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Empirical Research on the Relationship Between Critical Thinking, Learning Input, and Learning Gains of College Students Based on MOOC

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Abstract

The ability to think critically is the essential talent of the twenty-first century, and it is crucial to college students' learning and growth. The overall level of critical thinking among college students is good, but the development of the dimension of truth-seeking lags behind. The system of critical thinking and the desire for knowledge have a significant positive predictive effect on learning gains. Learning engagement's behavior has been studied to explore the relationship between critical thinking, learning input, and the learning gains of college students. In light of the findings, it is clear that relevant education and teaching enlightenments have been attained, including those that strengthen the cultivation of the truth-seeking spirit, correct deficiencies in college students' critical thinking development, foster curiosity, pierce systematic thinking, and maximize college students' learning gains, as well as those that strengthen the direction of learning input and center on enhancing college students' learning harvest. Additionally, it is crucial to identify the characteristics that influence college students' continued usage of MOOC so that the MOOC platform may optimize its offerings and enhance user experience.

Keywords: College Students, Critical Thinking, Learning Engagement, Learning Gains

Introduction

The development of students' critical and creative thinking has become the focus of international education reform since the turn of the twenty-first century, with the arrival of the new technology revolution and the digital information age. Recently, the United States' 21st Century Learning Alliance and the China Institute of Educational Innovation collaborated. It has proposed a 5C model for the core literacy of talents in the 21st century, namely cultural competence, critical thinking, creativity, communication, and collaboration. This model is based on research and empirical analysis of pertinent literature from major international organizations and countries. To further emphasize the value of encouraging students' critical thinking in participating nations and regions, the International Student Assessment Project (P

ISA), run by the Organization for Economic Co-operation and Development (OECD), has incorporated critical thinking and innovative thinking into the assessment framework (Chen et al., 2022). The development of innovative skills depends on critical thinking, and creativity in thinking demands critical thinking's support at all stages The growth of critical thinking education in the study country is comparatively trailing behind that of Western industrialized nations, which have included it into their national educational goals. According to studies, college students in the study nation still have a long way to go in terms of developing their critical thinking skills (Chioma et al., 2022). The development and enhancement of college students' critical thinking must be further reinforced in light of the requirement to provide a first-rate undergraduate education.

Nation's advancement in higher education has reached the popularization stage and is transitioning from a country with high education to a country with higher education (Zhang et al., 2022). The scope of higher education has been steadily growing, and as a result, its quality has drawn more and more attention from people from all walks of life. In his speech at the National College Undergraduate Education Work Conference in the New Era in June 2020, Chen Baosheng, the current Minister of Education, noted that "undergraduate education is the foundation of higher education and the foundation of development," and that "students' energy input is not in place," among other things (Liu & Ko, 2022). The issue is more obvious. Students must "return to common sense, which means they must study hard and study hard" in undergraduate education. A critical theoretical and practical issue in today's higher education is how to preserve and enhance students' learning input so they learn something. The course teaching for each course is the fundamental component that makes up the blueprint planning if the curriculum system is the guide for students' learning (Pu & Yu, 2022). Because of this, the purpose of this study is not to investigate the relationship between learning input and learning gain based on students' experiences in all courses, but rather to examine the learning input and learning outcomes of students in a particular course after they have studied it. In this approach, the research findings can more effectively relate to the instructional strategies used by college instructors for a certain course. In order to effectively improve the quality of college students' course learning and support the teaching reform of undergraduate education courses, this study combines the teaching practice of a course to investigate and analyze the relationship among college students' critical thinking, learning input, and learning gains.

Literature Review and Research Hypothesis

Critical thinking and learning engagement

The concept of critical thinking can be traced back to the "reflective thinking" proposed by the American educator Dewey (1987). According to Ennis, critical thinking is "reasonable reflective thinking in deciding what to believe or do" (Bowman, 2020). Although there is no generally accepted definition of critical thinking, Eastern and Western scholars agree that questioning, reflection, analysis, synthesis, and evaluation are the core elements of critical thinking (Moore et al., 2011). Learning engagement (aka academic engagement) can also be called academic engagement, student participation, etc. Early researchers considered learning input to be "time on task" and "quality of effort." Later, people gradually discovered and agreed that learning engagement is a unity of behavioral engagement (effort and participation in learning activities), cognitive engagement (self-monitoring and use of cognitive strategies), and affective engagement (positive or negative emotional experience) (Halder, 2021). Wijaya and others found that there is a positive correlation between critical

thinking and the learning engagement of college students, and it can predict students' learning engagement more significantly than self-efficacy (Kim, 2020). Lu Zhongyao and Chen Jianwen's research shows that critical thinking disposition can significantly predict the learning engagement of college students, and critical thinking disposition affects learning engagement through the formation of a chain intermediary effect of mastery approach goal orientation and academic self-efficacy (Chantana, 2020). In terms of learning engagement behavior, Liang Huiyun and Lv Linhai found through investigation and research that learning participation behavior is an intermediary variable that affects the development of critical thinking in college students (Sage, 2020). In terms of learning engagement, Wu Yajie and Jiang Shanshan's research confirmed that college students' deep learning methods (strategies) are significantly positively correlated with critical thinking. In summary, critical thinking is closely related to learning engagement, but the relationship between the emotional dimension of learning engagement and critical thinking has not been explored enough (Sharma et al., 2021).

Critical Thinking and Learning Gains

Learning outcomes can also be called learning outcomes or learning outcomes. The Council for Higher Education Accreditation (CHEA) believes that students' learning gains refer to the growth of knowledge, ability, and skills after a certain period of study. Huang Haitao believes that learning gains are the "results or outputs" obtained by students after participating in learning activities; that is, learning gains reflect the value-added situation of students (Kang, 2013). In short, learning gains can be summarized as the changes that learning activities bring to students. Relevant studies at home and abroad have found that there is a significant positive correlation between critical thinking and the academic performance of college students, and critical thinking can well predict academic performance. Liu Chunhui's investigation and analysis found that there is a significant positive correlation between college students' ability to ask creative questions and information literacy and critical thinking disposition, and critical thinking disposition plays a moderating role in the prediction of information literacy (Maroofi et al., 2012). A Villavicencio (F.T. Villavicencio) survey found that critical thinking helps college students properly use cognitive resources to help them solve problems, reduce their anxiety and helplessness, and thus improve their academic performance (Ellahi & Sharif, 2020). The above research shows that critical thinking has a positive effect on knowledge learning, ability improvement, and academic emotion in college students.

Learning Input and Learning Gain

G.R. Pike et al. used the data analysis of the National Survey of Student Engagement (NSSE) to find that college students' learning engagement is significantly related to learning gains (Muhammad, 2020). Another study by G.R. Pike and others showed that there is an indirect effect of learning input on learning gain (Wang, 2020). Wang Shu used the 2009 data of the “National University Student Survey” (NSSE-China) to analyze and find that learning input has a greater impact on learning outcomes than the variables of colleges and students’ family backgrounds and that the various dimensions of learning input's impact on learning gains vary (Sun & Li, 2019). Yang Yuan et al. divided the learning input of college students into six categories: "full commitment," "balanced input," "peer-dependent," "teacher-dependent," "examination-passing," and "learning resistance," and found that students with different types of learning input had different learning outcomes (Talha et al., 2019). Through analysis,

Wang Yashuang found that college students' learning input can explain 4.6% of the changes in their general skill gains and 4.9% of the changes in their professional knowledge gains, which is much higher than the explanatory power of school characteristics and individual student characteristics (Richard et al., 2019). Dimensions have different impacts on each dimension's learning gains. The above research shows that learning engagement is a key variable that affects college students' learning outcomes, and different dimensions of learning engagement have different effects on different aspects of learning outcomes.

Critical Thinking and MOOC

The continuous learning behavior of MOOC learners is mainly researched and analyzed in terms of its influencing factors. Previous scholar combined the theory of continuous use of information systems with self-determination theory and constructed a research model of influencing factors of MOOC users' continuous use intention, considering users' internal and external motivation factors (Sun et al., 2020);Former scholar not only analyzed learning partners' influence on MOOCs from the perspective of collaborative learning, the impact of continuous use behavior, also using the theory of learning success or failure attribution and learning motivation theory to demonstrate the relationship between success or failure attribution, learning motivation, and continuous use intention (Sarah & Ira, 2022); Some scholars used the literature analysis method to analyze th e relevant empirical research on CNKI sorted out and summarized the reasons that affect MOOC learners' continuous learning (Li, 2021). In the article Research on Factors Influencing MOOC Learners' Continuous Learning Willingness, some scholars based on the Expectation Confirmation Model Introduce the flow experience variable to research and analyze the influencing factors of MOOC learners' continuous learning intention (Zhang et al., 2021); Former scholars introduced the perceived ease of use into the expectation confirmation model and established the influencing factor model of MOOC continuous learning intention (Zhang, 2021); they explored the continuous use behavior of MOOCs from the environment (MOOC system quality, course content quality, course interaction quality) and learners themselves (learning motivation, self-efficacy).

The expectation confirmation model is mostly used in the current research on the influencing aspects of MOOC continuous learning intention to investigate and study the platform environment and the participants themselves (Teng et al., 2021).

Few researchers have looked at the perspective of learners and the interaction between learners and platforms to study the continuous use behavior of MOOC (Tu, 2020). Researchers combined critical thinking and MOOC, and looked at system quality, course content, and course quality, as well as factors like learning motivation and self-efficacy induction in terms of learners themselves. A strong interactive engagement between different learners, between learners and teachers, and between learners is necessary for the ongoing growth of the MOOC platform and for learners to learn effectively.

To sum up, there is a close relationship between the two variables of critical thinking, learning engagement, and learning gains for college students. However, most studies investigate students' learning input and learning gains based on the overall course learning experience and seldom focus on analyzing these relationships in the learning background of a specific MOOC course, which reduces the guiding value of the research results for specific MOOC course teaching. In addition, few studies have incorporated these three variables into the same analysis model to explore the relationship between them through MOOC. Based on the above analysis, this study proposes the following two hypotheses:

Hypothesis 1: Based on MOOC, there is a significant correlation among critical thinking, learning input and learning gain, and the former two have a predictive effect on the latter.

Hypothesis 2: Based on MOOC, learning engagement mediates the relationship between critical thinking and learning outcomes.

Research Design

Research object

This study adopts the cluster sampling method to conduct a questionnaire survey among all freshmen majoring in engineering in a key comprehensive university to understand their critical thinking status and course experience after a semester of linear algebra MOOC course learning. The lecturers are young teachers, who mainly use the lecture method and the heuristic teaching method to carry out teaching. The survey was carried out in the form of on-site online questionnaires. A total of 250 questionnaires were distributed, and 247 valid questionnaires were recovered. The effective recovery rate of questionnaires was 98.9 %. Among them, there are 100 boys, accounting for 40.49%; 147 girls, accounting for 59.51 %.

Research tools

Critical Thinking Ability Scale

This study uses the "Critical Thinking Ability Inventory (Chinese Version)" (C TDI-CV). The scale is based on the " California Critical Thinking Disposition Inventory (CCTDI) " developed by P.A. (Franco et al,2019), and Chinese scholars start from concept equivalence , obtained after a localized interpretation of the CCTDI, which retains the seven dimensions of critical thinking measured by the CCTDI: truth-seeking (truth-seeking), open-mindedness (openness), analytical ability (analytics), and systematic ability to think critically (systematic), confidence in critical thinking (self-confidence), cognitive maturity (maturity), and intellectual curiosity. C TDICV overall C ronbach's in the original study the α coefficient is 0.90, and the range of Cronbach 's α coefficient for dimension is 0.54-0.77 (Wang et al,2019). In this study, the overall C ronbach's α coefficient is 0.91, and the range of C ronbach's α coefficient for dimension is 0.52-0. 84, showing good internal consistency. The scale has been tested and used many times in domestic research, which shows that it has good stability. There are 10 items in each dimension of the scale, a total of 70 items, using a six-point Likert scoring method, for example, for positive items, the option "strongly disagree" is assigned a score of 1, and "strongly agree" is assigned a score of 6, the other options are assigned 2, 3, 4, 5 in sequence.

Learning Engagement and Learning Gains Questionnaire

This study uses the learning input and learning gain sub-questionnaires in the "Course Learning Experience Questionnaire for College Students" to collect data. The learning engagement sub-questionnaire was adapted by the above-mentioned developers on the basis of the mature learning engagement scales in domestic and foreign large-scale surveys (NSSE, NSSE-China), combined with classroom observation and student interviews, and explored factor analysis (Robert et al., 2008). The learning harvest questionnaire is adapted from the learning harvest questionnaire in the "National College Student Learning and Development Tracking Study" (CCSS). There are 57 items in the learning engagement questionnaire and 12 items in the learning harvest questionnaire. The Learning Engagement Questionnaire includes: Behavioral Engagement Sub-Questionnaire to examine elements of active cooperative learning, pre-class self-study, extended learning, focus, persistence, etc.

Cognitive Engagement Sub-Questionnaire to examine high-level and reflective learning, integrated learning, learning strategies, self-monitoring and adjustment, etc. Emotional engagement is divided into questionnaires to investigate elements such as happiness, interest, and a sense of accomplishment. The questionnaire mainly adopts the four-point Likert scoring method. The Cronbach's coefficients of the overall learning engagement questionnaire, the behavioral, cognitive, and emotional sub-questionnaires, and the learning outcomes questionnaire are 0.970, 0.949, 0.912, 0.770, and 0.916, indicating that the questionnaire has good internal consistency.

Data collection process and analysis

Data were collected after a one-semester linear algebra course, and the survey was conducted through a live web-based questionnaire under the guidance of the instructor. After data collection and sorting, statistical analysis was performed on the data using SPSS21.0 statistical software.

Common method bias control

In this study, self-reported questionnaires were used to collect data, which may lead to false covariation among variables due to the use of the same measurement method, that is, common method bias. Therefore, procedural control and Harman single factor statistical tests were used for possible common method bias. In terms of procedural control, explain to the surveyed students that the survey is for scientific research purposes, keep their private information strictly confidential, and conduct questionnaire surveys in batches at different times and locations. In terms of statistical control, the results of the Harman single-factor test show that, without factor rotation, there are 37 factors with a characteristic root greater than 1, and the variance explained by the first factor is only 20.42 %, which is less than the critical value of 4. 0%, indicating that the problem of common method bias in this study is not obvious.

Research Results

Descriptive statistics and correlation analysis of each research variable

It can be seen from Table 1 that the truth-seeking (M = 3.86, SD = 0.58), systematic (M = 3.94, SD = 0.55) and self-confidence (M = 3. 98, SD =0.64) dimension score is relatively low, while the overall score of critical thinking and other dimensions are higher than 4.20 (median value is 3.5). The scores of behavioral input (M =2.28, SD = 0.42) of learning input were lower, and the scores of cognitive input (M =2.56, SD = 0.47) and emotional input (M =2.73, SD = 0.35) were higher than the median value of 2. 5. The mean value of learning gains was 2.43, slightly lower than the median value of 2.5.

Table 1:
Descriptive Statistics of The Research Variables

	truth-seeking	Openness	analytical	systematic	self-confidence	thirst for knowledge	Maturity	critical thinking	Behavior	cognition	emotion	put in	income
m	3.86	4.35	4.40	3.94	3.98	4.61	4.41	4.22	2.28	2.56	2.73	2.43	2.43
SD	0.58	0.44	0.52	0.55	0.64	0.61	0.55	0.39	0.42	0.47	0.35	0.40	0.52

The statistical results show that the correlation coefficients of learning gains, critical thinking, and learning input are 0.445 and 0.658, respectively, and the correlation tests are significant. Critical thinking was significantly more correlated with the total score of learning engagement ($r=0.616$, $p<0.01$). In addition, learning gains are significantly positively correlated with the seven dimensions of critical thinking and the three dimensions of learning input, among which behavioral input ($r=0.624$, $p<0.01$) and cognitive input ($r=0.603$, $p< 0.01$) have a high degree of correlation. The correlation among the research variables is consistent with the theoretical assumptions, which provides preliminary support for the subsequent analysis.

Regression Analysis of Critical Thinking on Learning Gains

Regression analysis was used to test which of the seven dimensions of critical thinking had a significant predictive effect on learning gains. Table 2 shows the results of a stepwise regression analysis of the seven dimensions of critical thinking on learning gains. Among the seven predictor variables, two variables of intellectual curiosity and systematicness were retained in the regression equation. The coefficient of determination R^2 of the equation is 0.231, indicating that the two variables of curiosity and systematicness can explain 23.1% of the total variation in learning gains. At the same time, curiosity and systematicness have a significant linear regression effect on the overall learning gains ($F=36.745$, $p<0.001$). Curiosity ($\beta= 0.327$, $t=5.054$, $p<0.001$) and systematicness ($\beta=0.225$, $t=3.478$, $p<0.001$) have significant positive predictive effects on learning gains.

Table 2 :
Results of Stepwise Regression Analysis of Critical Thinking on Learning Gains

	β	S E	t	R^2	F
thirst for knowledge	0.327	0.055	5.054 ***	0.231	3 6.745***
systematic	0.225	0.06	3.478 **		

Note: $*$ means $p< 0.005$, $**$ means $p< 0.01$, $***$ means $p< 0.001$, the same below.

Regression Analysis of Learning Input on Learning Gain

Regression analysis is used to test which dimensions of learning input have a significant predictive effect on learning gain. Table 3 shows the stepwise regression analysis results of the three dimensions of learning input on learning gains. The three predictors of behavioral

engagement, cognitive engagement, and emotional engagement are all retained in the regression equation at the end. The coefficient of determination R^2 of the equation is 0.442, indicating that the three dimensions of learning input can explain 44.2% of the total variation of learning gains. At the same time, the linear regression effect of the three predictors on the overall learning gain is significant (F =64.146, p<0.001). Behavioral investment (β= 0.312, t= 3.698, p < 0.001), cognitive investment (β= 0.257, t = 3.184, p <0.01), emotional investment (β= 0. 187, t = 3.200, p <0.01) has a significant positive predictive effect on learning gains.

Table 3
Results of Stepwise Regression Analysis of Learning Input on Learning Gain

	β	S E	t	R^2	F
behavioral engagement	0.312	0.103	3.698 ***	0.442	6 4.146***
Cognitive investment	0.257	0.089	3.184 **		
Emotional engagement	0.187	0.086	3.200 **		

Mediating Effect Analysis

According to the research hypothesis, the three variables of critical thinking, learning input and learning gain are put into a model for investigation, with critical thinking as the independent variable, learning gain as the dependent variable, and learning input as the mediating variable, to investigate whether the mediating effect of the hypothesis is established. Mediating effects were tested using the bias-corrected percentile Bootstrap method using the Processmacro program developed by K.J. Preacher and A.F. Hayes. The Bootstrap method is currently the most ideal method for testing the mediation effect. When using the Bootstrap method, repeated sampling was carried out 5000 times, if the 95 % confidence interval of the indirect effect size does not contain 0, it means that the mediation effect is significant. The test results are shown in Table 4 and Table 5.

From Table 4 that when the predictive variable is only critical thinking, critical thinking has a significant positive predictive effect on learning engagement (β= 0.629, p< 0.001). When the predictive variables include critical thinking and learning input, learning input has a significant positive predictive effect on learning gains (β = 0.809, p <0.001), but at this time the predictive effect of critical thinking on learning gains Not significant (β = 0.085, p > 0.05). In addition, it can be seen from Table 5 that the total effect of critical thinking on learning gains is 0.594 (direct effect 0.085 + indirect effect 0.509). Among them, the 9.5 % confidence interval of the direct effect contains 0, so it is not significant; while the 9.5% confidence interval of the indirect effect does not contain 0, indicating that it is significant. The value of the indirect effect is 0.509, accounting for 85.69 % of the total effect. In summary, this model is a complete mediation model, and the mediating role of learning input between critical thinking and learning gains is established.

Table 4:
Regression Analysis Results Among Variables In The Model

regression equation		Model Fit Index				Significance of regression coefficient			
outcome variable	predictor variable	R	R^2	f	β	S E	t	95% confidence interval	
learning input	critical thinking	0.616	0.380	149.890***	0.629	0.051	12.243***	0.528	0.730
learning gains	learning input	0.660	0.436	94.104***	0.809	0.080	10.134***	0.652	0.966
	critical thinking				0.085	0.082	1.040	-0.076	0.245

Table 5:
Analysis Results of Mediation Model Effect

path	estimated value	standard error	95% confidence interval		Ratio of total effect
			lower limit	upper limit	
Critical Thinking → Learning Gain (Direct Effect)	0.085	0.082	-0.076	0.245	14.31%
Critical thinking → learning input → learning gain (indirect effect)	0.509	0.067	0.387	0.650	85.69%

Conclusion and Enlightenment

Based on the analysis of the overall level of critical thinking of college students, this study focuses on the relationship between critical thinking, learning engagement, and learning gains, especially the mediating role of learning engagement between critical thinking and learning gains. The research found that the overall level of critical thinking of college students is good, but the development of the dimension of truth-seeking lags behind (M =3.86, SD=0.58); the curiosity and systematicness of critical thinking have a positive impact on learning outcomes (standardized regression). The coefficients are 0.327 , 0.225 respectively); the impact of behavioral investment, cognitive investment, and emotional investment on learning gains is also positive (standardized regression coefficients are 0.312 , 0.257 , 0.187). In addition, the indirect path of learning input between critical thinking and learning gain is significant, and the indirect effect accounts for 85.69% of the total effect, and the mediation model is established. It shows that critical thinking can affect learning gains through learning input, and the relationship is positive, that is, learners with higher levels of critical thinking are more able to actively participate in learning activities, thereby improving their learning gains (Naji et al.,2019). The relationship between the three verified in this study has deepened people's understanding of the mechanism of critical thinking on learning outcomes, and

provided a reference for further clarifying the relevant mechanism of critical thinking. According to the conclusion, the following revelations are made:

Strengthen the cultivation of the truth-seeking spirit and make up for the shortcomings of college students' critical thinking development.

In the descriptive results of this study, the average total critical thinking score of the surveyed college students is 4.22, which is higher than the median value of 3.5. This reflects that the overall level of critical thinking of college students is in the upper middle position, which is consistent with other related studies on the overall level, but there are differences on the dimension level. The differences in the results of different studies at the dimension level may be caused by differences in survey samples, such as the level of schools and the majors of students (Tomaž &Tanja,2019). In addition, among the dimensions of critical thinking, the dimension of truth-seeking scored the lowest. The truth-seeking nature of critical thinking mainly reflects whether an individual is keen on pursuing the truth, dares to ask questions, and maintains a sincere and objective attitude towards the process of inquiry, regardless. The development of truth-seeking among college students may be affected by "face culture" (Jie, ,2018). Out of the protection of their self-esteem, in order to maintain their face, they are unwilling to face their mistakes with a realistic attitude and avoid related negative behaviors. Therefore, in the course of teaching, on the one hand, teachers should create a relaxed, harmonious, and safe classroom teaching environment, encourage students to question boldly, allow students to express different opinions, use facts and evidence to prove their views, and establish "not only books, not teachers." On the other hand, it is necessary to help students overcome the adverse influence of "face culture," guide them to learn from failures and mistakes, realize the positive educational value contained in failures and mistakes, and cultivate the courage to face courage and confidence to fail and correct mistakes (Nurullizam, ,2018).

Stimulate curiosity, permeate systematic thinking, and maximize students' learning gains.

Learning gains refer to the various changes in learners after completing a staged education or a period of course study. The learning gains in this study are characterized by changes in professional knowledge and skills, communication skills, autonomous learning skills, complex problem-solving skills, and good study habits (Yang, 2017). This study found that the curiosity and systematicness of critical thinking can have a significant positive impact on learning outcomes (the standardized regression coefficients are 0.327 and 0.225, respectively). In course teaching, teachers should stimulate students' thirst for knowledge, pay attention to the degree of difficulty of teaching content, and scientifically set the difficulty and level of teaching content based on students' zone of proximal development. Representation guides students to conjecture and verify, shows the cutting-edge research trends of the discipline, and arouses students' desire to explore major issues of the discipline. Systematic thinking mainly reflects whether students can analyze and solve problems in an orderly manner when facing problems (Sun, 1999). In course teaching, teachers should pay attention to helping students improve their abilities in discovering and posing problems, analyzing and solving problems, setting up problems scientifically, paying attention to the challenges and openness of problems, giving students opportunities to independently analyze and solve problems, and guiding students. Master the basic ideas of analyzing subject problems and the basic methods of solving them. After the students have laid a good foundation, they can be raised appropriately.

Strengthen the guidance of learning input and focus on improving students' learning outcomes。They are all positive (the standardized regression coefficients are 0.312, 0.257, and 0.187, respectively). This conclusion is consistent with the conclusions of related studies. Specifically, behavioral engagement mainly reflects whether students have good learning behavior habits, such as active cooperative learning, maintaining focus on the course, insisting on independent learning before class, expanding learning after class, etc., and good learning behavior habits can help improve student learning gains. Cognitive engagement mainly reflects whether students can use in-depth learning strategies and metacognitive strategies for learning to optimize learning efficiency and improve learning outcomes, such as higher-order thinking, reflective learning, integrated learning, self-monitoring, and adjustment. Emotional engagement mainly reflects the sense of pleasure, interest, and accomplishment that students experience in learning. Studies have shown that emotions have an impact on learning, and positive emotional experiences can promote college students' learning (Chen, 2019). Therefore, in the course of teaching, the first goal is to cultivate students' good learning habits and enhance the effectiveness of behavioral input. For example, there must be a preview before class, giving the scope of the preview and the questions to be considered; in class, students are required to listen carefully, think actively, cooperate, and communicate; after class, students are required to review and summarize to consolidate and improve. Secondly is to infiltrate learning strategies into teaching to help students improve the efficiency of cognitive input. For example, students are required to regularly review what they have learned, check for omissions, make up for gaps, and use online learning resources such as MOOCs for independent learning. Thirdly is to protect students' positive emotional experiences and improve their level of emotional investment. For example, when students solve problems or complete learning tasks, teachers should give timely encouragement to enhance their self-confidence in learning; when students encounter difficulties, teachers should give appropriate advice so that students can solve problems and experience hard work. The sense of accomplishment after solving the problem.

In order to enhance user interest, the MOOC platform needs to guide students to properly use the function of the comment area, prompting students to make a real evaluation of the teacher's teaching, so that the teacher can grasp the problems in the teaching process in a timely manner and make timely corrections to meet the needs of students; guide students Use the class notes function to encourage students not only to learn knowledge in class but also to consolidate knowledge after class. Improved platform service quality and user trust are the most important factors for users to continue to use the MOOC platform. Therefore, improving user trust in all aspects can more effectively increase user frequency of use. The MOOC platform should strengthen the course management system, strictly implement the platform's relevant review regulations for courses, and carry out regular dynamic maintenance and management of the platform. Establish a publicity area to display the necessary content, improve the prestige of the platform, and enhance the trust of users; teachers need to ensure that the knowledge content has a reliable source in course production and the explanation process is vivid and vivid, so as to improve students' trust in the teacher; in addition, encourage learners to display study notes in the note area, which promotes mutual learning among learners and enhances trust among learners.

In other words, this study confirms the connection between critical thinking, learning engagement, and learning gain in the context of learning a particular MOOC course, demonstrating that critical thinking is crucial to college students' learning input and learning gain. The objective of higher education should be to develop the critical thinking of college

students while also strengthening the infiltration of critical thinking in the education and teaching of specific courses in order to lay a solid foundation for college students' learning progress, career development, innovation, and entrepreneurship. This is in line with the goal of creating first-class undergraduate education.

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