

# Whether We Can Influence Students' Self- Efficacy and Emotional Expectation Value of Deep Learning Through the Perception of Teacher-Student Interaction and Peer Interaction? Through the Lens of IEEP

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**Abstract:** *This study investigates the deep learning of students in the Innovation and Entrepreneurship Education Program (IEEP). Based on the ecosystem theory and the expected value theory, this study studies whether teacher-student interaction and peer interaction can influence students' deep learning willingness through students' self-efficacy and emotional value expectation. The study examined the relationships between students' perceived teacher-student interaction, peer interaction, self-efficacy, emotional value expectations, and deep learning. A total of 265 students from a Chinese university who participated in the Innovation and Entrepreneurship Education Program (IEEP) participated in this study. The research tools were developed mainly through exploratory factor analysis (EFA) and partial least squares structural equation model (PLS-SEM) to verify the research hypothesis. The research results show that the teacher-student interaction and peer interaction perceived by students have a significant predictive effect on students' self-efficacy and emotional value expectations. Moreover, students' self-efficacy and emotional value expectation have a significant predictive effect on deep learning behavior, self-efficacy and emotional expected value for project success mediate between students' perceived teacher-student interaction and peer interaction and students' deep learning level. The result indicates that the influence of micro-ecosystem on people's intrinsic belief value will affect people's behavior, and it also shows that the creation of such activities has a significant impact on improving students' deep learning ability and innovation and creativity ability.*

**Keywords:** Teacher-student interaction; Peer interaction; Deep learning; Self-efficacy; Emotional value expectation

## 1. Introduction

Since 2015, the State Council of China has issued Opinions on Policies and Measures to Vigorously Promote Mass Entrepreneurship and Innovation, and various industries have been actively implementing the policies, including higher education. The report of the 18th National Congress of the Communist Party of China proposed to promote the connoted development of higher education, improve the quality of talent training, and cultivate more top-notch innovative talents (Liu & Zhang, 2020). The essence of "mass entrepreneurship and innovation"

for talent training in higher education is to cultivate students' deep thinking and independent innovation ability, which coincides with the demand for improving students' deep learning ability.

In the state of deep learning, students have intrinsic understanding motivation and learning intention for learning tasks (Marton&Saljo, 1997), summarizing and concluding the previous knowledge and experience, forming a systematic knowledge of the integration of old and new knowledge(Biggs, 1987), In addition, deep learning is a key strategy for meaningful learning, which represents students' comprehensive learning ability of integration, synthesis and reflection(Laird et al ., 2008), moreover, in the context of sustainable development education, deep learning represents the comprehensive ability of interdisciplinary thinking, innovation and insight(Warburton, 2003). Therefore, deep learning ability represents comprehensive thinking ability and learning ability, which is strongly related to innovation and creation ability. Environmental education and a sustainable educational environment help develop students' ability to think critically, creatively, solve problems and make effective decisions(PCSD, 1994), Providing a good teaching environment, learning support and appropriate content methods are more helpful for students to adopt deep learning ability(Ramsden, 1997). Therefore, the current research of the Innovation and Entrepreneurship Education Program(IEEP) based on a Chinese universities, the students take part in the project is divided into different professional, different grade, students volunteered to sign up for the project, the organizing committee of the project according to the students' specific project arrange in each group a guiding teacher. Finally, A total of 20 teams participated in the competition. The criteria for the success of the project competition will be decided by the project organizing committee. The selection criteria for the theme of the competition should be in line with innovation and entrepreneurship.

The study conducted model verification on students' perception of external teacher and peer environment, students' internal mental state and actual deep learning ability, Based on Microsystem in Ecosystem Theory (Bronfenbrenner et al., 2007), it is assumed that students' perceived teacher-student interaction and peer support have an impact on students' individual psychology. In addition, based on the theory of expected value (Atkinson, 1957), it is believed that students' high level of self-efficacy and emotional value expectation has a significant impact on students' deeper learning level, and plays a role in improving students' deep innovation ability and creativity level.

### **1.1 The Mediating Role of Self-efficacy between Perceived Teacher-student Interaction and Peer Interaction and Deep Learning**

Self-efficacy refers to a person's belief that he or she is capable of achieving a specific task, which reflects the individual's motivation and belief level and is directly proportional to the effort and time input of the individual in a certain task(Bandura, 1988,1997). In the Innovation and Entrepreneurship Education Program (IEEP), it is the inner main motivation and belief that supports students to complete the project creation.

Teacher-student interaction mainly includes three dimensions, emotional support, classroom organization and teaching support. Each part is related to students' academic achievements(Curby et al., 2009; Rimm-Kaufman et al ., 2009). Affective support includes positive atmosphere, negative atmosphere, teachers' sensitivity and the perspective dimension of students' concern. Classroom organization includes behavior management, productivity and teaching learning form. Teaching support includes concept development, feedback quality and language modeling dimension (Pianta et al., 2008).In the Innovation and Entrepreneurship

Education Program(IEEP), students need teachers to provide innovative guidance, and the degree of teacher-student interaction perceived by students is an important factor for the completion of the project.

According to the micro-system theory of ecosystem theory, the relationship between teachers and students is a key factor affecting the short-term and long-term development of students (Pianta, 1999). Studies have shown that students who experience more care and support from teachers exhibit more positive attitudes towards their studies and themselves (Wentzel et al., 2010), They also report higher levels of satisfaction with their studies (Solomon et al., 2000) and greater academic engagement (Ryan & Patrick, 2001; Solomon et al., 2000). Students' evaluation of intimacy between self-teachers is significantly correlated with social and learning skills (Pianta & Stuhlman, 2004). There is also a significant positive correlation between teacher-student relationship quality and student performance (O'Connor & McCartney, 2006). Positive teacher-student relationships are significantly associated with increased student participation (Hughes, 2011; Wu et al., 2010), which also contributes to the improvement of students' motivation and student achievement (Hughes, 2011). Therefore, a large number of relevant studies have proved that the degree of teacher-student interaction perceived by students has an impact on students' individual academic and psychological development.

Interaction between peers is a form of cooperation and communication between peers, which plays an important role in the development of students and the realization of educational goals (Johnson, 1981). For students, peers also belong to the micro system in the ecosystem theory, which is the key factor influencing students (Pianta, 1999). The dialogue form of peer assistance can improve students' sense of belonging and connection (McFarlane et al., 2017), develop friendship and enhance students' learning motivation and effective cooperation with others can also promote students to improve their level of academic challenges (Borup et al., 2020). Lacey et al., (2020) found that the form of peer interaction in the laboratory environment had an impact on students' personal achievement and work experience. Kamarainen et al., (2019) found that group cooperation helps to regulate the cognitive imbalance of each member in the group, and members in the group can self-regulate to reach the cognitive balance state. Therefore, through the related research of peer interaction, it can be found that peer interaction has an impact on students' learning motivation, academic achievement, personal performance and other aspects. The current research background is mainly based on IEEP . Students who participate in the competition form different groups, in which peer cooperation is the form of peer cooperation within one group, and peer competition is the form of peer competition among different group. Therefore, the perceived peer interaction is divided into two variable forms of peer cooperation and peer competition.

Based on the expected value theory, an individual has a high motivation when the task to be completed can be accomplished successfully (Zhan et al., 2020). The IEEP is a competition based on the realization of students' innovation ability development. The success of the competition is the aspiration of every participant. Through relevant studies, it is found that in a mixed teaching environment, students' self-efficacy is correlated with academic performance (Warren et al., 2020), and self-efficacy is positively correlated with self-regulating learning strategies (Lee et al., 2020), and career decision-making self-efficacy is correlated with students' learning style (Farhang et al., 2020). Akamatsu et al., (2019) proved that self-efficacy played a mediating role in the process of metacognitive strategies and self-regulating learning, and illustrated the correlation between self-efficacy and learning strategies. Therefore, the choice of academic self-efficacy and learning strategy, academic performance and students self-adjusting aspects of correlation, the current study was based on IEEP, student's self-

efficacy is for students to believe that the project implementation confidence level of the competition, and deep learning represents the students innovative ability in the competition process growth degree.

Although some articles have proved that teacher-student relationship and peer relationship are related to students' psychological state and learning state, as well as the correlation between self-efficacy and students' learning state, there is still no paper on whether self-efficacy can play a mediating role in perceived teacher-student interaction, peer support and deep learning. Therefore, hypothesis H1 is proposed: perceived teacher-student interaction can significantly predict students' self-efficacy;

Hypothesis H2, H3: Perceived peer support, cooperative interaction and competitive interaction can significantly predict students' self-efficacy;

Hypothesis H4: Students' self-efficacy can significantly predict students' level of deep learning.  
1.2 The mediating role of emotional value expectation among perceived teacher-student interaction, peer interaction and deep learning

Human behavior can be predicted by expectation and value beliefs. Expectation is a cognitive expectation, usually caused by cues in the situation, that is, the performance of a certain behavior will lead to a specific result, and the intensity of expectation represents the subjective probability of the corresponding behavior (Atkinson, 1957). In the current research, students' expectation of project emotional price value is the positive emotional expectation brought by the project achievement, and the inner satisfaction and joy brought by the project success to the participants. The main purpose of the current study was to examine whether the positive emotional expectation value belief could significantly predict the depth of the students learning behavior and whether the value belief can be used as dependent variable of students' in the micro environment system, namely the students perceived teacher and peer interaction's dependent variable, to increase students' deep learning behavior playing a mediating role.

Students' perception of teacher-student interaction includes the interaction of teaching, emotion and classroom situational organization (Curby et al., 2009; Rimm-Kaufman et al., 2009). According to ecosystem theory (Pianta, 1999), students' perception of teacher-student interaction will affect students' individual system. As for related studies, the relationship between teacher-student interaction and students' learning emotions has also been proved. There is a significant correlation between teachers' interpersonal behaviors and students' emotions and behaviors, and there is a great correlation between teacher-student conflicts and students' emotions and behaviors (Poulou, 2015). High-quality teacher-student interactions are more likely to contribute to positive emotions in school and to better math learning and reading skills (LoCasale-Crouch et al., 2018). The quality of teacher-student interaction is correlated with students' perception of emotional and social engagement in class (Martin & Rimm-Kaufman, 2015). The stability of students' emotional involvement in learning is correlated with the teacher-student relationship, and the emotional involvement tends to be stable over time (Ulmanen et al., 2016). Therefore, through relevant research, it can be found that the quality of teacher-student interaction is correlated with the stability and degree of students' emotional investment in the classroom, however, most relevant studies focus on middle school and primary school, and there are few related studies on college students. Moreover, related studies focus on the correlation of emotional engagement, and there is no study on the emotional state of a certain task.

According to the ecosystem theory, students' perception of the relationship between peers has an impact on individual emotions. In this study, the cooperative interaction between peers in the same group to complete the project is cooperative interaction, while the competitive interaction between different groups. Previous studies have shown that students' ability to regulate emotions is correlated with several indicators of social interaction quality, including interpersonal sensitivity and prosocial tendencies, the proportion of positive and negative peer nominations, and reciprocal friendship nominations (Lopes et al., 2005). Moreover, students' social behaviors have a stronger correlation with students' emotions and behaviors than teachers' interpersonal behaviors (Poulou, 2015). And students' emotional engagement in learning is not only related to the teacher-student relationship, but also strongly related to peer relationship (Ulmanen et al., 2016). Therefore, relevant research has demonstrated that peer relationships have an impact on students. Current research divides students' perceived peer interactions into perceived peer cooperative interactions and perceived peer competitive interactions, and verifies the correlation between these two variables and students' expectations of emotional value in the current project.

According to the expected value theory (Atkinson, 1957), the emotional value expectation in the current research refers to the students' joy and satisfaction for the success of the project, which comes from the students' inner emotional value expectation and is the students' value belief on the emotional level. Based on previous studies, the students' emotional state has a significant effect on critical thinking (Leasa, 2018), and in different environments, emotional state also has value for students to learn, such as in computer learning environment, through the evaluation of students' emotional and psychological state of students' learning process and learners' interaction with the environment have a significant impact (Megahed et al., 2019). Moreover, emotions are significantly correlated with language learning strategies and learning styles (Taheri et al., 2019). Therefore, students' emotional state is related to a variety of factors such as students' thinking, learning style, and interaction state of learning environment. In the current research, there has been no relevant research on whether emotional value expectation is related to students' deep learning state in projects or learning tasks.

Although some articles have proved that teacher-student relationship and peer relationship are related to students' emotional state and learning state, there is no empirical study on whether the expectation of emotional value can play a mediating role between perceived peer support in teacher-student interaction and deep learning. Therefore, hypothesis H5 is proposed: Perceived teacher-student interaction can significantly predict students' expectation of emotional value; Hypothesis H6, H7: Perceived peer cooperative interaction and competitive interaction can significantly predict students' expectation of emotional value; Hypothesis H8: Students' emotional value expectations can significantly predict students' level of deep learning.

## **2. Research Method**

### **2.1 Sample and Procedure**

To conduct an empirical test on the study model (refer To Figure 1), the data was collected from 265 students who participated in the Innovation and Entrepreneurship Education Program (IEEP) conducted by a local undergraduate university in China. The 265 students from different majors and grades volunteered to participate in the IEEP Competition, and the number of participants in each group is determined by the students voluntarily, with a maximum of 15 participants. The final number of participants is 10 groups with a total of 265 participants. The questionnaire is mainly online, and students will fill in the answers voluntarily. The



questionnaire is 5-Point Likert Scale (1= Strongly Disagree; 5= Strongly Agree). The questionnaire was collected. Through review, it was found that the conceptual framework analysis and verification of 265 valid questionnaires were mainly conducted through the structural equation model (Hair et al., 2006).

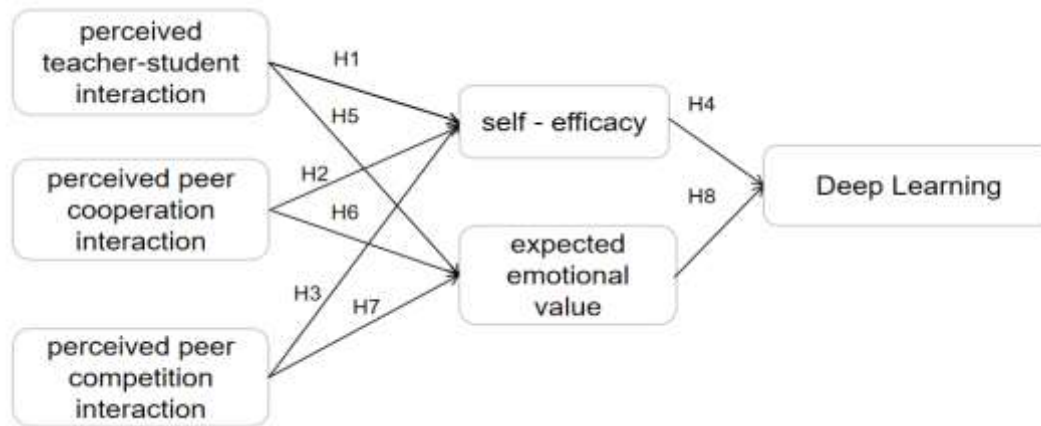


Figure 1: Conceptual Framework

## 2.2 Instruments

### Perceived teacher-student interaction instrument

The questionnaire was adapted in combination with the Classroom Assessment Scoring System (Pianta et al., 2008), the current research locations, students' backgrounds, and the specific situation of project implementation, forming 10 items. For example, "in the process of project completion, I think the instructor can provide me with sufficient and timely interaction and help"; "In the process of project completion, I think the instructor timely checked the progress of our project and discussed with us".

### Perceived peer cooperation and peer competition interaction instrument

The questionnaire is mainly compiled according to the current research location, students' background, and the specific situation of the project implementation, forming 10 questions, of which 5 are about perceived peer cooperation interaction. For example, "I think cooperation is more efficient for project innovation and project completion". The 5 items are perceived peer competitive interactions. For example, "I think that competition between different groups motivates us to achieve project success".

### Self-efficacy instrument

The questionnaire was adapted based on the Academic Milestone self-efficacy Scale (Lent et al., 1986), the location of the previous research, the background of the students, and the specific situation of the project implementation, forming 10 questions, such as: "I think I can complete the project well"; "I think my team will succeed in the competition".

### Emotional value expectation instrument

Questionnaire mainly according to the location of the current study and the student's background, and the specific situation of the project implementation are compiled and expected value theory, the formation of ten item, for example: "I think the project to succeed in the competition can bring me happiness and a sense of accomplishment"; "I think the project to succeed in the competition can bring me great satisfaction".

### Deep learning instrument

The Revised Two-Factor Study Process Questionnaire: R-SPQ-2F(Biggs et al., 2001), the location of the previous study, the background of The students, and the specific situation of the project implementation were adapted to form 10 questions. For example, "During the process of the project, I can generate innovative ideas and concepts in the process of deep thinking"; "During the process of a project, I can think about what I want to complete for a long time and achieve a high degree of completion."

### 2.3 Data Analysis

Data analyses were performed using SPSS and Partial Least Squares (PLS).Exploratory factor analysis (EFA) is used for these measurements; Sphericity Bartlett Test ( $p < 0.500$ ), factor loading, Kaiser-Meyer-Olkin ( $> 0.800$ ), Factor Loading  $\geq (0.500)$ , Communalities ( $\geq 0.300$ ), and Eigenvalue ( $\geq 1.00$ ) which were proposed by Hair et al.(2010) and Pallant (2011). In order to evaluate the measurement and structural model, the PLS method was used for structural equation modeling (SEM) (Ringle et al., 2005).For hypothesis testing, following the recommendations of Hair et al.(2011), a standard PLS algorithm was implemented to evaluate the estimated significance level based on 5000 bootstrap procedures.

## 3. Finding

### 3.1 Assessment of the measurement model

This study used a two-step approach, following Anderson and Gerbing (1988). The first step is to check and evaluate the convergent validity and reliability. When the model satisfies the following criteria, convergence validity can be achieved. Firstly, the indicators should reach the recommended value  $> 0.7$  (Hair et al., 2019), as shown in Figure 2, the indicators are all maintained above 0.7. Secondly, the reliability of composite reliability should exceed 0.70(Gefen et al., 2000). Finally, Fornell and Lacker (1981) pointed out that the average variance extracted (AVE) should exceed 0.5. In addition, Cronbach's Alpha and rho\_A values should exceed 0.7 (Hair et al. 2019), and these values are shown in Table 1.

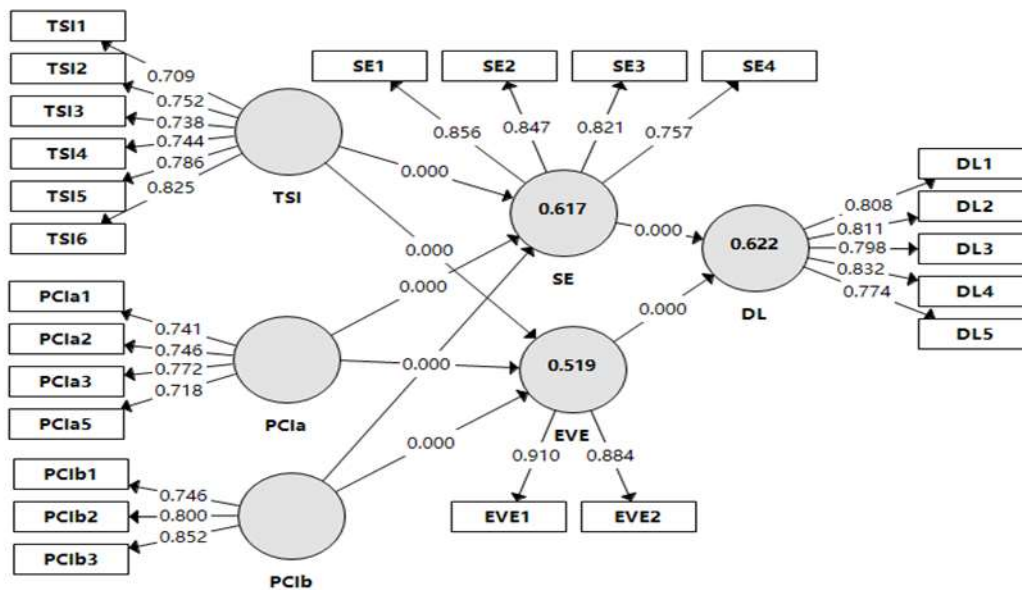


Figure 2: PLS-Path analysis of R-square values (n=265).

**Table 1: Measurement model of PLS**

Latent variable	Items	Loading	Cronbach's Alpha	rho_A	Average Variance Extracted(AVE)	Composite reliability
<b>Perceived teacher-student interaction</b>	TSI1	0.709	0.854	0.867	0.577	0.891
	TSI2	0.752				
	TSI3	0.738				
	TSI4	0.744				
	TSI5	0.786				
	TSI6	0.825				
<b>Perceived peer cooperation interaction</b>	PCIA1	0.741	0.732	0.732	0.554	0.832
	PCIA2	0.746				
	PCIA3	0.772				
	PCIA4	0.718				
<b>Perceived peer competition interaction</b>	PCIB1	0.746	0.723	0.748	0.641	0.842
	PCIB2	0.800				
	PCIB3	0.852				
<b>Emotional value expectation</b>	EVE1	0.910	0.758	0.766	0.805	0.892
	EVE2	0.884				
<b>Self-efficacy</b>	SE1	0.856	0.839	0.845	0.674	0.892
	SE2	0.847				
	SE3	0.821				
	SE4	0.757				
<b>Deep learning</b>	DL1	0.808	0.864	0.866	0.648	0.902
	DL2	0.811				
	DL3	0.798				
	DL4	0.832				
	DL5	0.774				

The following step examines the discriminant validity. Discriminant validity (Table 2) was tested using the HTMT criterion, if the value HTMT < 0.900, it meets the criterion (Hair et al. 2019).

**Table 2: Heterotrait-Monotrait Ratio (HTMT)**

construct	1	2	3	4	5	6
<b>1.DL</b>						
<b>2.EVE</b>	0.826					
<b>3.PCIA</b>	0.834	0.752				
<b>4.PCIB</b>	0.811	0.788	0.754			
<b>5.SE</b>	0.863	0.770	0.790	0.816		
<b>6.TSI</b>	0.822	0.811	0.812	0.729	0.836	



### 3.2 Assessment of the structural model

#### 3.2.1 Direct effects

Although this study only tested indirect effects between each variable based on theoretical assumptions, before running Smart PLS analysis and analyzing the indirect effects, it is indeed necessary to determine the direct effects. This study used a bootstrap technique with 5000 bootstrap samples to test the hypothesis. Its one-tailed t-test values are 1.645 (significant level = 0.05), 2.327 (significant level = 0.01) and 3.092 (significant level = 0.001) (Hair et al. 2017). According to the bootstrap process, Table 3 points out that the coefficient value and the t value expose the existence of direct influence.

**Table 3: Significance of direct effects-path coefficient(n=265)**

Path	Path Coefficient( $\beta$ )	Sample Mean	Standard Deviation	T Statistics	P Values	Result
EVE -> DL	0.348	0.350	0.068	5.098***	0.000	Supported
PC1a -> EVE	0.154	0.156	0.077	2.001*	0.023	Supported
PC1a -> SE	0.180	0.182	0.067	2.661**	0.004	Supported
PC1b -> EVE	0.271	0.270	0.075	3.610***	0.000	Supported
PC1b -> SE	0.296	0.294	0.064	4.626***	0.000	Supported
SE -> DL	0.525	0.525	0.063	8.339***	0.000	Supported
TSI -> EVE	0.405	0.406	0.082	4.932***	0.000	Supported
TSI -> SE	0.432	0.433	0.064	6.790***	0.000	Supported

\* $p < 0.05$ ,  $t > 1.645$ ; \*\* $p < 0.01$ ,  $t > 2.327$ ; \*\*\* $p < 0.001$ ,  $t > 3.092$  (one tailed)

#### 3.2.2 Indirect effects

In order to test the hypotheses, a bootstrapping procedure with a sampling rate of 5000 (Hair et al. 2017) was performed to obtain the Beta value, t-values, p-values, and bootstrapped confidence intervals. Since the hypothesis we previously put forward is based on theoretical assumptions, we put forward a hypothesis based on the indirect relationship between variables. Table 4 presents the results of the specific indirect effects of path coefficients. The results indicated that self-efficacy mediated between perceived teacher-student interaction and deep learning ( $\beta = 0.227$ , t-value = 2.512,  $p < 0.01$ ); and there was a mediating effect between perceived peer cooperative interaction and deep learning ( $\beta = 0.094$ , t-value = 4.930,  $p < 0.001$ ); and the correlation between perceived peer competitive interaction and deep learning was mediated ( $\beta = 0.155$ , t-value = 4.092,  $p < 0.001$ ). The results support hypothesis H1, H2, H3, H4. The relationship between perceived teacher-student interaction and deep learning was mediated by emotional value expectation ( $\beta = 0.141$ , t-value = 3.432,  $p < 0.01$ ); and there is a mediating effect between perceived peer cooperative interaction and deep learning ( $\beta = 0.054$ , t-value = 1.832,  $p < 0.05$ ); It also has a mediating effect between perceived peer competitive interaction and deep learning ( $\beta = 0.095$ , t-value = 2.710,  $p < 0.01$ ). The findings support the hypothesis H5, H6, H7, H8.

**Table 4: Significance of specific indirect effects- Path coefficients(n=265)**

Path	Path Coefficient( $\beta$ )	Sample Mean	Standard Deviation	T Statistics	P Values	Result
PC1a -> EVE -> DL	0.054	0.054	0.029	1.831*	0.034	Supported
PC1b -> EVE -> DL	0.095	0.096	0.035	2.71**	0.003	Supported
TS1 -> EVE -> DL	0.141	0.142	0.041	3.432***	0.000	Supported
PC1a -> SE -> DL	0.094	0.096	0.038	2.512**	0.006	Supported
PC1b -> SE -> DL	0.155	0.154	0.038	4.092***	0.000	Supported
TS1 -> SE -> DL	0.227	0.228	0.046	4.930***	0.000	Supported

\* $p < 0.05$ ,  $t > 1.645$ ; \*\* $p < 0.01$ ,  $t > 2.327$ ; \*\*\* $p < 0.001$ ,  $t > 3.092$  (one tailed)

### 3.2.3 R-square value and Q-square

The size of the R-square was used as a criterion for predictive relevance, a predictive sample reuse procedure (also known as the Stone-Geisser's (1974) Q<sup>2</sup> can also be applied. Henseler and Fassott (2009) also pointed out that this measure can be used to evaluate the research model's capability to predict. According to the blindfold procedure, Q<sup>2</sup> evaluates the predictive validity of a model via PLS. Q<sup>2</sup> values larger than zero indicate exogenous constructs possess predictive relevance for the endogenous construct (Hair et al., 2011). In this study, Table 6 indicated that the Q<sup>2</sup> of deep learning (Q<sup>2</sup>=0.392>0), expected value emotional (Q<sup>2</sup>=0.396>0) and of self-efficacy (Q<sup>2</sup>=0.406>0), indicating that the research model has excellent predictive relevance.

**Table 5: R-square value and Q-square value (n=265)**

Table 5. R-square value and Q-square value (n=265)		
Endogenous variable	R Square	Q-square
DL	0.622	0.392
EVE	0.519	0.396
SE	0.617	0.406

## 4. Discussion and conclusion

The current research aims to investigate the mediating mechanism of self-efficacy and emotional value expectation between students' perceived teacher-student interaction, peer interaction and students' deep learning through the construction and verification of the structural equation model, the mechanism of the relationship between variables is verified. The current research selects a local undergraduate university, which focuses on application-oriented talents and attaches importance to the cultivation of students' innovative and creative ability and technical application ability. This type of university accounts for half of the number of Chinese universities. Therefore, the selection of the current project data is based on one of the local undergraduate universities, and the data can represent the research status of student quality and ability in most of the local applied undergraduate universities in China.

Firstly, the research results support the micro-ecosystem theory (Bronfenbrenner et al., 2007). Students' perceived teacher-student interaction, peer support interaction, and peer competition interaction all have a significant predictive effect on students' self-efficacy and emotional expectation value beliefs, namely, H1, H2, H3, H5, H6 and H7 are supported, just as some related research (Martin & Rimm-Kaufman, 2015; LoCasale-Crouch et al., 2018; Kämäräinen et al., 2019; Lacey et al., 2020), Which also shows that the teacher-student interaction and

peer interaction perceived by students have an impact on students' inner psychology, which indicates the rationality of the research model results. The research results prove the applicability of micro-ecosystem theory in the IEEP, and students' perception of teachers' influence on students or the communication and cooperation between students has a significant impact on students' psychology.

Secondly, the research results support the theory of expected value (Atkinson, 1957). Students' internal self-efficacy and emotional value belief of achievement in project competitions have a significant predictive effect on students' deep learning ability, that is, hypothesis H4 and H8 are valid. Just as some related research (Taheri et al ., 2019; Megahed et al ., 2019; Warren et al., 2020; Zhan et al ., 2020), students' inner emotion and self-efficacy are related to their learning behavior. Therefore, it shows that students' internal expectation for the success of the task and the sense of achievement and joy brought by the success of the task can further predict the generation of students' deep learning behavior, which is reasonable to product this model. The research results prove that the theory of expected value is applicable to the IEEP, and students' self-efficacy and emotional expectation for the success of projects have a significant impact on students' deep learning behaviour.

The study verified the validity of the model. At present, the knowledge imparting of Chinese college students is still based on general systematic knowledge, with teachers as the main body of teaching and students as the receivers of knowledge. The indirect acquisition of knowledge does not require innovation or deep thinking about the source of knowledge. However, the demand for talents for the current social development is not only limited to skilled and applied talents, but more needs innovative talents. In this situation, the talent cultivation of higher education and the demand talents of social development do not match and will appear gap,at present, the innovation and entrepreneurship projects carried out by the school take students as the main body and the center of knowledge creation, and teachers as the auxiliary, emphasizing the development of students' internal creativity and innovation ability. Through the research, it also shows that this innovation and entrepreneurship project has an effective effect on enhancing students' deep thinking and innovation and creativity.

This study provides reference value for more schools and is supported by empirical research data for improving students' deep learning ability and innovation and creativity. In future research, a more detailed study should be conducted on the basis of the existing model, with the observation and interview of students, so as to further discover the actual experience of students in the current activity program and the more detail problems that need to be solved.

## **5. Limitation and further studies**

The current research has several limitations. First of all, the biggest limitation of this research is the sample size. Due to the limited research resources, the research mainly focuses on the research of Innovation and Entrepreneurship Education Project in a local applied university. Secondly, the research is mainly horizontal research, and the judgment of causality in real problems is limited. Future research will conduct more educational experiments based on the model to explore more relevant factors affecting students' deep learning ability and innovation and creativity ability. Third, the current research background is mainly focused on China, and more relevant studies are needed for the applicability of the model in the international context.

## 6. Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/ or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. All research procedures have been approved by the current research university, and the research procedures take full ethical issues into consideration.

## 7. Informed consent

Informed consent was obtained from all individual participants included in the study, the research was also approved and approved by the guardian of each participating student.

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