The Influence of College Students' Online Learning Engagement on Deep Learning -- The Mediating Role of Learning Interaction

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Abstract
The occurrence of online deep learning is a common expectation among researchers. And whether the depth and frequency of online learning interactions and the depth of learning engagement affect learners' deep learning is a hot topic in the current research field. Based on the vision of 3P teaching theory, this study constructs a conceptual framework of 3P teaching model with learning engagement as a prerequisite (Presage), learning interaction as a process (Process), and deep learning as a result (Product). The relevant hypotheses were proposed based on theoretical analysis, and the hypotheses were verified through experiments. The study conducted a questionnaire survey with 602 college students in a university in Chongqing. Using structural equation modeling, the relationship between online learning engagement, learning interaction and deep learning and the internal influence mechanism were explored. The study found that: 1. learning engagement in online learning has a positive effect on deep learning. 2. multiple types of interactions have a significant effect on deep learning, among which peer interactions have the most significant effect on deep learning, and simple teacher-student interactions have no direct effect on deep learning. 3. online learning engagement affects students' deep learning through learning interactions, and learning interactions have a mediating role. Combined with the above findings, it provides some references for the implementation of online deep learning strategies and teaching practices.

Keywords: *Online learning; Deep learning; Learning interaction; Learning in*

1 INTRODUCTION

Along with the development of online education platforms and the opening of online courses, the occurrence of online deep learning has become a common goal pursued by researchers, while the demand for online learning activities is on the rise. But it also brings the negative impact of knowledge and information fragmentation. As learners in an online learning environment are separated in physical time and space, they are less engaged in learning and less interactive due to the environment. Online learning can easily become "shallow learning" in the form of "punch cards", making it difficult to achieve deep learning [1]. Thus learner engagement and learning interactions in an online learning environment are key points that influence learning outcomes. Online learning interactions include human-computer interaction, teacher-student interaction, self-interaction and peer interaction. So, does learning engagement affect learner learning interactions, does learner learning engagement and learning interactions affect deep learning, and what is the relationship between them? To address this issue, this study explores the relationship and mechanisms of action between learning engagement, learning interaction and deep learning based on the perspective of the 3P theoretical model.

2 THEORETICAL BASIS AND RESEARCH HYPOTHESIS

2.1 Theoretical foundations

The 3P teaching model was first proposed by M.J. Dunkin and B.J. Biddle in 1974 before being studied in depth and matured by J. Biggs. The conceptual framework of the 3P teaching and learning model is based on a constructivist perspective and an analysis of teaching and learning methods, divided into three stages

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according to time periods: the pre-stage, the process stage and the outcome stage [2]. The model emphasizes that the three stages are independent of each other, but in essence the three stages influence each other. Learning prerequisites act on the learning process and also influence the learning outcomes, becoming a key element of the teaching and learning interaction. Jinju Duan, a scholar, believes that elements of learning interaction process in online learning environment are important factors affecting students' deep learning [3]. Scholar Xiaoyong Hu's research proves that the prerequisite element of learning engagement promotes students' deeper understanding of knowledge and has a positive effect on their learning outcomes [4]. Based on the 3P teaching model, this study investigates the relationship between the three learning stages and the internal influence mechanism based on the 3P teaching model, with learning input as the prerequisite element of deep learning outcomes and learning interaction as the process element of deep learning outcomes (Figure 1).

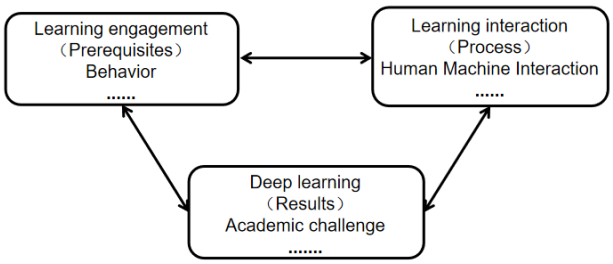

Figure 1 Resulting model of deep learning with input interactions

2.2 Research Hypothesis

2.2.1 The relationship between deep learning and learning engagement

The concept of deep learning was first introduced by the academics Marton F. and Säljö R [5]. As for the expression of deep learning, scholar Craik F I M believes that deep learning is from the shallow learning stage of simple and mechanical memorizing learning materials to the deep learning stage, integrating new ideas into their own cognitive structure [6]. The theory of learning engagement is consistent with the core connotation principle of deep learning, and behavioral engagement meets the needs of deep learning mechanism. As for the related expressions of learning engagement, scholar Fredricks believes that learning engagement is an active state that learners show in online learning activities, including cognitive investment, emotional investment and behavioral investment [7]. He believes that only by focusing on students' cognition, emotion and behavior can students carry out online deep learning [8]. Researcher Yajie Wu studied the factors that affect learners' online deep learning from the perspective of social cognition theory and found that self-regulation, learning motivation and learning engagement are important factors that affect deep learning, but the empirical study was carried out [9]. Later, researchers began to explore the relationship between learning engagement and deep learning. Zheyu Liu et al. randomly selected 45 college students to explain the deep learning mechanism through eye movement behavior experiment, and the experimental results proved that behavioral input significantly promoted the effect of deep learning [10]. Researcher Yu Zhang found that the characteristics of learning engagement in online micro-courses have a positive impact on deep learning through a survey of 80 college students [11]. From the above studies, we know that learning engagement, a prerequisite variable, is an important factor of the outcome variable of deep learning. As stated in the review, online learning engagement will promote students to carry out online deep learning from three aspects of behavior, cognition and emotion. Based on this, the hypothesis of this study is proposed:

H1: Learning engagement factors have a positive impact on deep learning.

2.2.2 The relationship between learning interaction, learning engagement and deep learning in online learning environment

Online learning is based on the network space, relying on the network teaching environment technology hardware and software facilities, so that learners in physical location in a separate state, so the interaction becomes an essential key node of online learning. Scholar Chen Li believes that learning interaction refers to the process of mutual communication and interaction between learners and the learning environment in the learning process for the purpose of constructing knowledge [12]. Researcher Xiufeng Ma believes that online learning interaction includes two aspects: interaction frequency and interaction depth. Online learning environment is used to share, select and utilize learning resources, as well as information exchange with teachers and other learners [13]. Hirumi A believes that learning interaction includes learner to learner, learner to teacher, and learner to content [14]. Combined with the above research, it is concluded that online learning interaction includes man-machine interaction, teacher-student interaction, self-interaction and peer interaction. Online learning interaction and learning engagement are important factors affecting deep learning. Relevant studies show that Filius R M et al. found through questionnaire survey that online learning has a high sense of engagement and learning interaction will be improved, which is conducive to improving students' deep learning [15]. Second, GARRISON D R believes that diverse interactions in online learning will affect the development of critical thinking, which is considered to be an important manifestation of deep learning [16]. Qiang Lu proved through empirical research that teacher-student interaction, peer interaction, and student-content

interaction have an impact on online deep learning [17]. Through the analysis and sorting of relevant literature, it is found that the researches on the influencing factors of online deep learning are mostly limited to the researches on the influence of a single interactive variable on deep learning, and there is a lack of researches on multi-variable factors, and there are few researches on the mechanism of action of intermediary variables. Therefore, based on the 3P model, this study takes learning engagement as the premise variable, learning interaction as the process variable, and deep learning as the outcome variable, to explore the relationship and internal mechanism among learning engagement, learning interaction, and deep learning in the online learning environment. Therefore, the following hypotheses are proposed in this paper:

H2: Learning engagement positively affects learning interaction factors.

H3: Learning interaction factors positively affect deep learning.

H4: Learning interaction factors play a mediating role in the influence of learning engagement on deep learning. In summary, the theoretical research framework constructed is shown in Figure 1 below:

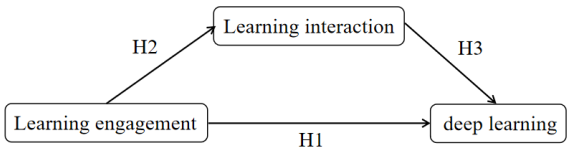

Figure 2 assumes a theoretical model

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3.1 Survey tools

The questionnaire used in this paper mainly includes the following four parts: The first part is basic information. It mainly includes the gender, grade and major category of the respondents.

The second part is the learning engagement scale. The learning engagement scale mainly refers to the learning engagement questionnaire compiled by Shuang Li [18], and is modified appropriately based on the information of expert interviews. The scale divides learning engagement into three secondary dimensions of learning behavior engagement, emotional engagement and cognitive engagement, with a total of 13 questions to measure students' learning engagement in online learning environment.

The third part is the learning interaction scale. The learning interaction scale mainly refers to the questionnaire design prepared by KUO [19] and combines expert interview opinions to measure learning interaction by dividing learning interaction into four secondary dimensions, namely human-machine interaction, teacher-student interaction, peer interaction and self-interaction, with a total of 12 items.

The fourth part is the deep learning scale for college students. The deep learning scale for college students mainly refers to the questionnaire design of researchers such as the deep learning scale developed by Quanliang Wang [20] and the deep Learning sub-scale constructed by NSSE-China research Group [21] of The Institute of Education of Tsinghua University. Combined with expert interview opinions, deep learning was divided into five dimensions of academic challenge, communication, active cooperation, deep processing, reflective evaluation, a total of 15 questions to measure deep learning. All questions were designed by five-point Likert scale (1-5 respectively means "completely inconsistent", "basically inconsistent", "generally consistent", "basically consistent", and "completely consistent"). The detailed design of the scale is shown in Table 1.

Table 1 Scale development

Level indicators	The secondary indicators	Item number
Learning interaction	Human Machine Interaction	12
	Teacher-Student Interaction	
	Self interaction	
	Peer interaction	
Learning engagement	Behavioral engagement	13
	Emotional engagement	
	Cognitive engagement	
Deep learning	Academic challenge	15
	communication	
	Active cooperation	
	Depth processing	
	Reflective evaluation	

3.2 Research object

In this study, students from freshmen to seniors who participated in online learning in a university in Chongqing, China, were selected as the subjects of the study. A total of 602 questionnaires were collected and 572 valid questionnaires were obtained by eliminating invalid questionnaires, with an effective rate of 95.50%. Among the respondents, 262 were male students and 340 were female students; 141 students were in their first year, 165 in their second year, 169 in their third year and 127

in their fourth year, which is a good representative sample with an even distribution.

3.3 Research methods

In this study, SPSS25.0 software was used for correlation analysis and variance analysis of the study variables, AMOS24.0 was used for confirmatory factor analysis to test the reliability and validity of the scale, parameter testing method was used to test the research hypothesis, and self-help method was used to test whether the mediation effect existed.

4 DATA ANALYSIS AND EMPIRICAL TEST

4.1 Reliability and validity test

In order to ensure the reliability and validity of the research conclusions, the reliability and validity of the 33-item, three-dimension measurement model was tested in this study to ensure the practical significance of the structural model. The reliability and validity of the questionnaire were tested by AMOS.24.0 as shown in Table 2. The combined reliability (CR) of learning interaction, learning engagement factor and deep learning scale were 0.930, 0.956 and 0.906, respectively, which all met the reliability standards of statistics, indicating that the four major variables of the questionnaire had high reliability level. In the validity test, the AVE value was used to evaluate the convergence validity. Generally, AVE value greater than 0.5 is ideal. In this study, the mean variance variation (AVE) was all greater than 0.5, indicating that the measurement model had good discriminant validity.

Table 2 Combined reliability and convergence validity of the measurement model

Latent variables	CR	AVE	Deep learning	Learning interaction	Learning engagement
Deep learning	0.906	0.659	0.812		
Learning interaction	0.930	0.691	0.786***	0.831	
Learning engagement	0.956	0.643	0.815	0.752	0.802

Note: when P<; 0.001, P value is represented by "***"

4.2 Correlation analysis of research variables

In this study, learning interaction, learning engagement and deep learning were studied (see Table 1). Mean value, standard deviation, skewness, and kurtosis were used to describe the overall level of the study variables (the absolute value of skewness was less than 2, and the absolute value of kurtosis was less than 7, which was regarded as normal distribution). According to the descriptive statistical analysis in Table 3, the mean value range of the study variables is [3.003, 3.043], the standard deviation range is [0.830, 1.070], the skewness range is [-0.113, 0.091], and the kurtosis range is [-1.332, -1.032], which meets the standard of normal distribution. The correlation coefficients between the variables were all >=0.714, showing a strong positive correlation.

Table 3 Descriptive statistics and correlation analysis of study variables

The dimension	Learning engagement	Learning interaction	Deep learning
Learning engagement	1.000		
Learning interaction	0.716**	1.000	
Deep learning	0.797**	0.714**	1.000
The average	3.043	3.000	2.926
The standard deviation	0.913	1.070	0.830
Partial degrees	-0.094	0.091	-0.113
kurtosis	-1.324	-1.332	-1.032

Note: "**" means significant at 0.01 level.

4.3 Differences in online deep learning among students of different interaction types

The differences of students with different interaction types in online deep learning were analyzed by using human-computer interaction, teacher-student interaction, peer interaction and self-interaction as independent variables, and deep learning as dependent variable. The test results are shown in Table 4. There were significant differences between online deep learning and human-computer interaction, peer interaction and self-interaction (P values were all less than 0.05), while there were no significant differences between teacher-student interaction and online deep learning (P=0.053>0.05). Specific performance online learning tool types are increasingly rich, the improvement of students' information technology level to promote good human-computer interaction; With the development of online communication tools, students can communicate with each other more frequently and exchange opinions, thus improving their self-knowledge and promoting their understanding and reconstruction of knowledge. The interaction between teachers and students is not significant for deep learning, which may be due to the unsatisfactory effect of online teaching and the failure of teachers and students to quickly adapt to the new environment of online teaching.

Table 4 Differences of online deep learning among students of different interaction types

The independent variables	M	SD	F	P
Human Machine Interaction	0.956	3.690	1.766	0.034
Teacher-Student Interaction	0.833	3.820	1.658	0.053
Peer interaction	0.923	3.560	2.718	0.000
Self interaction	0.790	3.800	2.271	0.004

4.4 Hypothesis testing

4.4.1 Structural model testing

The fitting index of this research model is shown in Table 5. AMOS24.0 software was used to construct the influencing factor model of Learning engagement on deep learning, and the fitting degree test was carried out on the model. The fitting degree index data was shown in Table 5. It can be seen from Table 5 that the CMIN/DF value was 2.551, less than 3. RMSEA value is 0.052, less than 0.08; GFI, AGFI and CFI values greater than 0.9 all meet the fitting criteria, indicating that the structural equation model has good structural validity.

Table 5 Analysis table of the overall fit degree of the model

Model fit index	CMIN/DF	GFI	AGFI	CFI	RMSEA	SRMR
Adaptive value	2.551	0.921	0.903	0.968	0.052	0.074
The judgment standard	<3	>0.9	>0.9	>0.9	<0.08	<0.08

4.4.2 Research hypothesis testing

This study analyzes the influence of Learning engagement factors on deep learning in the online learning process through hypothesis verification in the model. AMOS24.0 statistical analysis tool is used to analyze the influence of learners' learning interaction, Learning engagement and deep learning. The parameter test values and path coefficients of the model are shown in Table 6.

Table 6 Hypothesis testing of the model

Impact	C.R.	P	Normalized path coefficient	Research hypothesis
Deep learning←Learning engagement	7.467	***	0.056	H1 hypothesis is true

Learning interaction←Learning engagement	16.598	***	0.043	H2hypothesis is true
Deep learning←Learning interaction	7.013	***	0.043	H3hypothesis is true

Note: when P<0.001, P value is represented by "***"

The standardized coefficient, C.R. and P-value between potential variables of the model are given in Table 6. The larger the absolute value of standardized coefficient is, the stronger the relationship between variables is. According to the P< 0.05, C.R.>1.96; The results show that the test value of learning engagement → deep learning path coefficient parameter is 0.056(P<0.05), the C.R. value was 7.467> 1.96, indicating that learning engagement has a positive and significant direct impact on deep learning, so research hypothesis H1 has been verified. Learning engagement → learning interaction path coefficient parameter test value is 0.043(P<0.05), the C.R. value was 16.598> 1.96, indicating that learning engagement has a positive and significant direct impact on learning interaction, so research hypothesis H2 has been verified. The coefficient test value of learning interaction → deep learning path is 0.043, and the C.R. value is 7.013>1.96, indicating that learning interaction has a positive and significant direct impact on deep learning, so research hypothesis H3 has been verified.

FIG. 2 shows the relationship between learning engagement and deep learning (β=0.056, P<0.001) influence is positive significant that online learning process, the behavior of the high input, emotional, cognitive input will promote the student to carry on the deep thinking, online teaching in teachers' reasonable stimulate students' learning enthusiasm and improve the students' emotion, behavior, input, will promote students from shallow to deep learning, so as to promote students' online deep learning. The relationship between learning engagement and learning interaction (β=0.0.043, P< 0.001), learning interaction and deep learning (β=0.043, P<0.001) The influence is positive and significant, indicating that students' behavioral investment, cognitive investment and emotional investment will affect the teacher-student interaction, self-interaction, human-computer interaction and peer interaction in online learning. Good interaction will induce students to conduct online deep learning, thus promoting the cultivation of students' higher-order thinking.

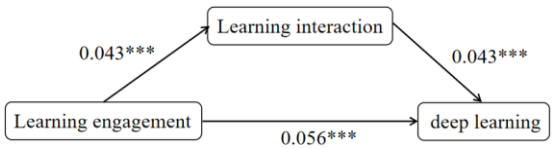

Figure 3 Model hypothesis testing and path coefficient

4.4.3 Mediation effect test

Table 7 shows the mediating effects of interaction factors: at the level of indirect effects, the higher the learning involvement, the higher the learning interaction, and the higher the influence of learning interaction on deep learning. In other words, Learning engagement will have a positive impact on students' deep learning through learning interaction. Its point estimate value is 0.246, and the CONFIDENCE interval of BC95%is [0.173, 0.343], excluding 0, indicating that Learning engagement will have a positive impact on deep learning through learning interaction factors, which has an indirect effect.

At the level of direct effect, the higher students' Learning engagement, the higher the effect of deep learning on students. Its point estimate value is 0.419, and the BC95% confidence interval is [0.290, 0.588], excluding 0, indicating that Learning engagement has a positive effect on deep learning and has a direct effect. This indicates that learning interaction plays a partially mediating role in the relationship between learning engagement and deep learning, and hypothesis H4 is verified. Study results show that the investment will pass learning interaction depth, high emotion, behavior, cognitive input can promote the interaction between teachers and students, interaction, human-computer interaction and peer interaction, so as to induce students to transition from shallow to deep learning, deep thinking, in turn, promote students to learn content, develop the students' ability of higher-order thinking.

Table 7 Test table of mediating effect of learning interaction

effect	Point estimates	Product of Coefficients		Bootstrap1000times			
				bias-corrected95%		Percentile95%	
		SE	Z	Lower	Upper	Lower	Upper
Indirect effect	0.246	0.041	6.000	0.173	0.343	0.168	0.334
Direct effect	0.419	0.074	5.662	0.290	0.588	0.285	0.583
The total effect	0.665	0.059	11.271	0.554	0.783	0.554	0.784

5 CONCLUSIONS

Based on the perspective of 3P teaching theory, a 3P teaching model is constructed with Presage as the premise, learning interaction as the Process and deep learning as the Product. The empirical results show that:

Learning input factors positively influence deep learning (P< 0.05). The empirical research results show that students' emotional investment, behavioral investment, and cognitive investment will stimulate students to learn from superficial mechanical knowledge to in-depth independent knowledge. Students who are highly interested in the knowledge they have learned will engage in action, thus triggering students' in-depth thinking and knowledge processing. It is suggested to cultivate students' interest in online learning and improve their learning involvement. Students who maintain high interest in online learning will have high emotional investment, such as curiosity, pleasure, sense of belonging and other positive emotions, and these emotions will promote students to further study, have the desire to explore knowledge, and then promote students to carry out in-depth learning. Such as teachers in teaching design in combination with characteristics of the students' learning motivation, personality, learning styles and the time of the dynamic, etc., to choose suitable for effective teaching strategy, combined with the actual situation to design appropriate teaching activities, arouse the enthusiasm of students learning, stimulate students' interest in learning, promote students to study the behavior of investment, emotional engagement, in-depth thinking ability, Then train students higher order thinking.

Learning interaction positively influences deep learning (P<0.05). Human-computer interaction (P=0.034<0.05), peer interaction (P=0.000<0.05) and self-interaction (P=0.004<0.05) had a positive effect on deep learning, while teacher-student interaction had no significant effect on deep learning (P=0.053<0.05). The reason why teacher-student interaction has no significant influence on deep learning may be that most of the interaction between teachers and students is simple knowledge communication, and the negotiation, questioning and in-depth study of problems rarely occur, which leads to the failure of self-construction of knowledge. It can be seen that shallow level interaction will not promote the occurrence of online deep learning [22]. It is suggested to build online learning community and deepen online interaction. Establish a reasonable online learning interaction system to enhance the emotional viscosity between learning communities. In online learning environment, students are the main leaders of learning, and teachers' proper guidance, encouragement and accompanying students to conduct online learning and research discussion will better promote the interaction between teachers and students. Students can interact with the learning content, the interaction between teachers and students and the interaction between peers, including browsing the learning content and completing online knowledge tests, actively communicating with peer teachers in teaching, actively participating in online activities, dare to raise their own doubts and so on.

Learning interaction plays a mediating role in the influence of learning input factors on deep learning. At the level of indirect effect, its point estimate value is 0.246 in the BC95%confidence interval [0.173, 0.343], excluding 0; At the level of direct effect, its point estimate value is 0.419, excluding 0 in the CONFIDENCE interval of BC95% [0.290, 0.588]. It indicates that students' behavioral, affective and cognitive engagement in online learning can affect students' deep learning through influencing learning interaction including human-computer interaction, teacher-student interaction, peer interaction and self-interaction. It can be seen that good interaction will promote students' learning involvement, and students will change from simple and boring knowledge learning to deep thinking about knowledge itself, reconstruct and internalize knowledge and apply it to new situations, and reach the level from understanding basic meaning of knowledge to transferring and using it.

REFERENCES

[1] Li jingjie. Research on adult online deep learning strategies based on immersion theory [J]. Adult education, 2019, 39(03):18-22.

[2] Wang Peng. Student-teacher-learning: The evolution of pathways of teaching evaluation in American universities--based on John Biggs' 3P model of teaching and learning[J]. Explorations in Higher Education, 2017(10):52-57.

[3] Duan Jinju. Research on strategies for promoting deep Learning in e-learning Environment [J]. China Electronic Education,2012(05):38-43.

[4] Chen Ze-xuan, Hu Xiao-yong, XU Huan-yun. An empirical study on the Relationship between learners' information literacy, online Learning Engagement and Learning Performance [J]. China Electronic Education, 2020 (03):77-84.

[5] Marton F, Säljö R. On qualitative differences in learning: I — Outcome and process[J]. British journal of educational psychology, 1976, 46(1): 4-11.

[6] Craik F I M, Lockhart R S. Levels of processing: A framework for memory research [J]. Journal of verbal learning and verbal behavior, 1972, 11(6): 671-684.

[7] Blumenfeld P C ,Fredricks J A, Paris A H. School engagement: Potential of the concept, state of the evidence[J]. Review of educational research, 2004, 74(1): 59-109.

[8] Fredricks J A. Eight myths of student disengagement: Creating classrooms of deep learning [M]. Corwin Press, 2014.

[9] Wu Yajie. Factors affecting learners depth of online learning and its measurement [J]. Journal of electrochemical education research, 2017, 38 (9): 57-63. DOI: 10.13811 / j.carol carroll nki. Investigate. 2017.09.008.

[10] Liu Zheyu, Wang Zhijun. An empirical study on the impact of behavioral engagement on deep learning: A case study of video learning in virtual reality (VR) [J]. Distance education journal, 2017, 35 (01): 72-81. The DOI: 10.15881 / j.carol carroll nki/g4.2017.01.008 cn33-1304.

[11] Xu Haixia, Zhang Yu. The impact of learning engagement characteristics on deep learning in online micro-courses for nursing undergraduates [J]. Journal of Inner Mongolia medical university, 2021 lancet (S1): 65-68. The DOI: 10.16343 / j.carol carroll nki. Issn 2095-512 - x. 2021. S1.023.

[12] Chen Li. The Essence of the Term "Teaching Interaction" and The Discrimination of Related Concepts [J]. Distance Education in China, 2004 (03):12-16+78-79.

[13] Liu Dong, Li Tongtong, Ma Xiufeng. On the impact of learning style on online learning interaction degree experimental study [J]. Open education research, 2011 (4): 96-101. The DOI: 10.13966 / j.carol carroll nki kfjyyj. 2011.04.015.

[14] Hirumi A. Analysing and designing e-learning interactions [J]. Interactions in online education: Implications for theory and practice, 2006: 46-71.

[15] Filius R M, Kleijn R A M, Uiji S G, et al. Promoting Deep Learning through Online Feedback in SPOCs[J]. Frontline Learning Research, 2018, 6(2): 92-113.

[16] AKYOL Z,GARRISON D R. Role of instructional technology in the transformation of higher education [J]. Journal of computing in higher education, 2009, 21(1): 19-30.

[17] Lu Qiang. Interactive teaching levels on the depth of college students' online learning study [J]. The influence of electrochemical education research, 2021, and (3): 34 and 41. DOI: 10.13811 / j.carol carroll nki. Investigate. 2021.03.005.

[18] Li shuang, yu Chen. Development and application of distance students' learning engagement evaluation scale [J]. Open education research, 2015, 21(06):62-70+103.

[19] Belland B R, Kuo Y C, Walker A E, et al. A case study of integrating Interwise: Interaction, internet self-efficacy, and satisfaction in synchronous online learning environments[J]. International Review of Research in Open and Distributed Learning, 2014, 15(1): 161-181.

[20] Wang Quanliang. Research on current situation and Influencing Factors of Deep Learning of College Students in Network Environment [D]. Yunnan University, 2016.

[21] Education Research Institute of Tsinghua University.2009 School Situation Questionnaire Manual [Z].2009.

[22] Du Yanyan, Huang Qingshuang. Online deep learning mechanism and promoting strategies [J]. China's higher education research, 2020 (6): 58-63. DOI: 10.16298 / j.carol carroll nki. 1004-3667.2020.06.11.