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The influence factors of students' transferable skills development in Blended-Project-Based Learning environment: a new 3P model

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Abstract
Based on the existing 3P model, this paper constructed a new 3P model under the blended-project-based learning (BPBL) environment, used the course teaching data to verify this model, and revealed the potential factors that affect the learning process and learning outcomes. The results showed that the presage variables of academic motivation and course design positively affect the process variables of blended learning experience and learning engagement, respectively. The presage variable of academic motivation and the process variable of learning engagement positively affect the product variable of transferable skill development, respectively. In blended-project-based learning, it is necessary to enhance students' sense of experience and engagement by improving their academic motivation and optimizing course design, thereby promoting the development of students' transferable skills. This study has certain implications for optimizing blended-project-based teaching and promoting the development of students' team work ability, demonstration skills, management skills, and other transferable abilities.

Keywords New 3P model · Transferable skill development · Blended-project-based learning · Academic motivation · Course design · Learning experience · Learning engagement

1 Introduction

In 2009, the Partnership for 21st Century Skills (P21) put forward "The 21st Century Knowledge-and-Skills Rainbow", reshuffled and condensed the eleven skill sets into seven, all beginning with the letter "C" (7C skills), and combined with 3Rs (i.e., reading, writing and arithmetic) to put forward learning formula in the 21st century

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(Fadel et al., 2009). In 2016, China put forward a model of student development ability suitable for its own country in the 21st century (Core Competencies Research Group, 2016). These skills are also soft skills in employment (Ringvold & Digranes, 2017). Scholars propose that these 21st century skills can be converted in different disciplines and lives, so they are also called transferable skills (Hayakawa, 2014; Bridges, 1993). In order to equip students with 21st century skills, teachers must teach 21st century skills in the classroom. This goal requires changes in classroom teaching methods and course design (Namsone et al., 2016). Researchers explore different new teaching models to promote the development of students' 21st century skills. Some scholars have studied the application of situational teaching method, meaningful learning and new technology in 21st century education (Peña-Ayala, 2021). Research has shown that project-based or problem-based inquiry teaching is well consistent with the development of the 21st century skills (Odell & Kennedy, 2020). Some scholars also pointed out that project-based learning method is much better than traditional learning method in improving the 21st century skills, especially high-level skills (Fadel et al., 2009). The project-based learning method can help learners acquire the soft skills needed in the workplace in the 21st century (Musa et al., 2012).

Learning environment is of great help to develop students' transferable skills, such as the well-known blended learning environment. With the support of the blended learning environment, college students can practice skills such as information literacy, communication ability, ICT literacy, etc (Zurita et al., 2015). Under the blended learning environment, learners have significantly improved their learning motivation, attitude, academic achievement, teamwork and other aspects, and have acquired transferable skills outside the classroom through the online learning process (Bourdeau et al., 2018; Singh & Singh, 2017). Through quasi-experimental research on traditional and blended learning classes, it is found that students in blended learning classes have significantly improved their 21st century skills development (Hadiyanto et al., 2021).

The integration of project-based learning and blended learning provides a unique intersection for developing 21st century skills in the classroom (Alamri, 2021). Project-based learning, supplemented by blended learning, can give full play to the advantages of blended learning environment, and create student-centered courses around the project to achieve better student engagement, so as to cultivate students' core skills such as communication, collaboration, critical thinking, and creativity (Simeonov, 2016; Krajcik & Blumenfeld, 2006). So, what factors in blended-project-based learning (BPBL) activities will affect students' acquisition of transferable skills? The 3P model on the relationship between learning and teaching activities and results well explains the relationship between presage factors, process factors and product factors in teaching (Biggs, 1987; Biggs et al., 2001).

Previous studies have shown that new teaching models can promote the development of transferable skills. However, few studies have focused on the influencing factors of BPBL on students' transferable skills development. Based on the 3P model and combined with the BPBL environment, this study constructs a new 3P model to explore the relationship between students' personal factors, perceived teaching quality, learning experience and learning engagement factors and the development of students' transferable skills from the perspective of students. Therefore, this study focuses on the following issues: First, in the BPBL environment, whether students' personal factors and teaching factors will significantly affect the development of students' transferable skills; The second is how students' personal factors and teaching factors affect the development of students' transferable skills in the BPBL environment.

2 Theoretical Framework and Hypothesis

2.1 3P model

3P model is a learning model, which considers that students and teaching environment factors, learning methods and learning results form a system. This system consists of three parts, each of which starts with "P", so it is called "3P model" (Presage-Process-Product, 3P model). Presage factors include students' personal factors and teaching environment factors. Students have certain prior knowledge abilities, learning motivation, and cognition of university learning before they study in university. The teaching environment includes course design, course content, teaching methods and course evaluation. The process factor mainly refers to the learning methods used by students to explain the teaching environment according to their previous experience and motivation, and form the learning methods used to engage in specific learning tasks and achieve learning results. The learning outcomes depend on the method used. Product factors mainly include knowledge acquisition, achievements and emotional results (Biggs, 1989).

The 3P model is a balanced interactive system. The three components of presage, process and product tend to be dynamically balanced (Von Bertalanffy, 1968). This system model reveals the principles of teaching. First, learning is the direct result of students' individual differences; Second, learning is the result of proper teaching; Third, learning is the result of students' learning activities, which are the result of students' perception and investment in themselves and the whole teaching environment (John Biggs, 2012).

2.2 3P model in BPBL

2.2.1 Presage variables and Process variables

Academic motivation is one of the most studied concepts in educational psychology (Stover et al., 2012). Academic motivation is considered to be one of the most important psychological dimensions in students' learning and development (Roeser & Eccles, 1998). It is generally divided into internal motivation, external motivation and motivation (Vallerand et al., 1992). In the 3P model, academic motivation belongs to the individual factor of presage factors. Therefore, in this study, academic motivation is regarded as a presage variable.

In blended learning, course design integrates teachers and students into the blended mode, and realizes course discussion, teacher feedback, evaluation and interactive activities through face-to-face teaching and online teaching (McGee & Reis, 2012). Course design generally has four important features: organization and presentation, learning objectives and evaluation, interpersonal interaction, and technology application (Jaggars & Xu, 2016). In the 3P model, course design belongs to the teaching environment factor among presage factors. Therefore, in this study, course design is one of the presage variables.

Learning experience can be understood as the interaction between students and learning environment. In the process of interaction with the learning environment, students acquire subject knowledge, develop personal ability and improve professional skills (Ning & Downing, 2011). Students' learning experience will affect their online learning decision (Guo et al., 2016; Huang et al., 2017).

Student engagement refers to students' active participation in academic, extracurricular and school-related activities, as well as their commitment to educational goals and learning (Christenson et al., 2012). It can also be said that engagement refers to dynamic, targeted and sustained actions, or the observable quality of students' actual interaction with academic tasks (Ellen & Jennifer, 2012). Engagement is regarded as multi-dimensional, involving students' emotions, behaviors (participation, academic learning time), and cognition (Fredricks et al., 2004).

There are many motivations for students to learn a course, including the happiness generated in the process of learning, the consistency of the course and personal values, the value of learning activities, the desire to gain recognition from others or society, employment needs, and the requirements of university curriculum (Moneta & Spada, 2009; Ryan & Deci, 2000). These motivations may make students have different views on course learning, especially in terms of their preference for participating in course learning. Generally speaking, students with positive academic motivation will have a better impression of the course and experience the course learning activities more actively (Lepper et al., 2005). Therefore, we propose a hypothesis.

H1: Academic motivation positively affects students' blended learning experience.

In theoretical and empirical research, it is found that motivation is a prerequisite for student engagement (Anderman & Patrick, 2012; Skinner et al., 2009; Reeve, 2012). There is a positive relationship between motivation level and student engagement (Cox et al., 2013; Liu et al., 2009). Students driven by internal interests, recognized learning values and personal initiative are more likely to show higher engagement in learning activities (Ryan & Deci, 2017). Therefore, we infer that in blended-project-based learning (BPBL), the stronger the students' academic motivation, the more students will participate in the course learning. Therefore, we propose a hypothesis for this study.

H2: Academic motivation positively affects student engagement.

Students' blended learning experience is affected by the quality of course content, online interaction design and online learning platform (Chang et al., 2017; Weidlich & Bastiaens, 2019). Course design is one of the important factors that affect students' blended learning experience (Kaushal et al., 2021). Therefore, this study proposes a hypothesis.

H3: Course design positively affects students' blended learning experience.

Research shows that course design affects student engagement. With clear learning objectives and evaluation strategies, organized activities, reasonable course interaction design, and appropriate application of information technology, the course design will attract students to participate in the course learning more actively (Bhagat et al., 2016; Fredricks, 2011; Hew, 2016). Therefore, we propose a hypothesis for this study.

H4: Course design positively affects student engagement.

Learning experience is a kind of perception and interaction of students to the learning environment in the learning process. Learning engagement is the input degree of students in the learning process. In this study, learning experience and student engagement are regarded as learning process variables and are affected by academic motivation and course design.

2.2.2 Presage variables and Product variables

Transferrable skills can be understood as skills that can support learning in different disciplines, and can also be transferred to higher education, the workplace or other environments (Bennett et al., 1999), and are important skills in employment (Kearns, 2001). Different scholars have different understandings of transferable skills, but it is generally regarded as a general term, including various non-technical skills, such as teamwork, critical thinking, problem-solving, management skills, argumentation and presentation skills, leadership skills, etc. (Chan et al., 2017; Chan & Fong, 2018; Pellegrino & Hilton, 2012) .

Research shows that students' learning outcomes include "general academic achievements" and "personal transferable skills" (Otter, 1992; Eisner, 1979). The learning outcomes of higher education include subject outcomes and individual transferable outcomes. Subject outcomes based on learning objectives can be evaluated. Individual transferable outcomes mainly include independent action, cooperation ability, information technology use ability, communication ability, organizational skills, critical thinking, and comprehensive information analysis ability (Joann Allan, 1996). It can be seen that transferable skills are a part of learning outcomes, so this study takes transferable skills as product variable.

Research shows that academic motivation promotes the achievement of learning outcomes for students (Bailey & Phillips, 2015; Hsieh, 2014). There are empirical studies on the impact of academic motivation on learning outcomes and their differences between online learning and face-to-face learning (Francis & Wormington, 2019). Guided by the theory of learning motivation expectations, research has shown that academic motivation and learning experience are key factors determining learning outcomes (Lo et al., 2022). Research has shown that learning motivation positively affects students' cognitive and non-cognitive learning outcomes, while learning experience plays a moderating role between learning motivation and learning outcomes (Zhang et al., 2022). In an adapted 3P model, learning outcomes are defined as the integration of academic achievement, satisfaction, and core skills. At the same time, academic motivation is one of the student factors that affect students' learning outcomes as a presage variable (Barattucci et al., 2021). Transformable skills, as part of learning outcomes, are also influenced by academic motivation. Therefore, this study proposes the following hypothesis.

H5: Academic motivation positively affects students' transferable skills development.

Research has shown that course design can affect students' learning outcomes (Wang, 2017). As mentioned in the introduction of this study, some studies have shown that blended learning design and project-based learning design can greatly help develop students' transferable skills. Therefore, this study proposes the following hypothesis.

H6: Course design positively affects students' transferable skills development.

2.2.3 Process variables and Product variables

Researches have shown that learning outcomes directly or indirectly depend on students' perceptions of learning experiences (Diseth et al., 2010). Learning experience is related to educational performance, learning behavior, learning engagement, and learning outcomes (Blunsdon et al., 2003; Ning and Downing, 2011). Students' experience of the learning environment predicts learning behavior, which in turn predicts learning outcomes (Dent & Koenka, 2016; Guo et al., 2017; Trigwell et al., 2013). There are two types of learning outcomes commonly evaluated in the literature: cognitive learning outcomes and non-cognitive learning outcomes. Cognitive learning outcomes are usually evaluated through grade point average (GPA); Non-cognitive learning outcomes are measured by the development of students' self-reported general skills, such as problem solving, oral presentation skills, analytical skills, team work, and other transferable skills (Douglass et al., 2012; Lizzio et al., 2002).

Increased learning engagement contributes to learning outcomes (Kahu, 2013; Llorens et al., 2007). Researchers have found that university environment, teacher-student interaction, and classroom participation have significant effects on improving students' academic performance (Ko et al., 2016). A longitudinal study constructed a cognitive interaction model of college students' learning environment, engagement, and learning outcomes, further verifying the relationship between learning engagement and learning outcomes (Guo et al., 2023).

Based on the above discussion, this study proposes the following hypotheses.

H7: Blended learning experience positively affects students' transferable skill development.
H8: Learning engagement positively affects students' transferable skills development.

3 Methods

3.1 Participants

The participants were from a public university in Lanzhou, China. They were from the same major and had studied the same course taught by the same teacher. Participants have the same professional learning experience and the same teaching method to learn the same course. There were 153 participants, including 40 male students and 113 female students. Their ages range from 20 to 25 years old.

3.2 Treatment

This study is a survey of students who have studied the course "Multimedia Course Resource Design and Development". This course is taught by teachers with 12 years of teaching experience. The main purpose of the course is to enable students to learn the design and development of multimedia resources such as multimedia courseware and micro-course. The teaching method of the course mainly adopts blended-project-based learning. The online learning platform used in the course is the Fanya online teaching platform developed by China Chaoxing Corporation. With the help of this online teaching platform, teachers can build courses and publish courseware, learning videos, test questions, discussion topics, and project activities according to the teaching progress.

The teaching hours of this course consist of theoretical hours and practical hours. The course is highly practical and requires students to practice. The theoretical part of teaching is divided into online learning and offline classroom learning. The teaching of the practical part mainly adopts project-based learning, which is carried out through online management projects and offline group cooperation practical projects. Overall, the teaching method of the course is blended-project-based learning. The specific course implementation description is as follows.

Before class, teachers publish relevant learning notices and tasks on the online learning platform. Students use the online learning platform to preliminarily learn the relevant theoretical knowledge of this course and answer relevant test questions. In class, for theoretical knowledge, the teacher sorts out key knowledge and interprets students' questions based on their feedback from online learning before class. For practical content, the teacher publishes project topics and project requirements on the Fanya online learning platform, allowing students to plan, manage, and implement projects according to project requirements. According to the overall requirements of the online project, students are divided into groups to complete the team project plan, division of labor among team members, phased and final results of the project, project report display, and project evaluation. After class, teachers view the progress of student projects through the online learning platform, and use the discussion area under the PBL column of the Fanya online learning platform to post messages to guide students' project progress. Students continue to complete the course project, upload the project results online according to the timeline, and use the discussion area to communicate with team members about project implementation issues.

3.3 Instruments

The survey scale of this study mainly includes five variables: academic motivation, course design, blended learning experience, learning engagement, and transferable skill development, using the Likert 7-point scale, from 1 to 7. These five scales are all from the stable quality scale of the existing researches (see Table 1), and have been appropriately adjusted according to this study (see Appendix Table 6). The scale has added a scenario for filling out a questionnaire, such as "Please recall your feelings when learning the course 'Multimedia Course Resource Design and Development' and choose the appropriate item". In addition, the course design scale has been adjusted based on the course design and online learning platform functions of this study, such as adding the sentence "In teaching based on the Fanya platform". All the scales in this study underwent a reverse translation process (Brislin, 1970) and were modified according to the Chinese context.

The data analysis method in this study is a partial least squares structural equation model, and the analysis tool is SmartPLS 4.0. The data analysis process is mainly divided into two parts: one is to analyze the measurement model to evaluate its reliability, internal consistency, convergence validity and discrimination validity. The second is to analyze the structural model to evaluate the fitting degree, Coefficient of determination, and path coefficient of the model (Hair et al., 1998).

Table 1 Summary of the five scales and their sources

Scales	Adapted from
Academic Motivation	Academic Motivation measure developed by Yasuhiro et al. (2021)
Course design	Course design scale was adapted from the Blended learning Course Experience Scale (BLCES) proposed by Kaushal et al. (2021)
Blended learning experience	Blended learning experience scale was adapted from the Blended learning Course Experience Scale (BLCES) proposed by Kaushal et al. (2021)
Learning engagement	Learning engagement scale was adapted from the engagement with flipped and blended learning scale proposed by Fisher et al. (2018)
Transferable skills development	Transferable skills development measure developed by Ana Carvalho (2015)

4 Empirical Results

4.1 Measurement model results

4.1.1 Internal consistency reliability

Internal consistency reliability is the same degree of range and meaning of all items in a construct. It is usually measured by Cronbach's alpha and composite reliability (Cronbach, 1951; Werts et al., 1974). However, Chin (1988) recommends using composite reliability instead of Cronbach's alpha, since composite reliability overcomes some of Cronbach's alpha's deficiencies. Cronbach's alpha assumes that all items are equally reliable; therefore, it tends to severely underestimate the internal consistency reliability of latent variables in PLS structural equation models (Urbach & Ahlemann, 2010). In contrast, composite reliability takes into account that all items in a construct have different loadings (Henseler et al., 2009). Regardless of which coefficient is used for estimating internal consistency reliability, values above 0.700 are desirable for theoretical exploratory research and values above 0.800 or 0.900 in theoretical verification research, whereas values below 0.600 mean a lack of internal consistency reliability (Nunnally & Bernstein, 1994). However, values above 0.950 indicate potential common method bias (Straub et al., 2004). In this model, the Cronbach's alpha and composite reliability values of all latent variables are [0.812,0.919], [0.868,0.934] respectively (see Table 2), which are within the reasonable range.

4.1.2 Item reliability

Item reliability describes the degree to which a variable or group of variables is consistent regarding what it intends to measure (Urbach & Ahlemann, 2010). Item reliability can be assessed by the items' factor loadings. Generally, it is postulated that a latent variable should explain at least 50 percent of each item's variance. Accordingly, item factor loadings should be significant at least at the .050 level and greater than .707 (Chin, 1988). In theoretical exploratory research, item reliability value should be higher than 0.500 (Straub et al., 2004), 0.450 (Lewis et al., 1995), or 0.300 (Lederer & Sethi, 1992). And the significance of the item factor loadings can be tested using bootstrapping methods (Efron, 1992; Tibshirani & Efron, 1993). In this model, the factor loadings values of all items are [0.635, 0.871] (see Table 2). The significance of all the items' factor loadings is calculated by bootstrapping method ($k = 5000$) at the. 050 level, and the obtained P values are less than 0.05. Therefore, the reliability of all items in this model meets the requirements.

4.1.3 Convergent validity

Convergent validity refers to the degree to which individual items reflecting a construct converge in comparison to other items measuring different constructs. Usually,

Table 2 The results of the model's construct reliability and validity

Construct/Items	factor loadings, STDEV, T values and p values				Construct reliability and validity		
	Factor loadings	Standard deviation (STDEV)	T statistics	P values	Cronbach's alpha	Composite reliability	Average variance extracted (AVE)
Academic motivation (ACMO)					0.812	0.868	0.570
ACMO 1	0.747	0.038	19.547	***			
ACMO 2	0.666	0.075	8.822	***			
ACMO 3	0.750	0.050	14.960	***			
ACMO 4	0.746	0.045	16.735	***			
ACMO 5	0.854	0.024	35.132	***			
Course design (CODE)					0.907	0.923	0.574
CODE1	0.802	0.030	26.740	***			
CODE2	0.754	0.047	15.940	***			
CODE3	0.737	0.043	17.314	***			
CODE4	0.749	0.042	17.871	***			
CODE5	0.813	0.030	27.165	***			
CODE6	0.635	0.056	11.360	***			
CODE7	0.744	0.040	18.805	***			
CODE8	0.772	0.034	22.801	***			
CODE9	0.798	0.033	24.493	***			
Blended learning experience (BLEX)					0.894	0.917	0.614
BLEX1	0.729	0.049	14.878	***			
BLEX2	0.717	0.053	13.403	***			
BLEX3	0.746	0.051	14.716	***			
BLEX4	0.808	0.043	18.737	***			
BLEX5	0.862	0.025	34.690	***			

Table 2 (continued)

Construct/Items	factor loadings, STDEV, T values and p values				Construct reliability and validity		
	Factor loadings	Standard deviation (STDEV)	T statistics	P values	Cronbach's alpha	Composite reliability	Average variance extracted (AVE)
BLEX6	0.763	0.056	13.578	***			
BLEX7	0.847	0.026	32.178	***			
Learning engagement (LEEN)					0.889	0.918	0.692
LEEN1	0.818	0.034	23.769	***			
LEEN2	0.822	0.033	24.581	***			
LEEN3	0.809	0.027	29.575	***			
LEEN4	0.870	0.025	35.152	***			
LEEN5	0.840	0.034	24.759	***			
Transferable skills development (TRSK)					0.919	0.934	0.639
TRSK1	0.806	0.033	24.545	***			
TRSK2	0.733	0.039	18.670	***			
TRSK3	0.769	0.044	17.333	***			
TRSK4	0.828	0.030	27.399	***			
TRSK5	0.777	0.037	21.003	***			
TRSK6	0.787	0.037	21.315	***			
TRSK7	0.818	0.038	21.389	***			
TRSK8	0.871	0.021	41.238	***			

***$p < 0.001$

convergent validity is assessed by the average variance extracted (AVE) proposed by Fornell & Larcker (1981). An AVE value of at least 0.500 indicates that a latent variable is on average able to explain more than half of the variance of its items and, thus, demonstrates sufficient convergent validity. In this model, the AVE values of all latent variables are [0.570,0.692] (see Table 2), all greater than 0.500.

4.1.4 Discriminant validity

Discriminant validity refers to the degree to which the measures of different constructs differ from one another (Urbach & Ahlemann, 2010). Whereas convergent validity tests whether a particular indicator measures the construct it is supposed to measure, discriminant validity tests whether the indicators do not unintentionally measure something else. In PLS structural equation model, two criterions of discriminant validity are commonly used. For the first criterion, cross-loadings are obtained by correlating each latent variable's component scores with all the other indicators (Chin, 1988). If each item's factor loading is higher for its designated construct than for any of the other constructs, and each of the constructs factor loadings highest with its assigned indicators, it can be inferred that the different constructs' items are not interchangeable. The second criterion, the Fornell-Larcker index (Fornell & Larcker, 1981), requires a latent variable to share more variance with its assigned items than with any other latent variable. Accordingly, the AVE of each latent variable should be greater than the latent variable's highest squared correlation with any other latent variable (Urbach & Ahlemann, 2010). In this model, both cross-loadings criteria and Fornell-Larcker criteria meet the requirements (see Table 3 and Table 4).

4.2 Structural model results

It can be seen from the results of the previous measurement model that this model has reliable and valid outer model estimations (Henseler et al., 2009). Next, we evaluated the internal model. The Structural model was assessed from endogenous variables' explanatory power (i.e., R^2), the PLS goodness-of-fit proposal by Tenehaus et al. (2005), and the estimates for path coefficients.

Table 3 The results of model's discriminant validity by Fornell-Larcker criterion

	ACMO	CODE	BLEX	LEEN	TRSK
ACMO	**0.755**				
CODE	0.646	**0.758**			
BLEX	0.631	0.731	**0.783**		
LEEN	0.674	0.618	0.720	**0.832**	
TRSK	0.650	0.672	0.699	0.702	**0.799**

The bold values in the diagonal row are the square roots of the average variance extracted for the constructs in the research model

Table 4 The results of model's discriminant validity by Cross-loadings criterion

Items	ACMO	CODE	BLEX	LEEN	TRSK
Academic motivation (ACMO)					
ACMO1	**0.747**	0.463	0.485	0.591	0.551
ACMO2	**0.666**	0.323	0.291	0.289	0.326
ACMO3	**0.750**	0.485	0.495	0.521	0.428
ACMO4	**0.746**	0.599	0.539	0.546	0.522
ACMO5	**0.854**	0.513	0.512	0.522	0.565
Course design (CODE)					
CODE1	0.533	**0.802**	0.508	0.453	0.446
CODE2	0.486	**0.754**	0.450	0.348	0.467
CODE3	0.378	**0.737**	0.450	0.345	0.475
CODE4	0.476	**0.749**	0.490	0.388	0.475
CODE5	0.548	**0.813**	0.544	0.447	0.567
CODE6	0.519	**0.635**	0.613	0.672	0.514
CODE7	0.457	**0.744**	0.604	0.457	0.455
CODE8	0.427	**0.772**	0.567	0.498	0.557
CODE9	0.534	**0.798**	0.667	0.498	0.571
Blended learning experience (BLEX)					
BLEX1	0.534	0.657	**0.729**	0.455	0.518
BLEX2	0.404	0.584	**0.717**	0.440	0.514
BLEX3	0.503	0.460	**0.746**	0.571	0.544
BLEX4	0.463	0.532	**0.808**	0.555	0.548
BLEX5	0.553	0.562	**0.862**	0.669	0.620
BLEX6	0.467	0.513	**0.763**	0.576	0.499
BLEX7	0.524	0.676	**0.847**	0.665	0.581
Learning engagement (LEEN)					
LEEN1	0.523	0.478	0.590	**0.818**	0.564
LEEN2	0.544	0.495	0.568	**0.822**	0.571
LEEN3	0.584	0.589	0.623	**0.809**	0.589
LEEN4	0.618	0.542	0.627	**0.870**	0.632
LEEN5	0.527	0.458	0.582	**0.840**	0.557
Transferable skills development (TRSK)					
TRSK1	0.537	0.512	0.540	0.511	**0.806**
TRSK2	0.498	0.601	0.579	0.464	**0.733**
TRSK3	0.368	0.476	0.510	0.537	**0.769**
TRSK4	0.543	0.471	0.489	0.581	**0.828**
TRSK5	0.554	0.560	0.556	0.567	**0.777**
TRSK6	0.513	0.537	0.545	0.489	**0.787**
TRSK7	0.586	0.534	0.605	0.664	**0.818**
TRSK8	0.535	0.594	0.629	0.646	**0.871**

The bold values are the loadings of each item on its latent variable in the research model

4.2.1 Coefficient of determination(R^2)

R^2 measures the explained variance of a latent variable relative to its total variance. Since the main goal of PLS-SEM path modeling is to maximize the explained variance of all endogenous latent variables in the model, thus, R^2 of endogenous latent variables is considered as an important criterion in the PLS structural model (Henseler et al., 2009). The value of R^2 of endogenous latent variables should be sufficiently high for the structural model to have a minimum level of explanatory power (Ringle, 2004). About the standard of R^2 value, Chin (1988) suggested values of approximately 0.670 substantial, values around 0.333 moderate, and values around 0.190 weak. This model has three endogenous latent variables, namely, blended learning experience, learning engagement and transformable skills development. The corresponding R^2 values of the three endogenous latent variables were 0.578, 0.512 and 0.618, respectively (see Fig. 1), with sufficient explanatory power.

4.2.2 Goodness-of-fit (Gof)

Although the PLS algorithm does not provide any overall goodness-of-fit index, a global criterion of goodness-of-fit has been proposed by Tenenhaus et al. (2005). The value of global goodness-of-fit is the geometric mean of the average AVEs and the average R^2 of endogenous latent variables, whereas higher value represents better path model estimations. The value of GoF is described as small (0.100), medium (0.250) and large (0.360). According to this calculation method, the Gof value of this model is 0.593. Therefore, the path model constructed in this study was acceptable.

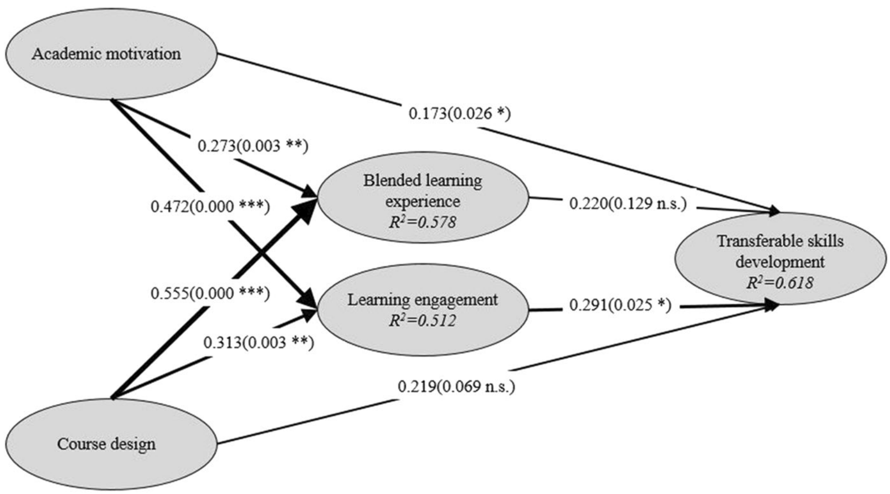

Fig. 1 Structural model for the research. Note. *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$; n.s.=nonsignificant

4.2.3 Path coefficients

The algebraic sign, magnitude, and significance of the path coefficients between the model's latent variables were assessed. If the sign of the path coefficient is opposite to the theoretical hypothesis, the preset hypothesis will not be supported. A path coefficient's magnitude refers to the strength of the relationship between two latent variables. In general, resampling techniques such as bootstrapping (Efron, 1992; Efron & Tibshirani, 1994) or jackknifing (Miller, 1974) should be used to determine the significance of path coefficients. In this model, bootstrapping method(K=5000) was used to determine the significance of path coefficients.

The validation results of path coefficients were presented in Table 5 and Fig. 1. In this model, all path coefficients' algebraic signs are consistent with the theoretical assumptions. In the environment of blended project-based learning, learner's blended learning experience was significantly affected by their academic motivation and the quality of course design, therefore supporting H1 and H3. Learner's learning engagement was significantly affected by their academic motivation and the quality of course design, therefore supporting H2 and H4. Learner's transferable skills development was significantly affected by their academic motivation and learning engagement, therefore support H5 and H8. Learner's transferable skills development was not significantly affected by the quality of course design and their blended learning experience, therefore reject H6 and H7.

5 Discussion

Previous studies have mentioned that blended learning or project-based learning can cultivate students' 21st century abilities or transferable skills (Simeonov, 2016; Alamri, 2021). However, most studies have theoretically demonstrated that new teaching models will promote the development of 21st century skills (or transferable skills) (Stephanie Bell, 2010; Devkota et al., 2017; Nurhayati et al., 2020) . There are also empirical studies conducted at the level of learning outcomes, indicating

Table 5 The result of the structural model

Hypothesis	Path	Path coefficients	Standard deviation (STDEV)	T statistics	P values	Support
H1	ACMO ➔ BLEX	0.273	0.093	2.921	**	yes
H2	ACMO ➔ LEEN	0.472	0.090	5.233	***	yes
H3	CODE ➔ BLEX	0.555	0.094	5.896	***	yes
H4	CODE ➔ LEEN	0.313	0.106	2.954	**	yes
H5	ACMO ➔ TRSK	0.173	0.078	2.231	*	yes
H6	CODE ➔ TRSK	0.219	0.121	1.816	n.s.	no
H7	BLEX ➔ TRSK	0.220	0.145	1.520	n.s.	no
H8	LEEN ➔ TRSK	0.291	0.130	2.244	*	yes

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$; n.s.=nonsignificant

that project-based or blended learning has a positive effect on 21st century skills (Baran et al., 2021; Ravitz et al., 2012; Bani-Hamad & Abdullah, 2019; Eliyasni et al., 2019). Few studies have investigated the impact of project-based learning and blended learning on transferable skills based on learning processes. Since the results of blended-project-based learning indicate that it can affect students' transferable skills development, we believe it is necessary to study dynamic learning processes and reveal potential factors for learning outcomes.

Based on the existing 3P model, this study reconstructs research variables according to research topics to form a new 3P model. The new 3P model not only provides suggestions for improving the effectiveness of course instructional design, but also completes a theoretical framework for understanding the impact of learning behavior on the development of transferable skills in blended-project-based learning. Based on the 3P model, we assume that students' motivation and course design will affect their experience and engagement in the course, which in turn will affect the development of students' transferable skills.

5.1 The blended learning experience is influenced by presage variables, academic motivation and course design

The methods used in teaching and learning have been proven to not only directly affect the learning experience, but also improve students' learning experience (Poon, 2013). For example, blended learning is a way to improve students' learning experience (Bouilheres et al., 2020). Other new teaching models, such as flipped classrooms, can also affect students' learning experience, motivation, and engagement (Awidi & Paynter, 2018). It can be seen that the design of course teaching models will affect students' learning experience. Academic motivation plays a mediator and moderator role between learning experience and academic achievement (Ning & Downing, 2011). Some studies have shown that academic motivation can affect learning experience (Lepper et al., 2005). In this study, academic motivation and course design positively affect the blended learning experience, which is consistent with existing researches.

From the path analysis, students' academic motivation and course design have a significant direct impact on their blended learning experience. These factors account for a 57.8% variation (R^2=0.578) in the blended learning experience. The impact of course design is higher than that of academic motivation. This indicates that good course design will enable students to have a better course learning experience. In addition, the stronger the students' academic motivation, the better their experience of the learning process during course learning.

Our results show that blended learning experience can be improved as a process variable in the 3P model, and learners' own factors and learning environment factors play an important role. If educators want to give students a better experience in BPBL, they need to start by optimizing course design and stimulating students' academic motivation.

In terms of course design, educators can continuously try new teaching models and optimize all aspects of course teaching (McGee & Reis, 2012; Kaushal et al., 2021). For example, we can refine the course objectives to allow students to learn targeted. It is possible to divide learning content into project activities, guide students to actively participate in project practice, and do a good job in project supervision, project feedback, and evaluation. In the classroom, teachers often organize learning activities aimed at knowledge application and improvement to promote the occurrence of deep learning and the improvement of high-level skills among students. Online teaching should be well planned for teaching content, management of project activities, feedback, and evaluation.

The motivation for students' learning behavior stems from their needs and the value of goals available in the environment (Eccles & Wigfield, 1995). In particular, internal motivation itself is related to reward activities, so reward and punishment systems can affect academic motivation (Pintrich & Schunk, 2001). Motivation activities can stimulate students' confidence in acquiring new abilities and make them feel satisfied with the results of learning tasks (Keller, 1987). Both project-based learning and blended learning methods can improve students' academic motivation (Shin, 2018; Chiang & Lee, 2016; Islam et al., 2018). Therefore, in order for students to be interested in learning, the design of project activities for courses needs to be related to the students' experience, learning objectives, and real life. We should establish appropriate reward and punishment evaluation mechanisms in learning to stimulate students' academic motivation. Teachers should provide more guidance on learning methods, professional knowledge, and skills, organize students to carry out reflective activities, and let students feel the support of learning and be willing to actively participate in learning. Teachers can use online learning platforms and online communication tools to focus on online language and learning interests, and increase their affinity (Wenzhi Zheng et al., 2021). In teaching, teachers can carry out more sharing activities that focus on emotional communication, argumentation, criticism, and reflection, so that students can feel the value of the course and benefit from cooperative knowledge construction (Coyne et al., 2018; Zhang, 2018).

5.2 Learning engagement is influenced by presage variables, academic motivation, and course design

Researches have shown that there are many factors that affect student engagement, and they can be divided into two categories. The first category refers to the intrinsic factors of students, including thoughts, methods, intellectual factors (attention, memory, thinking) and non-intellectual factors (academic motivation, learning interest, personality, emotions, learning attitudes, learning habits, etc.). The second category refers to the external factors of students, including three aspects: social education environment, family education environment, and school education environment. Among them, students' non-intellectual factors are the key factors (Li & Xue, 2023). It can be seen that students' non-intellectual factor, academic motivation, is the key factor affecting learning engagement, and empirical researches have confirmed this point (Hongbin et al., 2020). In addition, course design, as a part of the school educational environment, also affects students' engagement (Fink, 2007). Different course design models can also affect student engagement. Project-based learning improves student engagement and performance (Robinson, 2013). There are empirical studies that explore the impact of project-based learning on student engagement, and study the influencing factors (Bédard et al., 2012). In this study, academic motivation and course design affect learning engagement, which is consistent with existing researches.

From the path analysis, students' academic motivation and course design have a significant direct impact on their learning engagement. These factors account for a 51.2% variation (R^2=0.512) in learning engagement. The impact of academic motivation is higher than that of course design. This indicates that the stronger students' academic motivation, the more likely they will participate in the learning of the course. In addition, a well-designed course will also attract more students to participate.

Our results show that learning engagement as a process variable in the 3P model can be improved, and students' own academic motivation and different course design can have an impact. Educators can improve students' learning engagement by enhancing their academic motivation and improving course design. Similarly, teaching workers can improve students' academic motivation by setting reasonable rewards and punishments, setting learning activities that learners are interested in, and providing learning support and feedback. Educators can improve course design from aspects such as course objectives, course activities, project activities, teaching activity organization, teaching feedback, project supervision and evaluation, and online and offline teaching activity arrangements to explore more suitable new teaching models.

5.3 Transferable skills development as a product variable is influenced by academic motivation as a presage variable and learning engagement as a process variable

Transferable skills are the non-cognitive part of learning outcomes, mainly skills that students can transfer to different contexts. In this study, the presage factors of academic motivation and the process factors of learning engagement, significantly affect the development of transferable skills, respectively, which is consistent with existing research results (Zhang et al., 2022; Llorens et al., 2007). The presage factors of course design and the process factors of blended learning experience have no significant impact on the development of transferable skills. From the path analysis, these factors explain the 61.8% (R^2=0.618) variation in transferable skill development.

From the results of our research, it is found that students' own academic motivation and engagement in learning are key influencing factors for the development of their own transferable skills. Therefore, it is possible to promote the development of students' transferable skills by improving their academic motivation and participation in learning.

In this study, course design and blended learning experience are not factors that affect the development of transferable skills. This result may be due to the fact that the development of students' transferable skills is not achieved overnight and requires accumulation over time. The main investigation in this study is whether course design and students' blended learning experience can promote the development of students' transferable skills in the learning of a professional course, which has certain limitations. It is difficult to change students' transferable skills through a semester of course teaching. The development of students' non-cognitive abilities is influenced by multiple factors and is the result of long-term effects (Gutman & Schoon, 2013; Khine & Areepattamannil, 2016).

As discussed earlier, course design can affect learning engagement, which indicates that optimizing the course design can improve students' engagement in the learning of the course. Only when students are more engaged in the course learning can they achieve better learning results. It can be seen that the quality of course design will still have an impact on students' learning outcomes. The blended-project-based learning course design in this study cannot directly affect the development of students' transferable skills, but it will affect the degree of students' engagement in this course. From this, the author draws inspiration that in future teaching, it is also necessary to strengthen the teaching design of this course, refine learning projects and management, and enable students to exercise their transferable skills more in the course learning.

6 Conclusion and limitation

6.1 Conclusion

Our research builds a new 3P model in BPBL environment based on existing 3P models, with academic motivation and course design as presage variables, blended learning experience and learning engagement as process variables, and transferable skill development as product variables. At the same time, we verified the relationship between these variables. Decades of researches have integrated and proven that new learning models, such as project-based learning and blended learning, can promote the development of students' 21st century core competencies or transferable skills, but efforts to study the process and understand intermediate factors are limited. Our research explores the impact of BPBL on the development of students' transferable skills from the perspectives of students' own factors, course design, and student learning processes (learning experience and learning engagement), and identifies the intermediate factors. This study has made some contributions to understanding students' learning behavior in BPBL. The results show that students' own academic motivation and learning engagement can improve the development of students' transferable skills; The students' academic motivation and course design quality affect their blended learning experience and learning engagement.

There are some implications for teachers and practicing BPBL. Firstly, students' own factors (such as academic motivation) are important factors in the learning process and learning outcomes. Secondly, learning environment factors (such as course design) can have an important impact on students' learning processes (such as learning experience and learning engagement). Thirdly, the engagement of the learning process can also affect students' learning outcomes (such as transferable skill development). Therefore, in course teaching, efforts should be made to design teaching elements in terms of project activities and blended experiences, which can improve course teaching in the following aspects. Firstly, the arrangement of course project activities is more comprehensive, which can integrate course knowledge into project activities, make students feel the value of project activities, and stimulate their internal learning motivation. Secondly, the project management process should establish a reasonable reward and punishment mechanism to improve students' external learning motivation. Thirdly, teachers should provide timely feedback and appropriate support, so that students have a better learning experience and are more willing to participate in the course learning. Fourth, a mechanism can be established to promote group communication, enabling students to actively communicate and have subjective initiative in group projects. For example, it is possible to establish team project management rules, clarify the division of roles, rotate team members as team leaders, and randomly select team members to report project progress.

Educators should intentionally design classroom and project activities to highlight students' active participation in learning activities and the exercise of their comprehensive abilities. For example, we can guide students to realize the value of BPBL and position their functions within the team. These can increase students' effort, attention, and persistence in BPBL tasks, ultimately improving their motivation, thereby having a positive impact on the development of transferable skills in learning (Lo et al., 2022). In project activities, it is possible to create an environment suitable for collaborative learning in student groups, guide students to use information tools to collect information and solve problems in project activities, boldly propose their own views, demonstrate, and criticize. These can increase students' active participation in blended learning project activities, ultimately improving their learning engagement, while exercising their transferable skills.

6.2 limitations and future studies

This study builds and validates a new 3P model for blended-project-based learning based on the 3P model for learning outcomes research. However, there are certain limitations in the research, which also provides a direction for future research.

First, the data analyzed in this study are from self-reporting surveys. After completing the course, students recall the learning process of the course and report their learning experience through a questionnaire, which may have some bias and subjectivity. In future research, some data sources can be added, such as teacher observations of students, and student learning process outcomes. Different research paradigms, such as structured interviews or observations, can also be used. So as to have a more comprehensive study of the learning process and results of students. Secondly, all data are from students studying the same course at a university in Lanzhou, China. The horizontal nature of research is a limitation, so the universality of these results should be carefully viewed, as well as whether there are other factors that can affect the learning process and results, especially the development of students' transferable skills. Future research directions can expand the variables of presage, process, and product to enrich our research models.

Appendix 1

Table 6 Dimensions and items of the research model

Construct	Secondary dimension	Item
Academic Motivation (ACMO)	Intrinsic Motivation to Know (ACMO 1)	When I master new knowledge and skills, I will feel happy.
		By studying professional courses, I can learn something that interests me.
		When I achieve my personal achievements and surpass myself, I experience happiness.
		I have experienced personal satisfaction in pursuing excellence in professional courses.
	Identified Regulation (ACMO 2)	I believe that a college education will help me better prepare for the career I choose.
		Studying professional knowledge in college will enable me to obtain a job that I enjoy after graduation.
	Introjected Regulation (ACMO 3)	When I succeed in college, I feel important.
		I want to prove that I can succeed in my studies.
	External Regulation (ACMO 4)	Studying in college is to get a more prestigious job in the future.
		To study in college, in order to have a better salary in the future.
	Amotivation (ACMO 5)	I understand and care about why I went to college.
		In college, I know how to learn and plan.

Table 6 (continued)

Construct	Secondary dimension	Item
Course design (CODE)	——	CODE1: In teaching based on the Fanya platform, teachers clearly describe course objectives, project tasks, learning activities, etc.
		CODE2: In the course, the teacher clearly stated the course objectives, teaching objectives, project activity requirements, and released online learning tasks
		CODE3: Overall, the teachers have organized the course teaching well.
		CODE4: Face-to-face classroom teaching and online teaching on the Fanya platform are well connected.
		CODE5: Teachers have a good grasp of the teaching rhythm of the course.
		CODE6: Teachers pay more attention to my course learning.
		CODE7: In face-to-face and online teaching, feedback from teachers on my homework and task completion has been very helpful to me.
		CODE8: The teacher used the Fanya platform to guide me, which was very helpful for my learning.
		CODE9: The course resources on the Fanya platform have a reasonable structure and are easy to navigate.

Table 6 (continued)

Construct	Secondary dimension	Item
Blended learning experience (BLEX)	——	BLEX1: The course resources on the Fanya platform have enriched my learning experience.
		BLEX2: Communicating with classmates and teachers based on the Fanya platform has improved my academic performance.
		BLEX3: The blended learning of online and offline has improved my time management skills.
		BLEX4: The blended learning of online and offline has improved my digital literacy.
		BLEX5: The blended learning of online and offline has improved my academic performance.
		BLEX6: Blended learning enables me to learn at any time, at any speed, anywhere, using any device.
		BLEX7: Using the Fanya platform to view teaching resources, submit assignments, carry out project activities, and communicate with teachers and students are all satisfactory.
Learning engagement (LEEN)	——	LEEN1: During this course, I focused on learning the content of the course.
		LEEN2: During this course, I have the motivation to complete the course content, assignments, and project activities.
		LEEN3: During this course, I had a pleasant learning experience.
		LEEN4: During this course, I was able to fully understand the course content.
		LEEN5: During this course, I can better control the learning rhythm.

Table 6 (continued)

Construct	Secondary dimension	Item
Transferable skills development (TRSK)	——	TRSK1: Through this course, my information search skills have improved to a certain extent.
		TRSK2: Through the study of this course, my team work skills have improved to a certain extent.
		TRSK3: Through the study of this course, my argumentation skills have improved to a certain extent.
		TRSK4: Through the study of this course, my conflict management skills have improved to a certain extent.
		TRSK5: Through the study of this course, my ability to apply knowledge has improved to a certain extent.
		TRSK6: Through the study of this course, my reporting or presentation skills have improved to a certain extent
		TRSK7: Through the study of this course, my self-confidence has improved to a certain extent.
		TRSK8: Through the study of this course, my ability to “view and solve problems from multiple perspectives” has been improved to a certain extent.

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Authors' contributions XL conducted blended-project-based teaching, found research problems, designed research plans, and conducted investigation research. WZ processed and analyzed the research data. Both authors participated in the writing, revision and submission of the manuscript.

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Data availability The original contributions presented in this study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Declarations

Ethics approval This study did not require institutional review board approval because none of the questionnaire items involved personal information.

Informed consent All participants were volunteers who provided written informed consent.

Conflict of interest The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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