Research on Learning Behavior Modeling of MOOC Based on Social Cognition Theory

Le Yang*, Huanhuan Zhang, Lianlian Fu, Pingzhu Liu, Yingwen Zhu, Yuanjun Liao

*jxnzhyangle@163.com

Jiangxi Agricultural University College of Computer and Information Engineering Nanchang, China

Abstract—The inability to visually observe a range of learning behaviors of MOOC learners makes benign interventions and sound guidance ineffective, and many MOOC learners end up halfway or failing in their learning. Many studies have pointed out that online learning behavior patterns are highly correlated with learning effects. MOOC learners have diverse learning behavior patterns. Selecting factors that influence MOOC learning behavior, effectively dividing online learning rows, and studying the correlation between learners' online learning behavior patterns and learning effects can effectively alleviate MOOC learners' loneliness, maintain their learning motivation, and enhance MOOC learners' stickiness. On the basis of analyzing the connotation of social cognitive theory and MOOC learning behavior, we classify MOOC learning behavior from the cognitive involvement of learning behavior, construct a model of MOOC learning behavior based on social cognitive theory, test and analyze the validity of the model through statistical questionnaires, and explore the complex relationship between MOOC learning context, MOOC learning behavior and MOOC learning effect. The results show that this MOOC learning behavior model is more accurate in analyzing the relationship between learning context, learning behavior, and learning effect, which can improve MOOC learners' learning motivation and enhance the completion rate of MOOC courses.

Keywords-social cognition theory; MOOC; learning behavior; effecting actors

1 INTRODUCTION

MOOC online learning is highly respected for its advantages of abundant learning resources, diversified learning space, and free learning time, etc. Teaching through MOOC online learning platform can not only provide teachers and students with more choices, but also shrink educational resources, promote educational equity, and accelerate the process of education informatization [1]. Statistics show that more than 76 million users have registered on the Coursera platform. However, behind such a high enrollment rate is a low course completion rate [2]. The 16 courses offered by the University of Pennsylvania on Coursera in the United States, only 4% of learners eventually received certificates; Harvard University's courses on edX also had a completion rate of only 6%; According to a survey and analysis of MOOCs in China by GoShell.com, the completion rate of learners was also only 6% [3]. Because MOOCs adopt a "space-time separation" learning style, learners are inevitably lonely in the learning

ITEI 2022, December 23-25, Harbin, People's Republic of China

DOI 10.4108/eai.23-12-2022.2329153

process, and teachers cannot visually observe the learning behaviors of MOOC learners as they do in traditional classrooms, so they cannot detect and provide feedback and early warning in a timely manner. In the MOOC teaching mode, the teaching process generates a large amount of student learning behavior data, and relying on algorithms to analyze the data and use student online learning behavior data to evaluate students' learning It has become an unstoppable trend to analyze the data based on algorithms and use the data of students' online learning behaviors to assess their learning performance and provide better services for students [4-6].

Hwang *et al*. concluded that the relationship between cooperative learning behaviors and learning performance in online learning is significant, and the study explored six different categories of cooperative learning behaviors in learning activities [7]. Linan focused on theoretical exploration and analysis, focusing on elaborating and explaining the similarities and differences in educational big data, sorting out the intrinsic connection between big data and online courses, and laying a solid foundation for the later research [8]. Park Y used a data-driven and cluster analysis approach to study learning behavior data from an open course at a large private university in Korea and classified learners into four typical categories based on the results of the analysis [9]. Kenneth's study focused on examining the extent to which learning behaviors are influenced by reflective learning, and it used an online business course as an example to provide an in-depth analysis of the connection between the two issues [10]. Prior *et al*. proposed that learning attitudes, information literacy, and self-efficacy influence learners' online learning behaviors, and experimentally analyzed the extent to which these three aspects influence online learning behaviors [11]. Wu *et al*. found that self-directed and collaborative learning behaviors can influence academic performance by increasing student motivation [12]. Ma *et al*. argued that the cognitive and affective engagement of learners in online learning has a significant impact on learning outcomes [13]. Li *et al*. classified online learning behaviors and constructed a correlation model between online learning behaviors and learning performance by quantitatively analyzing learning data of blended teaching cases [14]. Based on an empirical perspective from the perspective of online learning resources, Zhao *et al*. empirically investigated online learners' learning behavior patterns and their impact on learning effectiveness, showing that the behavior patterns of accessing online learning resources are related to learning effectiveness [15]. Based on the UTAUT model, Zhang *et al*. constructed a framework of factors influencing college students' online learning behavior, and by using SPSS24.0 to study and analyze the collected data, they derived the influencing factors that affect learners' online learning [16].

In recent years, scholars have mostly based their learning effectiveness evaluation studies on one or several behavioral data of MOOC learning behaviors, and the results of the analysis have been effective in promoting the learning effectiveness of MOOC courses to some extent. This paper focuses more on research supported by learning behavior data, pays attention to the comprehensiveness and depth of MOOC learning behavior analysis, constructs a MOOC learning behavior model based on social cognitive theory, and verifies the reliability and validity of the model with data as evidence.

2 SOCIAL COGNITIVE THEORY AND MOOC LEARNING BEHAVIOR

Social cognitive theory is the study of how people acquire and apply knowledge, and the range of human mental activities in the process. On the basis of summarizing previous studies, Bandura proposed the triadic interaction theory of social cognitive theory. He believed that behavior, individual and environment interact with each other, and there is no absolute dominance, but only the intensity of mutual action varies according to the actual situation. When social cognitive theory is applied to the study of MOOC learning behavior, it can be understood that in the specific teaching process composed of MOOC learners and teachers, no matter the objective environment, including computer equipment, MOOC platform, etc., or the subjective environment, including MOOC learners' cognitive characteristics, learning styles, curriculum expectations, etc., will work together.

MOOC learning behaviors are considered to be all learning-related activities that occur before a MOOC learner achieves a specific learning purpose under a certain learning place, driven by learning motivation, and are an important part of the learning process. MOOC learning behaviors refer to behaviors that occur during the learning process and are related to learning, such as the learning activities of various MOOC learners. Obviously, MOOC learning behaviors can include both external behaviors that can be observed and measured, as well as some implicit thinking activities, such as memory, analysis, etc. MOOC learners are the subject of MOOC learning behavior, the specific objects of various MOOC learning behaviors are the objects of learning behaviors, which may include learning operation objects or learning resources, etc. The environment of MOOC learning behaviors includes learning places, learning platforms, etc. The means of MOOC learning behaviors include learning methods, etc.

3 A MODEL OF MOOC LEARNING BEHAVIOR BASED ON SOCIAL COGNITIVE THEORY

Numerous studies have shown that the online learning behavior of MOOC learners is an important predictor of learner effectiveness. Moreover, with the deepening of the research, people gradually realize that MOOC learning behavior is affected by many factors, especially learners' learning psychology. In this paper, we refer to the factors that influence MOOC learning behavior as learning contexts and classify learning contexts in MOOC learning as MOOC technology features, interactive learning environments, and learning psychology. In addition, the series of learning activities performed by learners in MOOC can be regarded as a kind of interactive behavior based on learning contents and tools, which can be classified into different levels depending on their requirements for learners' cognitive engagement. According to the relevant theories and based on the literature [1], this paper constructs a MOOC learning behavior model based on social cognitive theory as shown in Fig. 1.

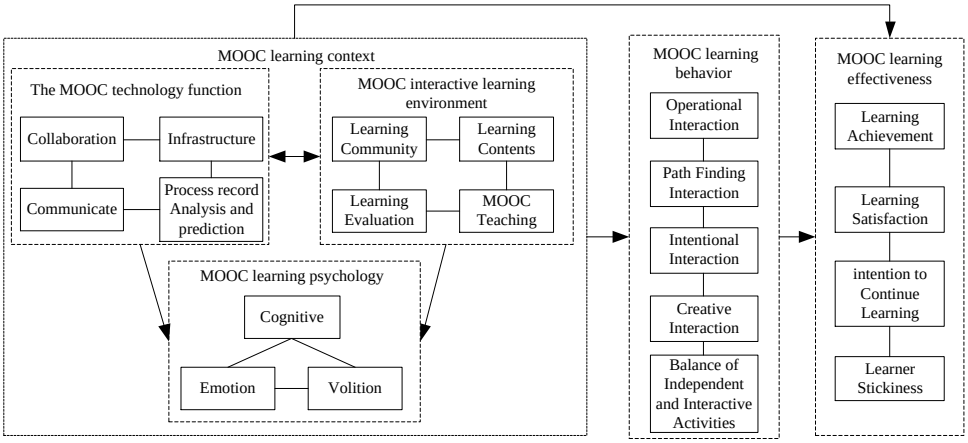

Figure 1. MOOC learning behavior model based on social cognitive theory

3.1 MOOC Learning Context

It is an important factor affecting MOOC learning behavior and learning effectiveness, including three aspects of MOOC technology features, interactive learning environment and learning psychology. The MOOC technology function and MOOC interactive learning environment are mainly responsible for providing technical support and learning environment services. The MOOC technology function provides infrastructure construction for independent personalized learning, and learners can collaborate with their peers to learn with the help of various communication tools or methods, and exchange learning styles and learning experiences with each other. Record the learning process with the analysis tools and evaluation tools provided by the MOOC platform, and generate a database of MOOC big data to lay the foundation for the model to make reasonable predictions of learning trajectories. In the MOOC interactive learning environment, the teacher arranges the teaching content, and the learners participate in the corresponding MOOC course content independently and individually according to the model prediction results. Autonomous personalized learning and collaborative learning are not independent or contradictory. On the contrary, learners can also form a learning community, communicate with each other and interact in real time through MOOC technology function platform, achieve cooperative learning and inquiry learning in the process of independent personalized learning, and enhance the trust between learners. Learners use assessment tools to systematically analyze and comprehensively evaluate their course learning process, allowing them to continuously reflect on the learning process and thus achieve creative learning. Learning psychology is characterized by cognitive, emotional, and volitional psychology. In terms of cognitive psychology, preparatory skills and target skills represent the existing and still needed knowledge and abilities of MOOC learners, as well as their own perceptions and attitudes, and specifically include cognitive level and cognitive strategies. The psychological aspect of emotion is used to characterize the intuitive feelings of MOOC learners during the learning process, and is generally divided into positive and negative emotions. Volitional psychology mainly describes the volitional activities of MOOC learners in

overcoming learning difficulties in their efforts to complete academic tasks, such as resilience, sense of stress, and coping tendencies.

3.2 MOOC Learning Behavior

Based on the literature [17], a series of learning behaviors of MOOC learners are classified into five areas: operational interaction, path finding interaction, intentional interaction, creative interaction, and balance of independent and interactive activities. The act of manipulating interaction is mainly the act of creating a personal learning space and learning environment for MOOC learners. For example, browsing teaching dynamics and browsing lecture resources are mainly personal actions of MOOC learners with low cognitive involvement. The path finding interaction behavior mainly lies in connecting information and everyone in the learning community, including reading posts, finding information, and establishing learning groups, etc. It involves part of the collaborative behavior of MOOC learners, and the degree of cognitive involvement is higher than that of operational interaction. Intentional interactions focus on negotiation, communication and sharing, such as creating discussion topics, asking and answering questions, sharing and recommending learning resources, summarizing learning gains, etc., and require a high level of cognitive engagement. The meaning of the act of creating interaction is to appreciate the evaluation and resynthesize the learning artifacts. It is mainly demonstrated by evaluation behaviors and works, which involves the comprehensive quality of MOOC learners, reflects the reflection, evaluation and creation in the learning process, and requires the highest level of cognitive engagement of MOOC learners. The independent learning activities of MOOC learners are called independent activities, while the social interactions between teachers and students or between students and teachers are called interactive activities. MOOC courses use time-space separation for learning, which can easily lead to isolation for MOOC learners if there are too many independent activities for learners; If there are too many interactive activities, they can interfere with the learning process and suppress independent and personalized learning. Therefore, MOOC learners need to reasonably allocate the balance between independent activities and interactive activities, and adjust the learning time of independent activities and interactive activities in a balanced way, then the maximum advantages of MOOC education can be brought into play and the learner stickiness can be enhanced.

3.3 MOOC Learning Effectiveness

Characterized by learning achievement, learning satisfaction, intention to continue learning, and learner stickiness. The calculation of MOOC learning grades varies from platform to platform and course to course, and generally consists of several dimensions such as online quizzes, assignments, discussion forum activity, and video viewing hours. The satisfaction level of MOOC learners in the course learning process is called learner satisfaction, which is the subjective feeling of MOOC learners after comparing the actual experience value with the psychological expectation value, and is the customer satisfaction index in the field of education. MOOC learners' intention to continue learning means that after learning, learners are still willing to use the MOOC platform again or repeatedly to continue their online learning. In addition, persistent willingness to learn is also expressed by the willingness of MOOC learners to recommend the platform to others. The intrinsic motivation of a course to attract and

maintain learners' willingness to continue learning is called MOOC student stickiness [18]. Learners as users of the MOOC platform, MOOC learner stickiness shows learners' trust and good feelings towards the lecturers, their dependence on the MOOC platform and their expectation of re-use. The higher the satisfaction of students in the MOOC platform, the stronger their interest in learning will be. Good course satisfaction can stimulate their desire to continue learning, further sustaining the behavior of learners' course learning and enhancing learner stickiness, and MOOC learners' stickiness is enhanced, their time to continue learning MOOC courses is extended, and the completion rate of MOOC courses is improved.

4 MODEL EMPIRICAL STUDY

4.1 Data Collection

This paper adopts the research method of questionnaire, the whole questionnaire is divided into two main parts. The first part is mainly about the basic personal information, including gender, education background, major, occupation, and education level and learning motivation; The second part is the core part of the questionnaire. There are 28 question options in total. The potential variables of the test cover all aspects of the model, including 10 items for MOOC learning situations, 9 items for MOOC learning behaviors, and 9 items for MOOC learning effects. The question options were scored using a five-point Likert scale of strongly agree (5 points), agree (4 points), fair (3 points), disagree (2 points) and strongly disagree (1 point). 380 questionnaires were distributed using both online and offline methods, 140 electronic questionnaires were distributed on the official website of Questionnaire Star, and 240 paper questionnaires were distributed in classrooms, libraries and on campus. A total of 365 questionnaires were returned, with a return rate of 96.05%, of which 347 were valid, with an efficiency rate of 95.07%.

4.2 Reliability and Validity Analysis

To verify the reliability and validity of the questionnaire, reliability analysis and validity analysis are required. The reliability test of the questionnaire is shown in Table 1, and the Clonbach α values of all variables are greater than 0.8, which are within the acceptable range. The mean variance extracted AVE values were all greater than 0.5, and all met the minimum recommended standard values. The combined reliability CR values are all greater than 0.8, indicating that the overall is higher than the critical value, indicating that the overall level of questionnaire reliability is good and the internal consistency of the variable design is ideal.

Table 1 Reliability test

Measurement variables	***Number of items***	***α***	***AVE***	***CR***
MOOC learning context	10	0.857	0.529	0.861
MOOC learning behavior	9	0.811	0.532	0.814
MOOC learning effect	9	0.802	0.568	0.807

The validity analysis of the questionnaire is to test whether the variables measured can accurately express their connotations according to the questions. The higher the consistency between the questions and the variables, the higher the validity level of the questionnaire. The KMO values and Bartlett's spherical test values of the questionnaire can reflect the validity level of the questionnaire, and the results of the analysis are shown in Table 2. It shows that the KMO values of all dimensions of the questionnaire are above 0.7 and the Sig. values are 0.000, showing a significant level of validity, therefore, the questionnaire has good validity.

Table 2 Validity test

Measurement variables	***KMO***	***Bartlett sphericity test***	
		Df	***Sig.***
MOOC learning context	0.839	6	0.000
MOOC learning behavior	0.736	3	0.000
MOOC learning effect	0.773	3	0.000

5 ANALYSIS AND DISCUSSION

MOOC learning effect is the result of individual psychological and behavioral changes caused by learners' learning, which is influenced by a variety of factors and cannot be directly determined by one factor, but each complex random factor influences and interacts with each other, and the correlation analysis is generally used to study the correlation between the factors, and the analysis results are shown in Table 3.

Table 3 Validity test

Measurement variables	***MOOC learning context***	***MOOC learning behavior***	***MOOC learning effect***
MOOC learning context	1		
MOOC learning behavior	0.6151	1	
MOOC learning effect	0.5909	0.8015	1

The correlation coefficient between MOOC learning context and MOOC learning behavior was 0.6151, with values ranging from 0.5 to 0.8, indicating that MOOC learning context and MOOC learning behavior are significantly correlated. Good MOOC technology features can effectively improve the online interactive learning environment for learners, provide multi-dimensional means of interaction, form a good learning mindset for MOOC learners, and enhance the perception of MOOC learners that the course is helpful to them. At the same time, MOOC course resource developers should provide MOOC learners with more specific

experimental operations-related courses to further improve learners' perceived usefulness of MOOC courses.

The correlation coefficient between MOOC learning context and MOOC learning effectiveness was 0.5909, indicating that they were significantly correlated. The balanced development of various course learning resources can promote MOOC learners to use and learn various resources from multiple angles and perspectives. Integrating various software and technologies, especially social software and technologies, into the MOOC in learning contexts [19] and creating authentic learning opportunities that are relevant and meaningful to MOOC learners can indeed help MOOC learners take ownership, support and facilitate MOOC learners' autonomous and personalized learning, achieve more efficient knowledge acquisition, and improve the effectiveness of MOOC learning.

The correlation coefficient between MOOC learning behavior and MOOC learning effect is 0.8015 and its value is greater than 0.8, indicating that the two are highly correlated. Learning is essentially a process of continuous interaction, and learners can break the limitation of "time and space separation" through social interaction, which is conducive to accumulating knowledge and maintaining relationships, promoting learning motivation and course continuity, and enhancing their own stickiness. Teachers provide MOOC learners with necessary help through a series of interactive behaviors. The means of communication and learning efficiency of learners have been improved. The more frequently learners cooperate with others, the more they will have a positive attitude. Only in this way can they have a strong learning interest in MOOC courses, and effectively improve the stickiness of learners and MOOC courses.

6 DISCUSSION

Since the new crown epidemic broke out globally in 2020, MOOCs are attracting large numbers of learners with a fresh perspective. With the promotion of the application of MOOC online learning, how to improve the effect of online learning has become a research hotspot. This research focuses on the learning effect of MOOC learners. On the basis of in-depth consideration of the impact of learning situations on learning behavior, it constructs a MOOC learning behavior model based on social cognitive theory, clarifies the complex relationship among learning situations, learning behaviors and learning effects, and tests and analyzes the effectiveness of the model through statistical questionnaires. The results show that MOOC learning behavior is highly related to MOOC learning effect, and good learning behavior of learners will inevitably lead to good learning effect, which is conducive to improving the learning quality of MOOC learners. MOOC learning situation is significantly related to MOOC learning behavior. Excellent technical support and learning environment services will bring a series of convenience to MOOC learners, thus forming good learning behavior. The MOOC learning context is significantly related to the MOOC learning effect. A good learning context can increase the satisfaction of MOOC learners, promote learners to continue learning, and improve the course completion rate.

Acknowledgment. This work was supported by the Social Science Foundation of Jiangxi Province (No. 22JY27D), the 14th Five-years Plan of Jiangxi science of education the key Research topics (No. 22ZD014), the Research Project of Course and Textbooks Construction of

China Agricultural Science and Education Foundation (No. NKJ202103032), and the Humanities & Social Sciences Program of Jiangxi Province for Higher Education Institutes (No. JC22114).

REFERENCES

[1] Jin Mengtian. Research on Learning Behavior Modeling and Learning Effect Prediction of MOOC Based on Social Cognition Theory [D]. Wuhan: Hubei University, 2018.

[2] L.V.Morris. MOOCs Emerging Technologies and uality [J].Innovative Higher Education, 2013, 38(4):251-252.

[3] Yang Le. The Model of Social Interactions 'Influence on the Stickiness of MOOC Learners [J]. Journal of Jiangxi Radio & TV University, 2020: 9: 19-24.

[4] Francisco J, García P, Ángel F B, *et al*. Anadaptive hybrid MOOC model: Disrupting the MOOC concept in higher education [J].Telematics andInformatics, 2018, 35(4):1018-1030.

[5] Tsai Y H, Lin C H, Hong J C, *et al*. the effects of metacognition on online learning interest and continuance to learn with MOOCs[J]. Computers & Education, 2018, 121:18-29.

[6] Gold R, Hemberg E, O' Reilly U M. Analyzing K-12 Blended MOOC Learning Behaviors[C] .Seventh (2020) ACM Conference on Learning, 2020, 8: 12-14.

[7] Hwang W Y,Shadiev R,Wang C Y,*et al*.A pilot study of cooperative programming learning behavior and its relationship with students' learning performance[J].Computers & Education,2012,58(4):1267-1281.

[8] Laura, Calvet, Liñán, *et al*. Educational Data Mining and Learning Analytics: differences, similarities, and time evolution [J]. International Journal of Educational Technology in Higher Education, 2015, 12(3):98-112.

[9] Park Y, Yu J H,Jo I H.Clustering blended learning courses by onlinebehavior data: A case study in a Korean higher education institute[J]. The internet and higher education, 2016, 29:1-11.

[10] Strang K. How student behavior and reflective learning impact grades in online business courses [J]. Journal of Applied Research in Higher Education, 2016, 8(3):390-410.

[11] Prior D D, Mazanov J, Meacheam D, *et al*. Attitude, digital literacy and Self efficacy: Flow-on effects for online learning behavior [J]. Internet & Higher Education, 2016, 29:91-97.

[12] Wu Qing, Luo Ruguo. Predicting the Students' Performances and Reflecting the Teaching Strategies Based on the E-Learning Behaviors [J]. Modern Educational Technology, 2017, 27(6):18-24.

[13] Ma Zhiqiang, Su Shan, Zhang Tongtong. Research on the E-learning Behavior Model based on the Theory of Learning Engagement——Taking the Course of "The Design and Implementation of Network Teaching Platform" as an Example[J]. Modern Educational Technology, 2017, 27(1): 74-80.

[14] Li Xiaojuan, Liang Zhongfeng, Zhao Nan. The Influence of the Students' Online Learning Behaviors on the Blended Learning Performance [J]. Modern Educational Technology, 2017, 27(2):80-86.

[15] Zhao Chengling, Li Min, Shu Fengfang, Huang Yan. Research on Models of Participation in Online Learning Resources and Learning Effectiveness [J]. Modern Distance Education, 2019(4):20-27.

[16] Zhang Junxiang, Zhang Han, Zhu Yu, *et al*. Research on the factors influencing college students'online learning behavior based on UTAUT model [J]. Journal of Hubei Normal University (Natural Science), 2022, 42(2):50-58.

[17] Wang Zhijun, Chen Li. Instructional Interaction Pattern and Method Analysis in cMOOCs [J]. China Educational Technology, 2016, 349(2):49-57.
[18] Yang Le. Research on the Promotion Strategy of MOOC Learner Stickiness [J]. Journal of Jiangxi Radio & TV University, 2020: 1:78-81.
[19] Yang Yuqin. Designing Personalized and Self-regulated Environments in MOOC [J].Modern Educational Technology, 2014, 24(7): 12-17, 34.