A Study on the Factors Influencing College Students' Autonomous Learning Ability from the Perspective of Online Learning

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Abstract: Online learning has become one of the directions for major universities to achieve educational reform, and the online learning ability of college students is the key to the effectiveness of online education. Based on the Biggs3P theory, an online learning strength table was constructed, and factor analysis was used to construct college students' online learning ability. Regression analysis was conducted to identify the influencing factors of online learning ability and determine the mediating role of deep learning orientation. The empirical results indicate that multiple factors in the online learning environment, including but not limited to learning resources, student interaction, teacher support, and learning evaluation, all have varying degrees of positive effects on college students' deep learning orientation. Among them, the learning evaluation and teacher support of online learning have a strong influence, while the technical usability of online learning platforms has the weakest influence. In response, suggestions are proposed to enrich the construction of online learning resources, enhance the interactive experience of online learning students, strengthen the diversified development guided by online teachers, and build a multi-dimensional online learning evaluation mechanism.

Keywords: Online Learning Ability; Factor Analysis; Biggs3P Theory; Deep Learning Orientation; Autonomous Learning Ability

1. Introduction

The 14th Five-Year Plan proposes to "build a digital livelihood security system that is inclusive and convenient", and to carry out lifelong digital education. It is necessary to accelerate the construction of China's special education network and the "Internet + education" platform, build a ubiquitous online learning space, support the normal application of all kinds of innovative teaching, and promote the open sharing of high-quality educational resources. Therefore, the teaching reform of online education has attracted wide attention. Online learning, such as MOOC, live teaching and Xuexitong, has been integrated into the college students and become one of the learning modes. Compared with other learning modes, online learning has the advantages of breaking through time and geographical limitations. During the COVID-19 epidemic period, universities have been forced to shift from traditional education to online teaching. On the one hand, it forces teachers and students to adapt to the new teaching carrier. On the other hand, this more "open" learning environment stimulates students to explore learning with the help of the Internet. However, online learning is not just moving course content from offline to online, nor is it a simple change of teaching carrier. In a more open learning environment, students' autonomy is the core factor affecting the learning effect.

Compared with the face-to-face teacher "supervision", online learning is more open and free, and the initiative and autonomy of learning are more important. Students need to manage their own learning time and progress more effectively, master effective learning strategies and skills, in order to achieve good learning results. Therefore, it is of great significance to study how to cultivate students' autonomous learning ability and the influencing factors of online learning on students' autonomous learning. First of all, this new education mode can promote the innovation and development of educational theory. Secondly, the research on college students' autonomous learning in the online learning environment can deeply explore the cognitive and behavioral mechanisms in the learning process, and provide new ideas and breakthroughs for education and teaching.

Finally, the research on college students' autonomous learning in the online learning environment can provide strong support for educational practice and innovation.

2. Literature Review

Research on online education and autonomous learning ability mainly focuses on the status quo, influencing factors and construction of an online learning environment that can promote autonomous learning. Online teaching interaction helps to improve learners' learning participation, learning satisfaction, deep learning, etc[1]. The path to improve students' online learning effect from three aspects: schools, teachers and students. They believe that teachers should adjust the course schedule according to the characteristics of online learning, so that students can be more actively involved in teaching[2]. The implementation strategy, general methods and key links are the three key factors in the cultivation of autonomous learning ability [3].

The online learning situation in Ghanaian universities during the epidemic showed that the respondents all believed that online learning made the learning process simple and improved learners' confidence [4]. Diningrat et al. used the bidirectional difference method to analyze the effect of online learning on flipped classroom, and pointed out that the addition of online learning helps to improve students' comprehensive test scores compared with the traditional flipped classroom [5]. Online-learning can provide disruptive innovation, but it may also cause anxiety in teachers or speakers. Therefore, while using online education to bring changes to students' learning, online courses should be better adjusted [6]. Self-regulated learning (SRL) is a method to help teachers understand students' ability to manage online learning strategies and improve their performance [7]. And technological differences affect learners' online learning evaluation [8].

Throughout the existing research literature, there are a lot of literature on autonomous learning and the dimensions of autonomous learning ability, which provides a basis for this topic to further define the concept and dimensions of online autonomous learning ability. However, there is no systematic research on the influencing factors of college students' autonomous learning ability in online learning environment, and there is a relative lack of research on its specific influencing path.

3. Questionnaire Design and Hypothesis

According to the Biggs3P learning process model, a complete and successful learning process includes three stages: preset, process and output. The preset stage mainly includes individual factors such as students' own knowledge reserve and belief and environmental factors, which mainly refer to external factors such as teaching evaluation and curriculum structure that can affect learning. Biggs theory believes that the process stage is the core link, a comprehensive system for learners' learning and processing, and a process of binding learning strategies and learning motivation. This includes shallow learning motivation and deep learning motivation. Deep learning motivation is expressed as learners' active learning, with strong interest and self-innovation, which often brings good learning results. Shallow learning motivation is expressed as learners' passive and passive learning, such as learning to cope with exams or teacher inspection. The output stage is the learning outcome, which can be expressed as external forms such as academic achievements and achievements, or internal forms such as self-improvement and thinking ability development (see figure 1).

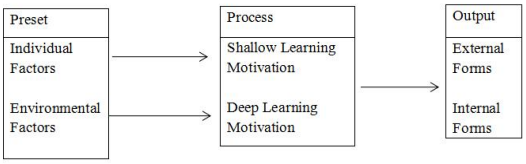

Figure 1. Biggs3P Theory Learning Process Model

The environmental factors in the preset stage have an indirect impact on learning outcomes through learning motivation. Online learning is divided into five dimensions, which are the usability of online learning technology, the richness of online resources, the interaction of online students, the guidance of online teachers and the evaluation of online learning; with deep learning orientation as the mediating variable, the autonomous learning ability of college students under online learning is divided into five dimensions, which are the formulation of technology and goal plans, the utilization of learning content and materials, the regulation of learning process, the

evaluation of learning outcomes and deep learning orientation[9]. Accordingly, the corresponding questionnaire is designed. For details, see Figure 2.

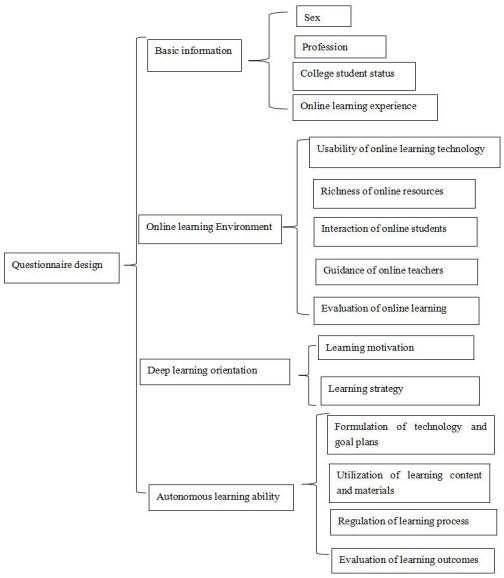

Figure 2. Online Learning Force Diagram

In summary, the usability of online learning technology, the richness of online resources, the interaction of online students, the guidance of online teachers and the evaluation of online learning are independent variables, deep learning orientation is the mediating variable, and the formulation of technology and goal plans, the utilization of learning content and materials, the regulation of learning process, and the evaluation of learning outcomes are dependent variables. And the hypotheses are as follows:

H1: Online learning environment factors have a positive promoting effect on deep learning orientation.

H2: Deep learning orientation has a positive promoting effect on autonomous learning ability.

4.Methodology

4.1 Data Source and Verification

The data sample comes from the college students in Fuzhou. According to the data of the National Bureau of Statistics, there are about 3960 college students in Fuzhou in 2023, and the college students here refer to the degree of junior college. Based on the confidence level of 95% and the allowable error of 5%, the initial sample size calculated by the sample size formula is 296. In order to consider the effective questionnaire ratio of 98%, the final sample size of the questionnaire is determined to be 302. A total of 355 questionnaires were actually collected, and after cleaning the data, 314 valid questionnaires were obtained, with an effective rate of 88.45%. Among them, the number of boys was 124, and the number of girls was 190, with a male-to-female ratio of about 4:6. There were 121 students in the literature and history class, 133 students in the science and engineering class, and 65 students in other classes.

4.1.1 Reliability test

As can be seen from the results in Table 1, the Cronbach's α coefficients of each variable in the questionnaire are above 0.6, indicating that the reliability of each scale is relatively ideal. Among them, except for the variable of the usability of online learning technology, the reliability of other variables is above 0.8, which is good. This result indicates that the questionnaire has a high reliability on the whole, so it can be used reliably.

Table 1. Reliability Test of Measurement Questionnaire

Scale	Variable	Number of entries	Cronbach's α
Online learning environment scale	Usability of online learning technology	2	0.688
	Richness of online resources	5	0.888
	Interaction of online students	6	0.936
	Guidance of online teachers	6	0.916
	Evaluation of online learning	3	0.839
Deep learning orientation scale	Deep learning orientation	13	0.958
Autonomous learning ability scale	Formulation of technology and goal plans	5	0.912
	Utilization of learning content and materials	4	0.886
	Regulation of learning process	4	0.886
	Evaluation of learning outcomes	4	0.878

4.1.2 Validity test

KMO test can be used to judge whether there is correlation between the item variables in the scale and whether it is suitable for factor analysis. The KMO values of the three scales are all greater than 0.9(see table 2), indicating that the item variables in the scale have a strong correlation.

Table 2. Measurement Questionnaires KOM Test and Bartlett Sphericity Test

Scale	KMO value	Chi-Square	DF	Sig.
Online learning environment scale	0.970	5866.894	231	0.000
Deep learning orientation scale	0.946	2302.937	45	0.000
Autonomous learning ability scale	0.975	4764.178	136	0.000

The significance of Bartlett test of the three scales is less than 0.05, that is, at the 95% significance level, the correlation coefficient matrix has a statistically significant difference.

4.1.3 Confirmatory factor test

When conducting confirmatory factor analysis, it is usually required that the sample data is at least 5 times or even 10 times more than the total number of questions, and at least 200 samples are needed. The sample size of the questionnaire is 314, which meets the basic data requirements of confirmatory factor analysis.

The quality of aggregation validity can be evaluated by AVE and CR coefficient. The AVE values of the questionnaire are greater than 0.5; the CR values are less than 0.7, indicating that the extraction degree of the measurement indicators within the factor is good (see table 3). Similarly, the extraction degree of measurement indicators in other factors also performs well.

Table 3. Test Results of AVE and CR

Scale	Variable	Variable symbol	Average variance extraction AVE value	Combined reliability CR value
Online learning environment scale	Usability of online learning technology	TU	0.528	0.691
	Richness of online resources	RA	0.616	0.889
	Interaction of online students	SI	0.711	0.936
	Guidance of online teachers	TS	0.645	0.916
	Evaluation of online learning	LA	0.631	0.837
Deep learning orientation scale	Deep learning orientation	DL	0.624	0.943
Autonomous learning ability scale	Formulation of technology and goal plans	TO	0.676	0.912
	Utilization of learning content and materials	CI	0.658	0.885
	Regulation of learning process	PR	0.662	0.887
	Evaluation of learning outcomes	RE	0.643	0.878

4.2 Factor Analysis

It is necessary to use factor analysis method to reduce the dimensionality of technology and goal planning, learning content and material utilization, learning process regulation and learning result evaluation. KMO test, Bartlett sphericity test and validation factor analysis show that the questions corresponding to each variable have a certain reflection on the variable, and the questionnaire sample size is large enough to meet the basic data requirements of validation factor analysis.

The descriptive analysis results of the four dependent variables show that the range of the four variables is large, and there is a large gap between the minimum and maximum values. KMO and Bartlett analysis methods are used for the model adaptability test of the four dependent variables.

The KMO measurement result is 0.879, exceeding the standard value of 0.5. At the same time, the P value of Bartlett sphericity test is less than 0.05, rejecting the null hypothesis that the correlation coefficient matrix is a unit matrix, which indicates that the data sample is suitable for factor analysis. The maximum variance method is used to extract the common factors of the original dependent variables. The information of the four original dependent variables is basically extracted in large quantities, and the information of the original variables contained in the common

factors is more than 89.1%. In particular, the extraction information of learning content and material utilization is as high as 92.2%, indicating that the extraction effect is good and the loss of information is less.

The total variance explained results (table 4) show that the extraction eigenvalue of the first common factor is greater than 1, and the cumulative variance contribution rate is as high as 90.712%, which indicates that the first common factor can well summarize the information of the original variables, so it is selected as an indicator to evaluate the independent learning ability of college students.

Table 4. Total Variance Explained

	Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.628	90.712	90.712	3.628	90.712	90.712
2	0.145	3.621	94.334			
3	0.132	3.294	97.628			
4	0.095	2.372	100			

The factor loading coefficient after rotation in the orthogonal rotation matrix is as high as 0.94, indicating that the loading of factor 1 on the four indicators is very large. Therefore, the formulation of technology and goal plan, the utilization of learning content and material, the regulation of learning process and the evaluation of learning results can be determined as a component.

According to the component score coefficient matrix, the main component, namely the independent learning ability of college students, can be determined as:

$$Y_m = 0.26\mathrm{TO} + 0.265CI + 0.264PR + 0.261RE \quad (1)$$

4.3 Regression Analysis

In order to confirm the impact of online learning on the independent learning ability of college students, as well as the mediating effect of learning orientation on the independent learning ability of college students, the model is set as a linear regression model, and the model is constructed as follows:

$$DL_m = \alpha_0 + \alpha_1 TU_m + \alpha_2 RA_m + \alpha_3 S\,\mathrm{I}_m + \alpha_4 TS_m + \alpha_5 LA_m + \xi_m \quad (2)$$

$$Y_m = \beta_0 + \beta_1 DL_m + \xi_m \quad (3)$$

The table 5 shows the descriptive statistical results of TU, RA, SI, TS, LA and DL. The standard deviation of online learning resource richness is the smallest, while the standard deviation of online student interaction is relatively large, indicating that the sample data is relatively discrete, reflecting that there are great differences in college students' satisfaction with online student interaction.

Regression analysis is conducted on Model 1 and Model 2 respectively (see the table 6). In Model 1, the T test of TU, RA, SI, TS and LA is significant, that is, they all have a significant impact on DL, and the influence coefficients are all positive, so H1 hypothesis is verified. Among them, the learning assessment of online learning has the greatest impact on deep learning, with an influence coefficient as high as 0.267. The goodness of fit of the model is 0.739, and the variance test equation regression results are significant. In addition, the VIF values of TU, RA, SI, TS and LA are all lower than 10, indicating that there is no multiple collinearity problem between variables.

The regression results of Model 2 show that the T test of DL is significant, and has a significant positive effect on Ym. For every 1% increase in deep learning orientation, online learning power will increase by 0.989%. The goodness of fit of the model is as high as 0.868, indicating good regression effect. Therefore, H2 hypothesis is verified.

Table 5. Descriptive Statistics

Variable	Variable symbol	N	Maximum	Minimum	Mean	sd.
Deep learning orientation	DL	314	1.00	5.00	3.7490	.86734
Usability of online learning technology	TU	314	1.00	5.00	3.8296	.92814
Richness of online resources	RA	314	1.00	5.00	3.8076	.86535
Interaction of online students	SI	314	1.00	5.00	3.6146	1.02251
Guidance of online teachers	TS	314	1.00	5.00	3.7687	.88749
Evaluation of online learning	LA	314	1.00	5.00	3.8556	.91526
Online learning ability score	Ym	314	1.05	5.25	3.9269	.92041
	Valid N (listwise)	314				

Table 6. Regression Results

Model 1							Model 2				
Variable	Unstandardized Coefficients		Standardized Coefficients	t	Collinearity Statistics		Variable	Unstandardized Coefficients		Standardized Coefficients	t
	B	Std. Error	Beta		Tolerance	VIF		B	Std. Error	Beta	
C	0.415	0.12		3.449***			C	0.22	0.084		2.619**
TU	0.093	0.046	0.099	2.014**	0.349	2.866	DL	0.989	0.022	0.932	45.352**
RA	0.124	0.072	0.124	1.718*	0.164	6.093					
SI	0.189	0.046	0.223	4.074***	0.284	3.52					
TS	0.211	0.069	0.216	3.041**	0.168	5.953					
LA	0.267	0.058	0.282	4.590***	0.225	4.436					
R	.859[a]						R	.932[a]			
R Square	0.739						R Square	0.868			
F Change	174.116***						F	2056.812***			
Durbin-Watson	1.996						Durbin-Watson	1.836			

Note: *** indicates a significant confidence interval of 0.99; ** indicates a significant confidence interval of 0.95; * indicates a significant confidence interval of 0.90.

In summary, the technical usability of online learning, the resource richness of online learning, the student interaction of online learning, the teacher support of online learning, and the learning assessment of online learning have a significant promoting effect on deep learning orientation, and deep learning orientation has a significant positive effect on online learning ability. Therefore, the mediating effect of deep learning orientation on online learning ability has been confirmed.To improve online learning ability, we can start from the aspects of deep learning orientation, the technical usability of online learning, the resource richness of online learning, the student interaction of online learning, the teacher support of online learning, and the learning assessment of online learning.

4.4 Robustness Test

In order to test the robustness of the above model, other professional samples are excluded, and the samples of literature and history and science and engineering are regression again (see the table 7). The results show that the technical usability of online learning, the resource richness of online learning, the student interaction of online learning, the teacher support of online learning, and the learning assessment of online learning still have a promoting effect on deep learning orientation, and the T test results of each variable are significant. The F test is significant, and the goodness of fit is good. Model 4 also shows that deep learning orientation has a significant positive correlation with online learning ability, and its F test is significant with good goodness of fit. In summary, after robustness test, the mediating effect of deep learning orientation is still stable, learning environment factors have a stable promoting effect on deep learning orientation, and deep learning orientation has a stable positive effect on online learning ability.

Table 7. Robustness Test Results

Model 3					Model 4			
Variable	Unstandardized Coefficients	Standardized Coefficients	t	Collinearity Statistics	Variable	Unstandardized Coefficients	Standardized Coefficients	t

	B	Std. Error	Beta		Tolerance	VIF		B	Std. Error	Beta	
C	.339	.121		2.798**			C	.202	.088		2.284**
TU4	.088	.048	.092	1.830*	.349	2.867	DL4	.999	.023	.941	43.716***
RA4	.273	.075	.274	3.663***	.156	6.397					
SI4	.118	.055	.138	2.125**	.206	4.846					
TS4	.221	.078	.232	2.822**	.130	7.708					
LA4	.205	.058	.221	3.546***	.224	4.460					
R	.887[a]						R	.941[a]			
R Square	0.787						R Square	0.885			
F Change	180.063***						F	1911.115***			
Durbin-Watson	2.085						Durbin-Watson	2.030			

5. Conclusions

Multiple factors in the online learning environment have different degrees of positive impact on college students' deep learning orientation, and deep learning orientation has a promoting effect on college students' autonomous learning ability. This means that through online learning, college students can get more learning resources and opportunities to improve their learning ability and level. Among them, the most important factors for improving college students' autonomous learning ability are the learning assessment of online learning and the teacher support of online learning, with the influence of 0.264, 0.209 respectively.The technical usability of online learning platform has the weakest influence, with the influence of 0.092. It can be seen that although the technical usability of online learning platform can improve the convenience and efficiency of students using the platform, it may not really improve students' autonomous learning ability and learning effect. The teachers' online teaching skills, guidance frequency, classroom flip setting and feedback of evaluation results are the key to stimulate college students' autonomous learning motivation and improve their online learning ability. Therefore, to improve college students' online learning ability, we can start from the following aspects.

5.1 Enriching the Construction of Online Learning Resources

In order to make the online learning environment truly effective, we need to pay attention to improving the construction of online learning resources. This includes providing high-quality teaching resources, designing colorful learning activities, and providing effective learning support and services. First of all, the quality and effectiveness of existing online learning resources can be improved by integrating and optimizing them. For example, add interactive elements, quizzes and exercises to existing video courses to better stimulate students' interest and motivation. Secondly, Develop more online learning resources to meet the learning needs and levels of different students. This includes writing online textbooks, designing online LABS, and producing online courses. At the same time, it needs to consider how to use advanced technologies, such as artificial intelligence and virtual reality, to enrich the form and content of online learning

resources. Thirdly, Provide effective learning support and services to help students better cope with learning challenges and difficulties. For example, set up online counseling services, academic writing tutoring, study plan guidance, etc., so that students can get timely help and support.

5.2 Enhance the Interactive Experience of Students in Online Learning

Firstly, more interactive learning activities can be designed, such as online group discussions, interactive tests, and student work displays. These activities can promote communication and cooperation among students and stimulate students' interest and enthusiasm for learning. Secondly, various online tools and platforms can be adopted to support students' interactive learning, such as online whiteboards, real-time chats, collaborative editing, and so on. These tools can make communication among students more convenient and efficient. In addition, students' interactive experience can also be improved by increasing the interaction between students and teachers. For example, teachers can conduct online Q&A on a regular basis, provide personalized feedback and guidance, and so on to help students better understand and master the learning content. Finally, the design and function of online learning platforms need to be continuously optimized to improve students' interactive experience. For example, virtual simulation elements can be added, and better user interfaces can be provided to attract students' attention and interest. In addition, the stability and reliability of the online learning platform should be ensured so that students can learn and interact smoothly.

5.3 Strengthen the Diversified Development of Online Teacher Guidance

Teacher guidance is one of the manifestations of teacher support. Teachers can try to adopt different teaching strategies and methods, such as classroom demonstrations, simulation experiments, online discussions, flipped classrooms, etc., in order to better stimulate students' learning interest and enthusiasm. In addition, teachers can use interactive tools provided by online learning platforms, such as online whiteboards, video conferences, etc., to provide students with more specific and real-time guidance. Teachers can also provide students with personalized learning resources and support according to their learning needs and levels. Furthermore, teachers can also use data analysis tools provided by online learning platforms to track and evaluate students' learning situation, timely find students' learning problems and give targeted help.

5.4 Build a Multi-Dimensional Online Learning Assessment Mechanism

Online learning assessment has a significant impact on guiding college students' online autonomous learning and stimulating students' deep learning orientation. In order to achieve comprehensive online autonomous learning assessment, a variety of assessment methods can be adopted, such as homework assessment, test assessment, project assessment, discussion assessment, chapter learning status, etc. Students' self-evaluation and peer evaluation should also be taken into consideration to better reflect students' learning status and ability level. However, there are still some challenges and difficulties in the actual implementation of comprehensive online autonomous learning assessment. Among them, the objectivity and fairness of assessment is one of the main problems. Therefore, a variety of means need to be adopted, such as anti-plagiarism software, online examination system, standardized assessment standards, etc., to ensure the objectivity and fairness of assessment. At the same time, teachers need to actively participate in the assessment process, provide students with necessary feedback and guidance, and promote students' learning progress.

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References

[1] Lu Qiang. Research on the influence of Teaching interaction Level on College students' online deep learning. Research on Audio-visual Education, 2021,42(3):34-41.

[2] Ye Liang, Wang Jiao. Exploration on the improvement path of students' online learning Effect. Journal of Higher Education,2023,9(15):78-80+84.

[3] Wang Zhanquan, Zhang Yongzhong, Chen Haibo. An empirical study on the cultivation strategies of college students' autonomous learning ability. Chemical Engineering Higher Education, 2023, 40 (01): 101-109.

[4] Ziggah S R, Eshun P, Mahama I. Perceptions and Experiences of Adult Learners of Online Learning in the Era of COVID-19 in Ghana. Psychological Research, 2022, 4(4):12.

[5] Diningrat S W M, Setyosari P, Ulfa S, et al. The Effect of an Extended Flipped Classroom Model for Fully Online Learning and its interaction with Working Memory Capacity on Students' Reading Comprehension. Journal of New Approaches in Educational Research. 2023, 12 (1): 77-99.

[6] Yee B C, Nawi A M, Abdullah T. Potential disruptive innovation: online learning of public speaking courses in higher education. Foresight: The journal for future studies, strategic thinking and policy, 2022(3/4): 24.

[7] Rizki P N M, Handoko I, Purnama P, et al. Promoting Self-Regulated Learning for Students in Underdeveloped Areas: The Case of Indonesia or Nationwide Online - Learning Program. Journal of Sustainability, 2022, 14.

[8] Alsuhaibani Z. Saudi EFL Students' Use and Perceptions of Blackboard before and during Online Learning Amid COVID - 19. Journal of Arab World English Journal (AWEJ), 2021 (1).

[9] Zhang M. Research on Influencing factors of college students' autonomous learning ability in online learning environment. Central China normal university, 2020.

