BPBL models using the ADDIE (Analysis, Design, Development, Implementation, and Evaluation) framework.
This section first summarizes the key elements of blended learning and problem-driven learning. Then, based on these elements and theoretical foundations, a new model, Tech-Blended PBL, was designed with three stages: online, face-to-face class and online, supported by online platforms and mind mapping.

3.1 Key Elements of Tech-Blended PBL

Various authors have identified different elements of a PBL approach. Sophonhiranraka et al. (2014) suggested nine elements (understanding the challenge, generating ideas, preparing for action, planning approach, learning activities, learning resources, feedback, interaction and evaluation). dos Santos (2017) listed five PBL elements (problem, environment, human capital, content, process); W. Zhang and Zhu (2017) noted 12 elements. Based on these ideas, we proposed a Tech-Blended PBL model with the elements shown in **Fig. 2.**

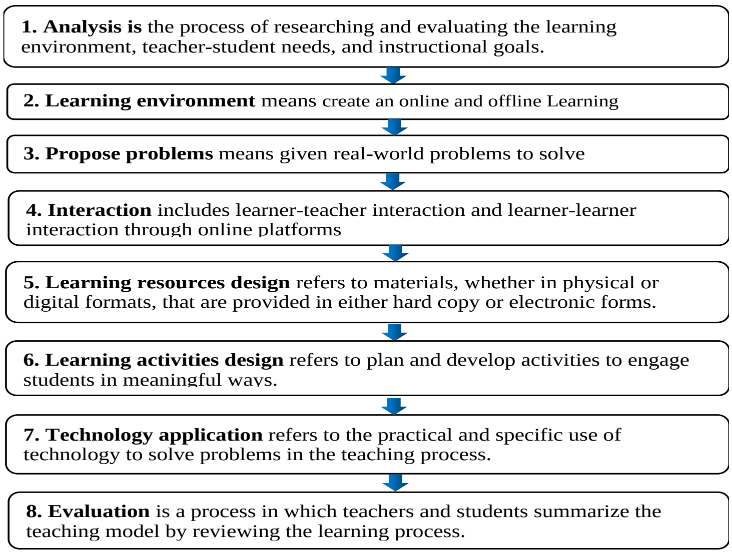


Fig. 2 Elements of Tech-Blended PBL

3.2 New Tech-Blended PBL model

Among the above eight elements that make up the Tech-Blended PBL model, the five elements of Analysis, Learning environment, Proposed problem, Interaction, and Learning resources belong to the online class stage. At this stage, teachers and students completed the course needs survey through Questionnaire Star. By studying on the OUCHN platform, they learnt and understood the online course content, became familiar with the learning environment, interacted-in the course forum discussion area, and solved questions related to real life. The two elements of learning activities and technology application were conducted offline. Through face-to-face teaching and group teaching, they used mind maps to complete assignment sharing. The evaluation element took place during the online phase. After the teaching activities, teachers and students evaluated the teaching effect. The learning activities of the experimental group are shown in **Fig. 3.**Then the new Tech-Blended PBL model, designed based on the key elements mentioned above, Knowles' adult theory and self-directed learning theory, integrated the OUCHN and mind mapping - see **Fig. 4.**

Fig.3 Student learning activities

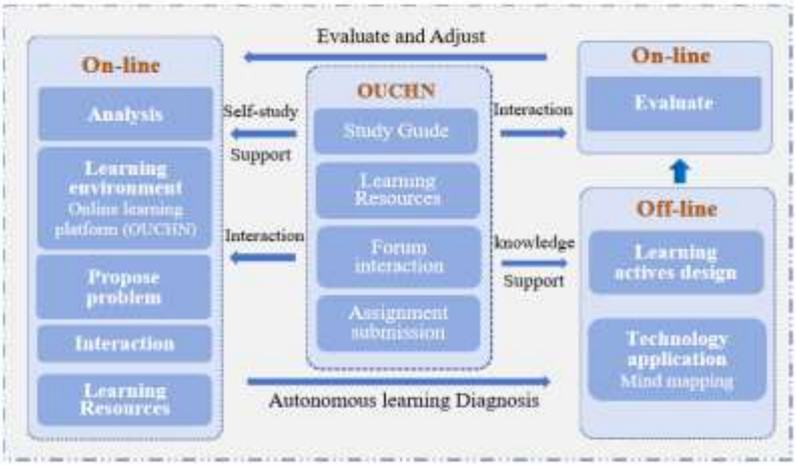


Fig. 4 Tech-Blend PBL Model

4 Methodology

4.1 Participants

The study used 70 second-year management students from Shandong Open University, China, randomly assigned to two groups (see **Table 1**). Both groups were taught by the same instructor with over ten years of experience. According to Bayoumy and Alsayed (2021), anonymity can protect student privacy, allowing them to freely express their opinions and genuinely share their thoughts. Therefore, in this paper, students participated in tests and questionnaire sessions anonymously.

4.2 Learning material

The "Social Security" course covers six main topics: pension, medical, unemployment, occupational injury, maternity cover and social assistance, with 24 subtopics. This study focused on the "Medical Insurance" theme, with four sub-topics: "Introduction to Medical Insurance," "Medical Insurance Premium Payment," "How to Calculate Medical Insurance," and "Development of Medical Insurance in China," which are significant in social security systems.

Table 1 Participant Details

Group	N	Gender				Age			
		Male		Female		<30	30-39	40-49	≥50
CG	34	26	76%	8	24%	4	16	12	2
EG	36	24	65%	12	35%	3	18	12	3
Total	70	50	71%	20	29%	7	34	24	5

Note: EG=Experiment Group CG= Control Group

4.3 Learning environment

The learning environment refers to the space where individuals or groups study (Jonassen et al., 1999). The experimental group in our study used a blended learning environment, including both online and offline learning. The traditional group used face-to-face teaching and learning methods.

4.3.1 Offline Learning 'Classroom'

The offline classroom in-person sessions for this experiment used a dedicated room, furnished with conference tables, flip charts and an internet-connected laptop.

4.3.2 Online Learning Platform

The teaching platform used was the China Open University online learning platform (OUCHN) which is an online learning system and a communication channel for schools, teachers and students. It allows teachers and students to use network tools for teaching and learning, making the teaching and learning of teachers and students more standardized, enriched, efficient and optimized teaching process. OUCHN requires users to have basic computer operation skills but the ability to use a web browser. Upon registration and login to the platform, students could access the courses.

Fig. 5 shows OUCHN web page Course learning interface

The teacher functions included managing resources, directing students to learn, designing teaching activities, reviewing and evaluating student work, organizing real-time discussions, conducting live teaching, checking student learning behaviours, etc; Student functions were browsing and learning from resources, participating in group activities and discussions, submitting assignments, taking online tests, checking learning progress etc.

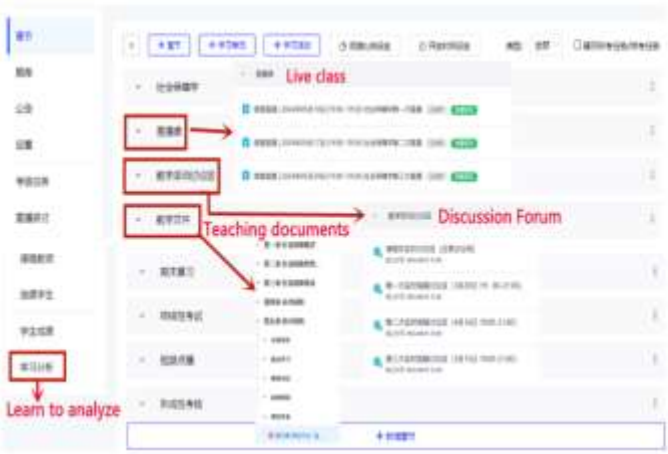


Fig. 5 OUCHN web page Course learning interface

4.3.3 Mind mapping

Mind mapping uses the X-Mind system, X-mind is a product to train students' conceptual understanding in the form of an interactive concept map assisted by learning media. In China, X-mind is a well-known mind-mapping application which provides tree diagrams, logical structure diagrams and fishbone diagrams (Wu & Chen, 2018). The interface is simple and easy to use, rich structure, supports free nodes, and is easy for mature students to learn and practice.

Fig. 6 is an example of homework completed by using mind mapping. Mature students, by combining real-life experiences and approaching from different angles, completed a mind map on "how to see a doctor," deepening their grasp of course knowledge and enhancing their problem-solving skills.

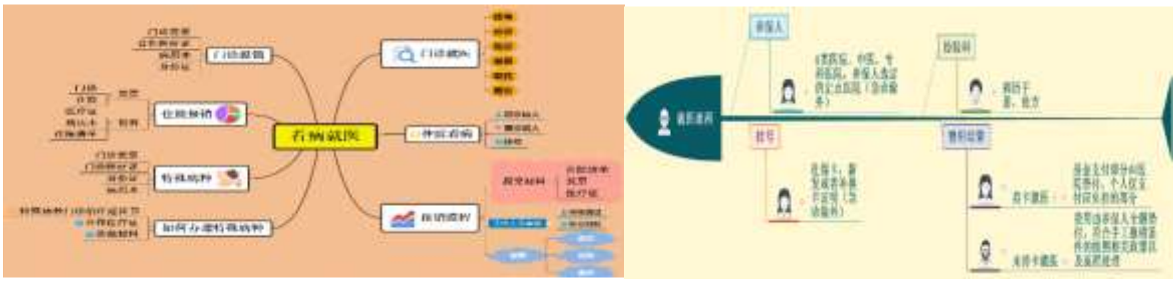


Fig. 6 Examples of student homework

4.4 Experiment procedure

The experiment ran for 8 weeks, with a 90-minute session each week, as shown in **Fig. 7.** In the first week, students were randomly assigned to either the traditional or experimental group. A pretest was administered to students in both groups to assess their mastery of course content. The teacher then introduced learning activities, with the traditional group receiving face-to-face instruction, while the experimental group followed Tec h-Blended PBL.

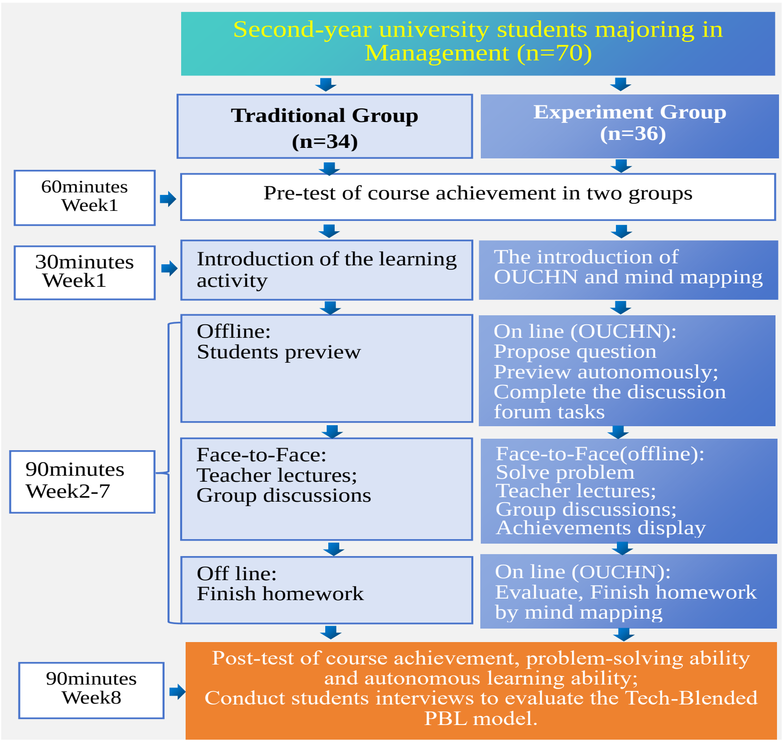


Fig. 7 Experiment procedure

From the second week, the traditional group followed an approach consisting of preview, teacher-led instruction and assignments. In contrast, the Tech-Blended PBL group used a problem-based blended learning method, using OUCHN and mind mapping for assignments and presentations.

In week 8, all students completed tests on course performance, problem-solving abilities and autonomous learning. Six students in the experimental group were interviewed to evaluate the Tech-Blended PBL model.

4.5 Instruments

Data was collected to address the research questions. For the first question, a pre-and post-test was administered to assess knowledge levels. The test content was developed in conjunction with seven experienced teachers. The pre-test assessed fundamental knowledge of medical insurance, for example, "What are the fundamental attributes of the healthcare system?". The post-test evaluated practical insurance applications in daily life, for example, "Which of the following situations is not covered by basic medical insurance?" Both the pre-and post-tests consist of 30 single-choice and 20 true-false questions, each question carried a value of 2 points, for a total of 100 points. A pilot test on 20 students verified the question paper reliability, Cronbach's a of the pre-and post-tests were 0.83 and 0.85, indicating good internal consistency. The content validity of the test paper was verified by the experts and met the requirements.

The problem-solving ability test, adapted from Barkman and Machtmes (2001), used a five-point Likert scale 24-question survey, including "When I have a problem, I first figure out exactly what the problem is?" Pilot testing by Perkins and Mincemoyer (2009) with Cronbach α = 0.86 indicated that the survey had good internal consistency; the test paper content validity was verified by the seven experts and met the requirements.

The third question used the Motivated Strategies for Learning Questionnaire (MSLQ) (Pintrich (1991)) and the Online Self-Regulated Learning Questionnaire (OSLQ) (Barnard et al., 2009). The questionnaire had 28 questions and covered five aspects: self-efficacy, motivation, perception, cognitive strategies and resource management strategies. The reliability test is in

Table 2. A pilot test used 20 students to verify the reliability of the question paper: Cronbach's a = 0.83, indicated good internal consistency. The content validity of the test paper was verified by seven experts and met the requirements.

Table 2 Questionnaire reliability test

Dimension	Cronbach a	Items
Self-Efficacy	0.78	5
Motivation	0.84	4
Perception	0.86	5
Cognitive Strategies	0.88	9
Resource Management Strategies	0.79	5
Overall Score for Autonomous Learning	0.83	28

Note that narrow distributions of responses for each aspect caused the overall score to lie between individual aspect scores.

4.6 Data analysis

A pre-test on the course content before the experiment measured differences in mastery of the course content between the two student groups. Shapiro-Wilk normality tests showed sig > 0.064, for all aspects and both groups, implying normal distributions. t-tests showed the differences between the two groups were insignificant, p = 0.931, confirming that the initial course content levels of the participants were similar.

For research questions 1, 2 and 3, MANOVA analyzed course achievements, problem-solving abilities and autonomous learning between the two groups after interventions and showed that at least one dependent variable (sig < 0.001 << 0.005) differed between the two groups, then t-tests determined which variables differed significantly.

An independent samples t-test examined the differences in five dimensions of self-directed learning ability between the two groups.

5. Results

5.1 Effects of the Tech-blended PBL model on course achievement

From the MANOVA (see Table 3), the F statistic was 22.71, and the significance level, Sig. < 0.01 << 0.05, indicating that there was a significant difference between the means of the two groups. The average score of the experimental group (85.4) was significantly higher than that of the control group (74.4). These results suggested that in terms of post-test course achievement, the performance of the experimental group was significantly better than that of the control group, indicating that the Tech-blended PBL model had a positive impact on course achievement.

Table 3 Independent samples t-test - three aspects

Group	**N**	**Mean**	**Levene's Test**		**MANOVA**				**Results**
			W	Sig.	Ss (pdf)	MS	F	Sig.	
	Post-test course achievement (Research Question 1)								
CG	34	74.4	4.870	0.031	SS_B:2106.981	MS_B: 2106.98	22.71	<0.01	EG> CG
EG	36	85.4			df_B:1				
	Problem-solving ability (Research Question 2)								
CG	34	71.7	8.805	0.004	SS_B:2252.424	MS_B: 2252.42	35.66	<0.01	EG> CG
EG	36	83.1			df_B:1				
	Autonomous learning (Research Question 3)								
CG	34	74.8	7.151	0.009	SS_B:2025.610	MS_B: 2025.61	41.30	<0.01	EG> CG
EG	36	85.5			df_B:1				

5.2 Effects of the Tech-blended PBL model on problem-solving ability

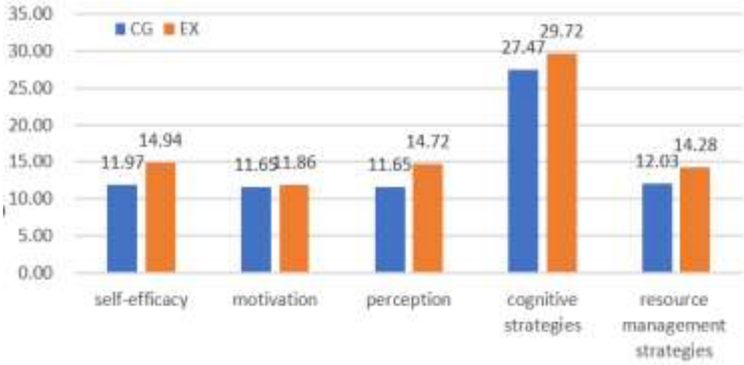
Based on the MANOVA results (seen in **Table 3**), the average score of the experimental group (83.1) was significantly higher than that of the control group (71.7), and this difference was significant (p < 0.001). This indicated that the Tech-blended PBL model had a positive impact on problem-solving ability.

5.3 Effects of the Tech-blended PBL model on autonomous learning

The MANOVA results show that there was a significant difference in autonomous learning ability between the experimental group and the control group ($p < 0.001$). The average score of the experimental group (85.5) was significantly higher than that of the control group (74.8). This indicated that the Tech-blended PBL model had a positive impact on autonomous learning.

An independent sample t-test was conducted on the differences in self-efficacy, motivation, perception, cognitive strategies and resource management strategies between the two groups. The results are shown in **Fig 8**. Although the experimental group's mean scores for motivation and cognitive strategies were higher than those of the control group, the p-values > 0.05.

Therefore, the Tech-blended PBL model did not have a significant impact on motivation and cognitive strategies. However, the Tech-blended PBL model had a significant impact on self-efficacy, perception, and resource management strategies ($p < 0.05$), with the experimental group mean scores being higher.



Dimensions	Levene's Test for Equality of Variances		t-test for Equality of Means		
	F	Sig.	t	Sig.(2-tailed)	MD
Self-efficacy	0.221	0.64	-4.315	0.000	-2.974
Motivation	0.590	0.44	-0.281	0.779	-0.214
Perception	0.042	0.84	-3.475	0.001	-3.075
Cognitive strategies	0.075	0.78	-1.609	0.112	-2.252
Resource management strategies	0.616	0.44	-4.360	0.000	-2.248

Fig. 8 Independent sample t-test results of 5 aspects of autonomous learning

5.4 Questionnaire responses and feedback

After the experiment, we conducted a questionnaire survey with 36 students in the experimental class. The survey covered topics such as the use of technology and their satisfaction levels. The questionnaire used a five-point Likert scale. After data collection, quantitative analysis was performed, and the results are shown in **Fig.**

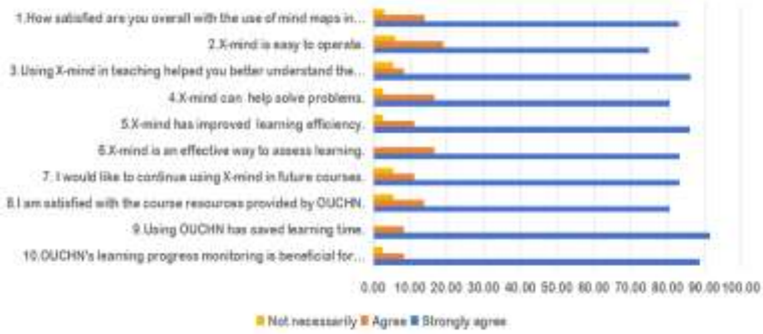


Fig.9 Technology Usage Satisfaction Survey

Overall, students have expressed a high level of satisfaction with the learning tools and resources provided by X-mind and OUCHN. X-mind has received widespread recognition for its ease of use, enhancement of course understanding, problem-solving capabilities, improvement of learning efficiency, and effectiveness in assessing learning. Additionally, 94.1% of students indicated that they would like to continue using X-mind in future courses. OUCHN has also excelled in saving learning time and enhancing self-directed learning abilities. This feedback provides valuable insights for further optimization and promotion of these tools and the establishment of models.

6. Discussion

6.1 Differences in course achievement

The first research question aimed to understand the impact on student achievement of the new teaching method: it improved course achievement in the experimental group. In the implementation, small group discussions were used and outcomes were presented using mind maps, that facilitated an in-depth understanding of the course content. Real-time access to the online course platform helped in mastering the course content.

This study was consistent with earlier research; Oberlander and Talbert-Johnson (2004) showed that the interactive and dynamic nature of technology-based PBL can increase student engagement and motivation, leading to deeper understanding and content retention. Woltering et al. (2009) further demonstrated that integrating course learning platforms into blended problem-based learning enhanced academic performance, satisfaction and autonomous learning.

6.2 Differences in problem-solving abilities

The Tech-Blended PBL model improved student problem-solving ability. The experimental group engaged in problem-oriented learning, seeking solutions based on real-world issues and relevant situations. They aimed to solve real-world problems by seeking resources to resolve the problems. Through this, they not only learnt from the course but also promoted learning as they actively engaged with the learning materials. Connecting the learned content to daily activities enhanced their knowledge and understanding. Mind mapping served as a real-time record of innovative points in learning, the asynchronous communication board on the online course platform provided a pathway for students to seek solutions. Through testing, the experimental group demonstrated higher proficiency in problem-solving.

Several studies found similar conclusions: Bransford et al. (1986) showed that integration of mind-mapping techniques into education significantly improved problem-solving skills. Similarly, the integration of course learning platforms and computer software with BPBL improved course performance and problem-solving skills (Efendi et al., 2022). Bukumiric et al. (2022) combined similar platforms and improved problem-solving ability.

6.3 Differences in Autonomous Learning

The problem-solving process improved the ability to learn autonomously and fostered the development of lifelong learning skills. When students studied on the online platform, it tracked and displayed progress, empowering them to steer their learning journey. Autonomous learning fostered problem-solving skills, promoting greater independence in their quest for knowledge.

From self-directed learning theory, learners enhanced their engagement and motivation in seeking solutions. This approach fostered the development of the capacity to adapt and persevere in challenging situations (Morris, 2019). Similarly, combining autonomous learning and problem-solving promoted personal responsibility for finding solutions (Yoesya et al., 2020). Furthermore, through self-directed learning, individuals had the flexibility to select what and how they wished to learn, enabling them to delve into areas of interest and customize their learning journey following their unique requirements and preferences (Hu & Zhang, 2017). Post-experimental testing indicated that students engaged in Tech-Blended PBL learning exhibit higher levels of autonomous learning than students in the traditional group.

6.4 Presenting real problems

Sweller and Cooper (1985) noted that in the early stages of learning, solving problems required a significant time investment in searching for materials, posing difficulties for them. Students presented problem-solving in the form of mind maps. As learners became more proficient in using the technology and gradually mastered the course content, their problem-solving abilities were strengthened.

Consequently, the teacher could progressively design more challenging problems for them to tackle. Therefore, during the study, we designed the following problems, ranging from simple to complex:

1) How many types of medical insurance are there, and what is the general content of each type?
2) Is medical insurance the same for all? How is individual insurance paid?
3) Since 2018, what major events affected medical insurance?
4) From your own experience or that of your family, how did you reimburse medical expenses after seeking treatment?

6.5 Suggestions for future study

Possible future research directions include:

1) How to facilitate the transformation of the teacher role? In Tech-Blended PBL, the teacher's role changed from being primarily a knowledge provider to a guide and facilitator of student learning. This transformation included guiding students familiar with OUCHN and mind-mapping, posing a challenge to the shift in their

role.
2) Xu et al. (2022) noted that learning behaviour on online course platforms, including engagement in forums, had a significant impact on autonomous learning. In this study, we found that students who actively participated in online course platforms, regularly posted in forums, watched course videos and showed higher autonomous learning ability. Therefore, data could be collected to confirm this in future studies.
3) Time management plays a crucial role in student success, especially for mature- creating a schedule: determining which learning tasks are most important; allocating specific periods for blended learning; and periodically assessing and adjusting time. So, in the future, attention to the impacts of time management on the effectiveness of teaching should be considered.

7. Conclusion

Although the implementation of the Tech-Blended PBL model required consideration of several factors, such as technology integration and the transformation of the teacher role, overall, the blended problem-based learning model, supported by online course platforms and mind mapping, led to student-centric teaching activities and was effective in enhancing motivation, interactivity and proactive behaviour**.** Our experiment demonstrated the new model effectively improved course achievement, problem-solving abilities and autonomous learning. In interview feedback, students were satisfied with the Tech-Blended PBL model.

7.1 Limitations

The sample used students, from the same major, lacked diversity, was relatively small and restricted in time. Compared with traditional learning strategies, the effect of PBL requires long-term observation (Schmidt et al., 2006), but we only evaluated short-term benefits and future study of long-term effects of Tech-BPBL is needed.

7.2 Recommendations

Some suggestions arose from our study:

1. In the early stages of the course, mature students should spend more time becoming acquainted with the use of mind mapping.
2. Using OUCHN requires good network support, so when students study online, they must ensure that the network bandwidth is adequate.
3. To enhance the efficiency of discussions, tutors may prescribe synchronous discussions during specific time slots.
4. To ensure the authenticity of experimental results, all students should remain anonymous.
5. Plagiarism was observed when students posted their work on the forum, requiring tutors to identify and address it.

7.3 Contributions

We developed a new Tech-Blended PBL model based on the elements of blended learning and problem-based learning.

1. **Technology integration:** This model integrates the OUCHN platform and mind mapping. OUCHN's adaptive learning system helps improve students' autonomous learning, and mind mapping helps students better understand and solve problems.
2. **Reflection and Improvement:** Design a questionnaire to conduct a satisfaction survey on the model, and qualitative analysis for reflection and improvement.
3. **The subjects were mature students.** New technologies have become a part of life and are changing the way we work. Mature students can add value to the economy as they are more likely to work while studying and have greater earning power after graduation.

7.4. Research ethics

All procedures in this study were conducted in accordance with the Research Ethics Committee of Shandong Open University, China. The approval reference number is 20240312.

7.5. Data availability

The datasets are available from the corresponding author on reasonable request.

Acknowledgements

This work was supported by King Mongkut's Institute of Technology Ladkrabang and Shandong Open University, China.

Funding Not applicable.

References

1. Aisyah, Mustaji, & Arsana, I. W. (2022). The effect of blended problem-based learning and independence

on learning outcomes chemical courses. Jurnal Mantik, 6(2), Article 2. https://iocscience.org/ejournal/index.php/mantik/article/view/2750
2. Amin, A. K., Sudana, I. N. D., Setyosari, P., & Djatmika, E. T. (2021). The Effectiveness of Mobile Blended Problem Based Learning on Mathematical Problem Solving. International Journal of Interactive Mobile Technologies (iJIM), 15(01), Article 01. https://doi.org/10.3991/ijim.v15i01.17437
3. Anwar, M. (2021). Analysis of Problem-Solving Skills of Vocational Teacher Candidates in Terms of Several Variables. Journal of Education Technology, 5(1), Article 1. https://doi.org/10.23887/jet.v5i1.33624
4. Baharudin, S. N. A., Murad, M., & Mat, N. H. H. (2013). Challenges of Adult Learners: A Case Study of Full Time Postgraduates Students. Procedia - Social and Behavioral Sciences, 90, 772–781. https://doi.org/10.1016/j.sbspro.2013.07.151
5. Barbey, A. K., & Barsalou, L. W. (2009). Reasoning and Problem Solving: Models. In Encyclopedia of Neuroscience (pp. 35–43). Elsevier Ltd. https://doi.org/10.1016/B978-008045046-9.00435-6
6. Barkman, SJ., & Machtmes, KL. (2001). Four-fold: A research model for designing and evaluating the impact of youth development programs. [4-H] News and Views, 54(4), 1, 4–6.
7. Barnard, L., Lan, W. Y., To, Y. M., Paton, V. O., & Lai, S.-L. (2009). Measuring self-regulation in online and blended learning environments. The Internet and Higher Education, 12(1), 1–6. https://doi.org/10.1016/j.iheduc.2008.10.005
8. Bayoumy, H. M. M., & Alsayed, S. (2021). Investigating Relationship of Perceived Learning Engagement, Motivation, and Academic Performance Among Nursing Students: A Multisite Study. Advances in Medical Education and Practice, 12, 351–369. https://doi.org/10.2147/AMEP.S272745
9. Bengo, N. M. de A. (2020). Managing Instructional Strategies in Classrooms With Adult Learners. The Journal of Continuing Higher Education, 68(2), 71–83. https://doi.org/10.1080/07377363.2020.1712578
10. Boelens, R., De Wever, B., & Voet, M. (2017). Four key challenges to the design of blended learning: A systematic literature review. EDUCATIONAL RESEARCH REVIEW, 22, 1–18. https://doi.org/10.1016/j.edurev.2017.06.001
11. Bransford, J., Sherwood, R., Vye, N., & Rieser, J. (1986). Teaching thinking and problem-solving: Research foundations. American Psychologist, 41(10), 1078–1089. https://doi.org/10.1037/0003-066X.41.10.1078
12. Brewer, L. (2013). Enhancing youth employability: What? Why? And How? Guide to core work skills.
13. Bukumiric, Z., Ilic, A., Pajcin, M., Srebro, D., Milicevic, S., Spaic, D., & Markovic, N. (2022). Effects of problem-based learning modules within blended learning courses in medical statistics – A randomized controlled pilot study | PLOS ONE. https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0263015
14. Busher, H., & James, N. (2019). Mature students' socio-economic backgrounds and their choices of Access to Higher Education courses. Journal of Further and Higher Education, 44. https://doi.org/10.1080/0309877X.2019.1576857
15. Buzan, T. (2002). How to Mind Map: The Ultimate Thinking Tool That Will Change Your Life (First Edition, First Printing). Thorsons.
16. Charnley, J. (2016). An Evaluation of the Relationship between Mature Students and Higher Education Institutions. https://www.academia.edu/28936108/An_Evaluation_of_the_Relationship_between_Mature_Students_and_Higher_Education_Institutions
17. dos Santos, S. C. (2017). PBL-SEE: An Authentic Assessment Model for PBL-Based Software Engineering Education. IEEE Transactions on Education, 60(2), 120–126. https://doi.org/10.1109/TE.2016.2604227
18. Dwiyogo, W. D. (2018). Developing a Blended Learning-Based Method for Problem-Solving in Capability Learning. The Turkish Online Journal of Educational Technology.
19. Efendi, A., Ariyani, A., & Asma, N. (2022). The Impact of Problem-Based Learning Models to Improve English Achievement at Middle-School 2 Karawang Barat. ETDC: Indonesian Journal of Research and Educational Review, 1(4), Article 4. https://doi.org/10.51574/ijrer.v1i4.355
20. Erickson, D. K. (1999). A Problem-Based Approach to Mathematics Instruction. Mathematics Teacher, 92(6), 516–521.
21. Evensen, D. H., Hmelo, C. E., & Hmelo-Silver, C. E. (2000). Problem-based Learning A Research Perspective on Learning Interactions. https://doi.org/10.4324/9781410604989
22. Fauzi, Z. A., & Metroyadi. (2020). The Effect of Mind Mapping Based Contextual Learning on Student Learning Outcomes. 75–78. https://doi.org/10.2991/assehr.k.201204.010
23. Fiore, S. M., Graesser, A., & Greiff, S. (2018). Collaborative problem-solving education for the twenty-first-century workforce. Nature Human Behaviour, 2(6), Article 6. https://doi.org/10.1038/s41562-018-0363-y
24. Gorghiu, G., Drăghicescu, L. M., Cristea, S., Petrescu, A.-M., & Gorghiu, L. M. (2015). Problem-based Learning—An Efficient Learning Strategy in the Science Lessons Context. Procedia - Social and Behavioral Sciences, 191, 1865–1870. https://doi.org/10.1016/j.sbspro.2015.04.570
25. Häkkinen, P., Virtanen, T., Virtanen, A., Näykki, P., Pöysä-Tarhonen, J., Niilo-Rämä, M., & Järvelä, S. (2020). Finnish pre-service teachers' perceptions of their strategic learning skills and collaboration

dispositions. Journal of Education for Teaching, 46(1), 71–86. https://doi.org/10.1080/02607476.2019.1708628
26. Hamzah, H., Tambak, S., Hamzah, M. L., Purwati, A. A., Irawan, Y., & Umam, M. I. H. (2021). Effectiveness of Blended Learning Model Based on Problem-Based Learning in Islamic Studies Course. International Journal of Instruction, 12(2), Article 2. https://repository.uir.ac.id/22354/
27. He, G. (2020). Blended Teaching Mode of Art Course based on Objective Achievement Scale. International Journal of Emerging Technologies in Learning (iJET), 15(13), Article 13. https://doi.org/10.3991/ijet.v15i13.14987
28. Heagney, M., & Benson, R. (2017). How mature-age students succeed in higher education: Implications for institutional support. Journal of Higher Education Policy and Management, 39(3), 216–234. https://doi.org/10.1080/1360080X.2017.1300986
29. Ho, Y. Y., & Lim, W. Y. R. (2020). Educating Adult Learners: Bridging Learners' Characteristics and the Learning Sciences.
30. Holec, H. (1981). Autonomy and Foreign Language Learning. https://eric.ed.gov/?id=ed192557
31. Hu, P., & Zhang, J. (2017). A pathway to learner autonomy: A self-determination theory perspective. Asia Pacific Education Review, 18(1), 147–157. https://doi.org/10.1007/s12564-016-9468-z
32. Huang, R., Chang, T.-W., & Zhang, X. (2020). Disrupted classes, undisrupted learning during COVID-19 outbreak in China: Application of open educational practices and resources | Smart Learning Environments. https://link.springer.com/article/10.1186/s40561-020-00125-8
33. Ibrahim, M., Arshad, M., & Rosli, M. (2015). The Need for an Integrated Framework for the Implementation of Blended Problem-Based Learning. International Education Studies, 8(13), Article 13. https://doi.org/10.5539/ies.v8n13p33
34. Jonassen, D. H. (2007). A Taxonomy of Meaningful Learning. Educational Technology, 47(5), 30–35. https://www.jstor.org/stable/44429440
35. Jonassen, D. H., Peck, K. L., & Wilson, B. G. (1999). Learning with Technology: A Constructivist Perspective. Merrill.
36. Kara, M., Erdoğdu, F., Kokoç, M., & Cagiltay, K. (2019). Challenges Faced by Adult Learners in Online Distance Education: A Literature Review (1). 11(1), Article 1. https://doi.org/10.5944/openpraxis.11.1.929
37. Kasworm, C. E. (2008). Emotional challenges of adult learners in higher education—Kasworm—2008—New Directions for Adult and Continuing Education—Wiley Online Library. https://onlinelibrary.wiley.com/doi/10.1002/ace.313
38. Knowles, M. S. (1978). Andragogy: Adult Learning Theory in Perspective. Community College Review, 5(3), 9–20. https://doi.org/10.1177/009155217800500302
39. Lee, D. (2000). Incorporating Adult Learning Characteristics and Preferences into a Course on Computer-Based Instructional Design. The Journal of Continuing Higher Education, 48(3), 24–30. https://doi.org/10.1080/07377366.2000.10400411
40. Lee, J., & Kwon, K. H. (2022). Motivation for improving academic achievement in cosmetological education. https://onlinelibrary.wiley.com/doi/10.1002/hsr2.919
41. Liu, M., Shi, Y., Pan, Z., Li, C., Pan, X., & Lopez, F. (2021). Examining middle school teachers' implementation of a technology-enriched problem-based learning program: Motivational factors, challenges, and strategies. Journal of Research on Technology in Education, 53(3), 279–295. https://doi.org/10.1080/15391523.2020.1768183
42. Loeng, S. (2020). Self-Directed Learning: A Core Concept in Adult Education. Education Research International, 2020, e3816132. https://doi.org/10.1155/2020/3816132
43. Mahan, J. D., & Stein, D. S. (2014). Teaching Adults—Best Practices That Leverage the Emerging Understanding of the Neurobiology of Learning. Current Problems in Pediatric and Adolescent Health Care, 44(6), 141–149. https://doi.org/10.1016/j.cppeds.2014.01.003
44. Morris, T. H. (2019). Self-directed learning: A fundamental competence in a rapidly changing world. International Review of Education, 65(4), 633–653. https://doi.org/10.1007/s11159-019-09793-2
45. Nunan, D. (1997). Designing and adapting materials to encourage learner autonomy. https://www.taylorfrancis.com/chapters/edit/10.4324/9781315842172-16/designing-adapting-materials-encourage-learner-autonomy-david-nunan
46. Oberlander, J., & Talbert-Johnson, C. (2004). Using Technology to Support Problem-Based Learning. Action in Teacher Education, 25(4), 48–57. https://doi.org/10.1080/01626620.2004.10648296
47. Pellegrino, J. W., & Hilton, M. L. (2012). Education for Life and Work: Developing Transferable Knowledge and Skills in the 21st Century. National Academies Press. https://doi.org/10.17226/13398
48. Perkins, D. F., & Mincemoyer, C. (2009). National life skills evaluation system. Unpublished reliability analysis findings. The Pennsylvania State University. He Pennsylvania State University. State College, PA.
49. Pintrich, P. R. (1991). A Manual for the Use of the Motivated Strategies for Learning Questionnaire (MSLQ). https://eric.ed.gov/?id=ED338122
50. Rasheed, R. A., Kamsin, A., & Abdullah, N. A. (2020). Students and teachers' challenges of using technology in blended learning environments. Proceedings of the 2020 3rd International Conference on Computers in Management and Business, 195–200. https://doi.org/10.1145/3383845.3383875
51. Reno, V. P. (2016). Social Security: The Foundation of Economic Security. SSA.

https://blog.ssa.gov/social-security-the-foundation-of-economic-security/
52. Ritchie, S. J., Della Sala, S., & McIntosh, R. D. (2013). Retrieval Practice, with or without Mind Mapping, Boosts Fact Learning in Primary School Children. PLoS ONE, 8(11), e78976. https://doi.org/10.1371/journal.pone.0078976
53. Schmidt, H. G., Vermeulen, L., & van der Molen, H. T. (2006). Long-term effects of problem-based learning: A comparison of competencies acquired by graduates of a problem-based and a conventional medical school. Medical Education, 40(6), 562–567. https://doi.org/10.1111/j.1365-2929.2006.02483.x
54. Shogren, K. A., & Wehmeyer, M. L. (2017). Problem Solving. In Development of Self-Determination Through the Life-Course (pp. 251–260). Springer Netherlands. https://doi.org/10.1007/978-94-024-1042-6_19
55. Shu, H., & Gu, X. (2018). Determining the differences between online and face-to-face student–group interactions in a blended learning course. The Internet and Higher Education, 39, 13–21. https://doi.org/10.1016/j.iheduc.2018.05.003
56. Solichin, M. M., Muhlis, A., & Ferdiant, A. G. (2021). Learning Motivation as Intervening in the Influence of Social Support and Self-Regulated Learning on Learning Outcome. International Journal of Instruction, 14(3), 945–964. https://doi.org/10.29333/iji.2021.14355a
57. Sophonhiranraka, S., Suwannatthachoteb, P., & Ngudgratokec, S. (2014). Factors affecting creative problem-solving in the blended learning environment: A review of the literature.
58. Stokhof, H., Vries, B. de, & Bastiaens, T. (2020). Using Mind Maps to Make Student Questioning Effective: Learning Outcomes of a Principle-Based Scenario for Teacher Guidance | Research in Science Education. https://link.springer.com/article/10.1007/s11165-017-9686-3
59. Sulastri, T. (2019). The Effect of The Mind Mapping Technique and Prior Knowledge in Guided Inquiry Learning Model on Critical Thinking Ability of Students. 345–349. https://doi.org/10.2991/icamr-18.2019.85
60. Surur, M., Degeng, I. N. S., Setyosari, P., & Kuswandi, D. (2020). The Effect of Problem-Based Learning Strategies and Cognitive Styles on Junior High School Students' Problem-Solving Abilities. International Journal of Instruction, 13(4), 35–48. https://doi.org/10.29333/iji.2020.1343a
61. Suryanata, W., & Wuryandani, W. (2019). Problem-Based Learning as an Alternative Method to Instill Cooperation: A Research Study. 534–537. https://doi.org/10.2991/iccie-18.2019.93
62. Sweller, J., & Cooper, G. A. (1985). The Use of Worked Examples as a Substitute for Problem Solving in Learning Algebra. Cognition and Instruction, 2(1), 59–89. https://www.jstor.org/stable/3233555
63. Woltering, V., Herrler, A., & Spitzer, K. (2009). Blended learning positively affects students' satisfaction and the role of the tutor in the problem-based learning process: Results of a mixed-method evaluation.
64. Wu, T.-T., & Chen, A.-C. (2018). Combining e-books with mind mapping in a reciprocal teaching strategy for a classical Chinese course. Computers & Education, 116, 64–80. https://doi.org/10.1016/j.compedu.2017.08.012
65. Xu, Q., Wu, J., & Peng, H. (2022). Chinese EFL University Students' Self-Efficacy for Online Self-Regulated Learning: Dynamic Features and Influencing Factors. Frontiers in Psychology, 13. https://www.frontiersin.org/journals/psychology/articles/10.3389/fpsyg.2022.912970
66. Yarbrough, J. R. (2018). Adapting Adult Learning Theory to Support Innovative, Advanced, Online Learning—WVMD Model. Research in Higher Education Journal, 35. https://eric.ed.gov/?id=EJ1194405
67. Yoesya, A. P., Nurihsan, J., & Adiwinata, A. H. (2020). Contribution of Self-Directed Learning in Maximizing Learning Outcomes of Students in Schools. 18–21. https://doi.org/10.2991/assehr.k.200130.071
68. Zhang, C., & Zheng, G. (2013). Supporting adult learning: Enablers, barriers, and services. Proceedings of the 14th Annual ACM SIGITE Conference on Information Technology Education, 151–152. https://doi.org/10.1145/2512276.2512323
69. Zhang, W., & Zhu, C. (2017). Review on Blended Learning: Identifying the Key Themes and Categories.
70. Zhang, Y.-B., Ning, T.-T., & Xue, T. (2017). Autonomous learning ability training of college students in Tianjin from the perspective of habitus and field. Journal of Discrete Mathematical Sciences and Cryptography, 20(1), 323–339. https://doi.org/10.1080/09720529.2016.1183309