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An Analysis of Online Learning Behavior Among College Students: A Systematic Review

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Abstract

The study of online learning behavior is a hot topic in the current study of online education. The purpose of this study is to conduct a systematic review of the online learning behavior of college students to explain the types of online learning behavior, research topics, influencing factors, variables, indicators, and research methods in this field of study. Using standardized steps of conducting a systematic review, an initial set of 3418 articles was identified. The final sample includes 59 key publications. The research findings indicated that the selected articles mainly focus on the following topics, such as online learning behavior and self-regulate learning, identification of learned behavior patterns, personalized intervention, academic performance prediction and academic early warning, as well as data privacy and security. Interestingly, self-regulate learning ability has been considered as the main factor influencing college students' online learning behavior. The online learning behavior variables used by researchers usually used are login activities, learning resources, forum interactions, assignments and tests. Additionally, the research methods usually used in selected articles are educational data mining and learning analytics. This study is important for educators to use the online learning behavior of college students to make instructional interventions timely to improve teaching effectiveness.

Keywords: Online Learning, Learning Behavior, College Students

Introduction

With the rapid development of the Internet and information technology, online learning has become one of the most popular ways of study for learners. Online learning behavior is considered as an adaptive learning behavior regarding the interaction between students, teachers, task levels and learning systems (Yu & Yu, 2010). Online learning behaviors are generally classified into login behavior, resource learning behavior, interaction behavior, and doing homework or test behavior. Large amounts of learning behavior data are generated by students in the online learning process and stored in the platform management system. These data provide the basis for the study of students' performance in online learning environment. It is an important factor in predicting the learning achievement (Huang, et al., 2021). Currently, the analysis of students' online learning behavior patterns on various network learning platforms has attracted the interest of researchers in the field of educational data

mining and learning analytics research (Yang, et al., 2021). Evaluating online learning behaviors is one of the hot topics in the field of IT education (Huang, et al., 2021).

Previous evidence has shown that analyzing and mining the data of students' online learning behaviors has many advantages. For example, it can prompt educators to make instructional interventions timely to improve teaching effectiveness, as well as to urge learners to conduct self-assessment and learning diagnosis based on feedback data (Ye & Pennisi, 2022; Hu, et al., 2014). Wang (2023) indicated that online learning behaviors and the corresponding data make it meaningful to explore the temporal aspects of learning, providing valuable insights about the features of the learning processes beyond only investigating learning outcomes. Besides, college students are an important demographic for online learning. Various estimates indicate that between 25% and 33% of college students in the US are enrolled in at least one online course (Allen & Seaman, 2013; NCES, 2013). Given the above, it is necessary to systematically review the existing research results and find out the problems that are worth studying, which will contribute to the in-depth research on online learning behaviors of college students.

However, although there have been many studies related to online learning behavior and a literature review of online learning behavior systems. For example, learning analysis methods for online learning behavior research, identify students at risk in online learning by analyzing learning behavior, and behavioral theories in online learning (Gao, 2019; Peechapol, et al., 2018). However, a comprehensive and systematic review of online learning behaviors of college students is still lacking. Therefore, the purpose of this study is to conduct a systematic review of online learning behaviors of college students and elaborate on issues, such as types of online learning behaviors, research topics, influencing factors, learning behavior variables and indicators, as well as research methods. In order to guide the systematic review, the following research questions were formulated:

i) What are the characteristics of publications selected for this study on online learning behaviors of college students?

ii) What are the research topics on the online learning behavior of college students?

iii) What are the types and influencing factors of online learning behavior of college students?

iv) What are the variables and indicators of college students' online learning behavior?

v) What are the research methods often used in the study of college students' online learning behavior?

Methodology

The *What Works Clearinghouse Procedures and Standards Handbook, Version 4.0 (2017)* released by the US Department of Education, Institute of Education Sciences, proposed a five-step systematic review process: (a) developing the review protocol, (b) identifying relevant literature, (c) screening studies, (d) reviewing articles, and (e) reporting findings. This study follows these steps to conduct a systematic literature review of college students' online learning behaviors. Furthermore, the researcher developed a research protocol that described the individual steps of conducting the systematic review to complete this study successfully. Figure.1. shows the flow diagram of conducting the systematic review.

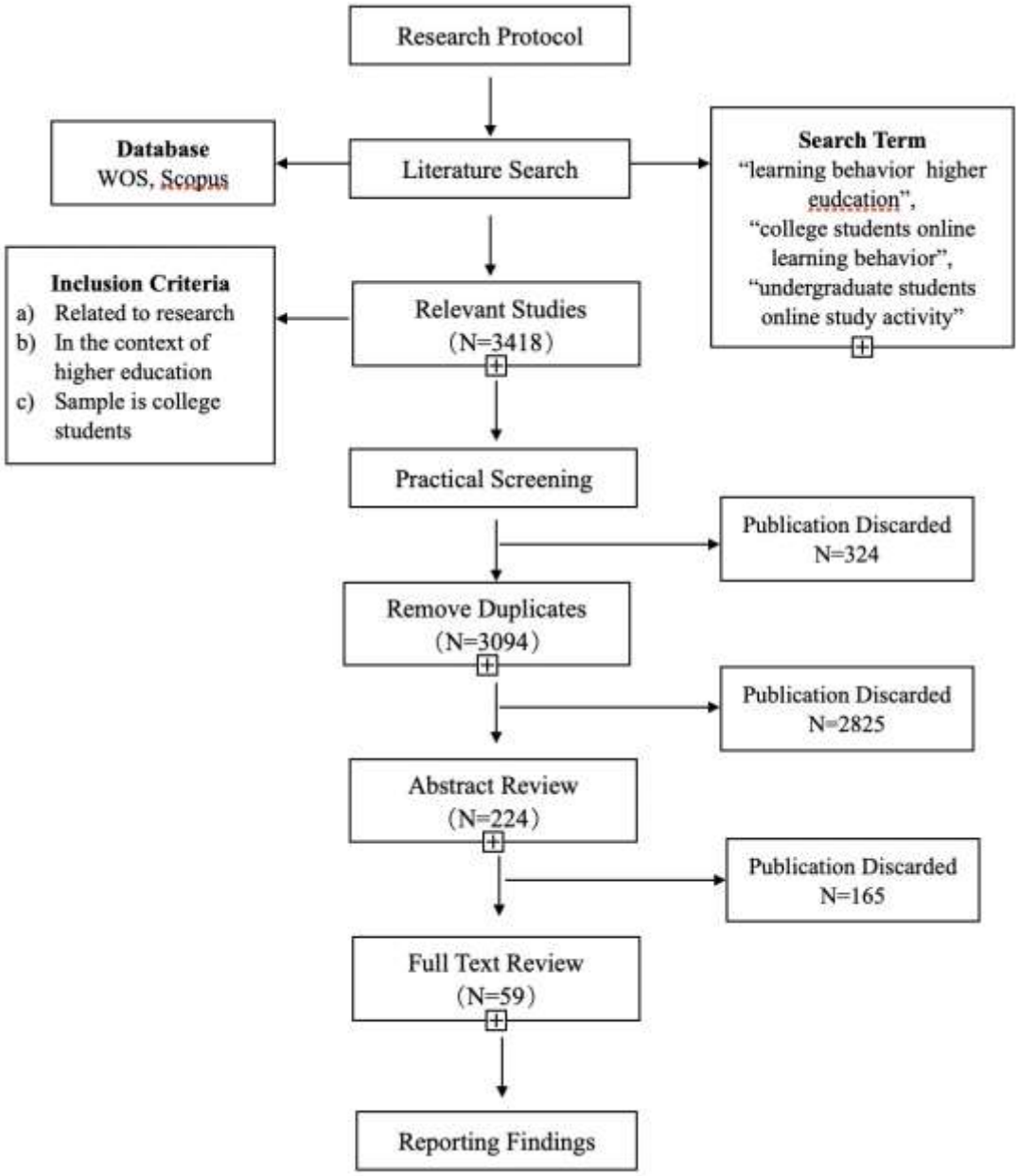

Figure. 1. Systematic review flow diagram

Literature Search

The following keywords were used to search for related publications in Scopus and WoS databases: "college students online learning behavior" or "undergraduate students online study activity" or "learning behavior analysis higher education". The initial search results included all Social Science research domains and peer-reviewed journal articles eventually published in the English language between 2019 and 2023. There are 3418 potentially relevant studies in total. A detailed systematic review protocol, with specific search terms has been provided in the additional Table 1.

Table 1
Search string used in the web search engine

Database	Search String	Search Date	N
Scopus	TITLE-ABS-KEY (college AND students AND online AND learning AND behavior) AND PUBYEAR > 2018 AND PUBYEAR < 2024 AND (LIMIT-TO (SUBJAREA , "SOCI")) AND (LIMIT-TO (DOCTYPE , "ar")) AND (LIMIT-TO (LANGUAGE , "English")) AND (LIMIT-TO (PUBSTAGE , "final"))	30 Dec 2023	141
	TITLE-ABS-KEY (undergraduate AND students AND online AND study AND performance) AND PUBYEAR > 2018 AND PUBYEAR < 2024 AND (LIMIT-TO (SUBJAREA , "SOCI")) AND (LIMIT-TO (DOCTYPE , "ar")) AND (LIMIT-TO (LANGUAGE , "English")) AND (LIMIT-TO (PUBSTAGE , "final"))		535
	TITLE-ABS-KEY (online AND learning AND behavior AND higher AND education) AND PUBYEAR > 2018 AND PUBYEAR < 2024 AND (LIMIT-TO (SUBJAREA , "SOCI")) AND (LIMIT-TO (DOCTYPE , "ar")) AND (LIMIT-TO (LANGUAGE , "English")) AND (LIMIT-TO (PUBSTAGE , "final"))		412
WoS	Results for college students' online learning behavior (Topic) OR undergraduate students' online study performance (Topic) OR learning behavior higher education (Topic) and 2019 or 2020 or 2021 or 2022 or 2023 (Publication Years) and Article (Document Types) and English (Languages) and Education Educational Research (Research Areas)	30 Dec 2023	2330
Total			3418

Inclusion and Exclusion Criteria

All original research articles on the online learning behavior of college students fulfilling the following eligibility criteria were included:

- the studies concern online learning behavior
- in the context of higher education
- the study samples are college students

The exclusion criteria were:

- articles falling outside students' online learning behavior
- the samples are not college students
- not use qualitative or quantitative method

- commentaries, case studies, posters, letters, review documents, discussion papers, conference abstracts, congress reports and dissertations
- other research domains and language, before 2019 and after 2023

Study Selection

The citations identified through the searches were imported into Endnote software. Study selection followed three stages: first, use the endnote software to find and remove 324 duplicates. Second, based on the inclusion and exclusion criteria, irrelevant 2825 publications were discarded by reviewing the abstract of the articles. Third, 165 publications whose method and sample fall outside of the set criteria were discarded by reviewing the full text of the articles, and 59 key publications eventually were retained.

Results and Discussion

Research question 1: What are the characteristics of publications selected for this study on online learning behaviors of college students?

The 59 key publications included in this systematic review were published in 2023(n=23),2022(n=12),2021(n=10),2020(n=8),2019(n=6). More than 50% of the articles were published in the JCR sections Q1 and Q2, with the largest number of journals being the International Journal of Emerging Technologies in Learning (7,8.43%), Internet and Higher Education (5,6.02%), Interactive Learning Environments (4, 4.82%), IEEE Access (4, 4.82%), indicating that most of the publications selected for this literature review are of higher quality. Most articles were conducted in China (N=20), followed by 15 articles in the US, UK, Spain (N=5), Australia, Japan, Korea, Malaysia, and Turkey (N=3). Detailed information on included articles is presented in Fig.1, 2,3.

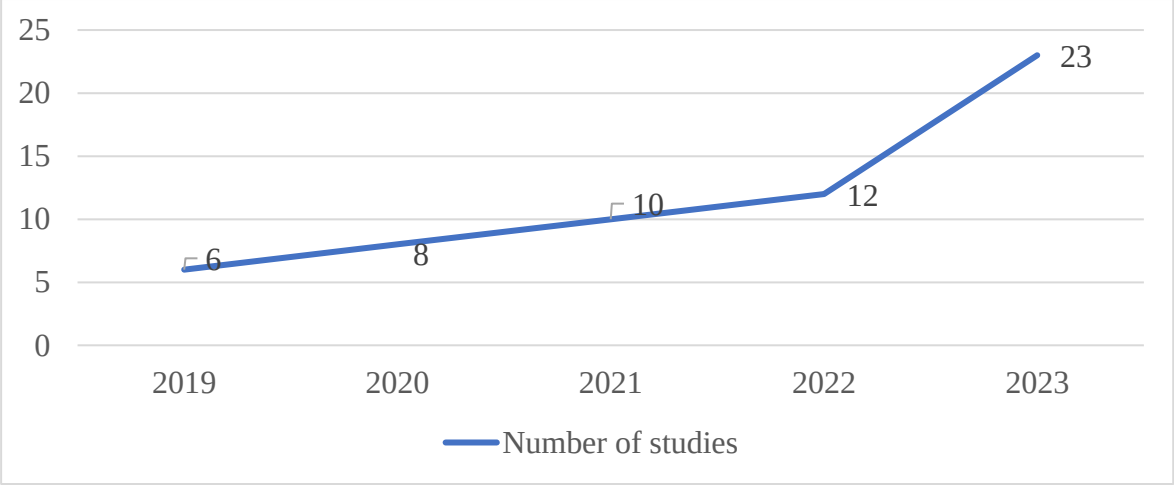

Figure 1. Distribution by publication year

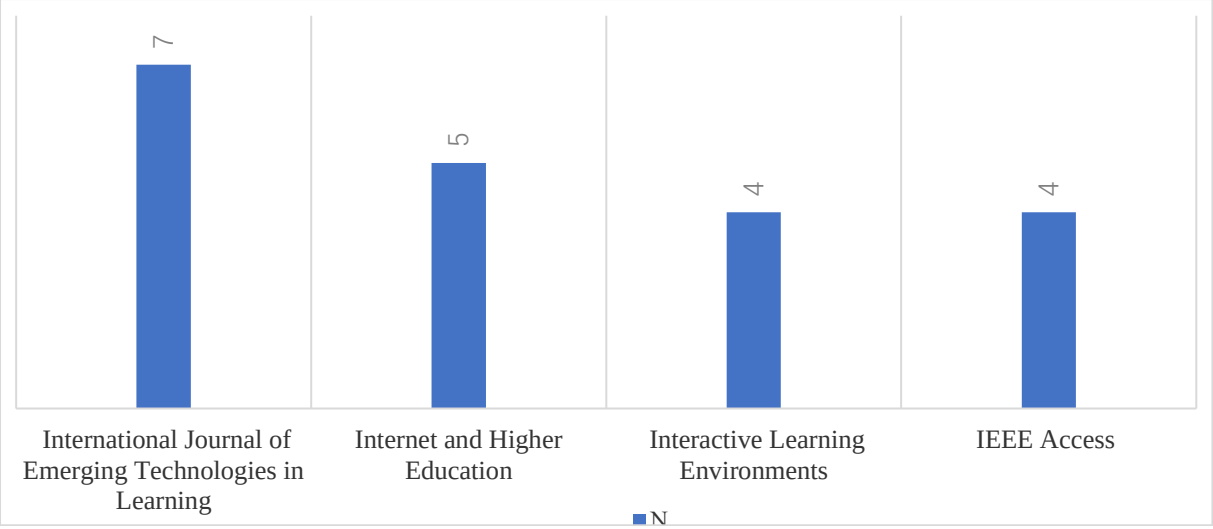

Figure 2. Distribution of most published journals

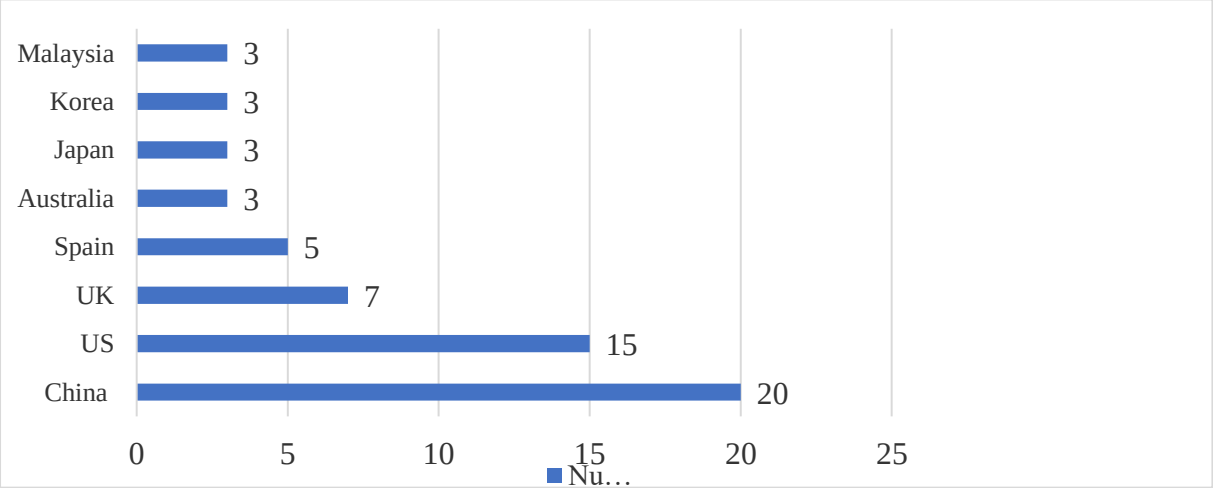

Figure 3. Distribution of publication by country

Research question 2: What are the research topics in online learning behavior of college students?

Online learning behavior research topic analysis

This section answers the second question raised in the study. Through the analysis of the selected studies about college students' online learning behavior, it is found that these studies mainly focus on the following topics: online learning behavior and self-regulate learning, identification of learned behavior patterns, and analysis of the relationship with academic performance, academic performance prediction and academic warning based on online learning behavior analysis, analysis of online learning behavior through design theoretical frameworks and models for personalized intervention, data mining and learning analysis, data privacy, and security issues. Detailed information on college students' online learning behavior research topic analysis is presented in Table 3.

Identifying learning behavior patterns and analyzing the relationship with academic performance is the most discussed topic among researchers. These studies mainly focus on the online learning behavior log data collected by the student management system. Some researchers clustered from different dimensions by using cluster analysis as an approach to

identify different types of online learning behavior patterns of college students (Yoon, et al.,2021; Yang, et al., 2021; Wu, 2023). Data mining and learning analytics is a common approach that uses big data technologies to analyze online learning behavior data of college students in the learning process. It aims to understand students' online learning behavior patterns and to improve the quality and effectiveness of education. These behavior data can include analysis of a wide range of data, such as students' online learning activities, course performance, interactions, assessment results, and so on. The analysis of online learning behaviors helps educators better understand student needs, provide individualized support and interventions, predict academic performance, improve course design, and make education policy decisions (Bezerra & Silva, 2020; Jayashanka, et al., 2022).

The other main topics of interest for researchers are academic performance prediction and academic early warning based on online learning behavior analysis (e.g., Peng & Jeang, 2023; Zhao, 2020; Chen, 2021). Such studies mainly focus on constructing academic performance prediction or academic warning models based on college students' online learning behavior data to predict academic performance or identify students with potential dropout risk (Peng & Jeang, 2023; Zhao, et al., 2020; Chen, et al., 2021; Sukhbaatar, et al., 2019). The purpose of it is to better personalized instructional teaching by teachers and reduce dropout rates of online courses for college students. These predictive studies are different from descriptive studies, which predict students' academic performance by analyzing their online learning behavior patterns for early warning or timely intervention.

Other researchers focused on developing new data analysis frameworks, models, and technologies for online learning behavior analysis. Among these studies, researchers mainly introduced a new data analysis framework, model, and technology for online learning behavior analysis. These studies established effective approaches for course design, intervention, and student supervision. Representative studies include (Prat and Code, 2021; Peach, 2019; Zhang, 2020).

Self-regulate learning of learners is one of the key topics of interest in the study of online learning behavior. Researchers in this field mainly explore the intrinsic link between self-regulate learning ability and online learning behavior (e.g., Huang, et al., 2022; Taub, et al., 2022; Ye & Pennisi, 2022). Besides, data security and privacy issues in learning behavior data mining are important issues that cannot be ignored in online learning behavior research. Jones and his colleagues (2020) indicated that learning analytics can lead to serious questions about student privacy, autonomy, and loss of student data (Jones, et al., 2020). At present, most researchers focus more on the mining and application of online learning behavior data, while fewer researchers focus on data privacy and security issues. Data privacy and security are the prerequisite and foundation of data use, so we should track and investigate more on the online learning behavior data of college students under the condition of ensuring the privacy and security of students' data.

Table 3
Online learning behavior research topics

Research Topic	Reference	N
Online learning behavior and self-regulate learning	Ye &Pennisi (2022); Reparaz, et al.(2020); Taub, et al.(2022); Huang, et al.(2022);	4
Identification of learned behavior patterns and analysis of relationship with academic performance	Wu, 2023; Yoon, et al. (2021); Yang, et al.(2021); Chen & Meng (2021); Bezerra & Silva (2019);Lu& Cutumisu (2022);Jones (2022); Bosch, et al.(2022); Alvarez-Risco, et al.(2021); Chen & Meng(2021);Peach, et al.(2021).	16
Academic performance prediction and academic early warning	Peng & Jeang (2023); Mubarak, et al.(2022); Kustitskaya, et al.(2023); Zhao, et al.(2020); Peach, et al.(2021); Chen, et al.(2021); Bravo Agapito, et al.(2021); Zhang, et al.(2020); Sukhbaatar, et al.(2019); Akram, et al.(2019);	11
Data analysis frameworks, models, and technologies	Peng & Jeang (2023); Prat & Code (2021); Peach, et al.(2021); Zhang, et al.(2020); Peach, et al.(2019); Pardos & Horodyskyj (2019); Cantabella, et al.(2019); Wong & Hughes(2023); Cebi, et al.(2023)	9
Data mining and learning analytics	Ye & Pennisi(2022); Jayashanka, et al.(2022); Hellings & Haelermans(2022); Yoon, et al.(2021); Lim&Lee (2021); Kokoç & Altun(2021); Sokout, et al.(,2020); Dooley &Makasis (2020); Moreno-Marcos et al.(2019); Foung & Chen (2019); Bezerra & Silva(2020)	13
Data privacy and security	Slade, et al. (2019); Jones, Rubel & LeClere (2020); Jones, et al. (2020)	3

Research question 3: What are the types and influencing factors of online learning behavior among college students?

This section mainly aims to answer the third question raised in the study. In the selected studies, most researchers focus on students' learning behavior in the whole online learning process, which involves the comprehensive use of multiple behavior data. The influencing factors of online learning behavior can be divided into internal factors and external factors by analyzing the selected articles in the literature review. The internal factors mainly include learner demographic characteristics, self-regulate learning ability, learning attitude or motivation, prior knowledge level and learning time (Myers, et al., 2021). External factors include teacher or peer influence, technical support, learning resources, and learning environment (Li & Yi, 2023).

Research question 4: What are the variables and indicators of college students' online learning behavior?

For further research, it is necessary to analyze and summarize the behavioral variables of online learning. After a summary analysis of relevant studies, it is found that variables of online learning behavior usually used are login access, learning resources, assignments and tests, and forum posts. The login access variables usually adopt indicators such as the number

of login visits, time and IP. Learning resource variables are measured by clicking frequency of courseware, files or course videos, browsing or viewing time, degree of completion, and other indicators; The variables of assignments are mainly measured by visiting o submitting assignments, viewing assignment feedback frequency, time and scores. Test variables were selected to measure the number of test attempts, test completion time, test scores and other indicators. Forum variables usually use the total number of forum replies or posts, time and content to measure. Detailed information on variables and indicators of online learning behavior is presented in Table 4.

Table 4
Variable and indicators of online learning behavior

Behavioral variables	Indicators	Reference	N
Login access	Login access frequency	Ye & Pennisi (2022); Zhao, et al.(2022); Chen, et al.(2021); Bravo-Agapito, et al.(2021);	5
	Login access time		
	Login access IP		
Learning resources access	Frequency of clicks or downloads of courseware, files, or course videos	Ye & Pennisi(2022); Mubarak, et al.(2022); Lu & Cutumisu(2022);Avcı& Ergün(2022); Yoon, et al.(2021); Yang, et al.(2021); Lim&Lee (2021); Chen, et al.(2021); Bravo-Agapito, et al.(2021); Cebi, et al.(2023)	12
	Time to browse or watch courseware, documents and course videos		
	Completion of course video viewing		
Assignment	Access, view, or submit jobs or view job feedback frequency	Lu &Cutumisu(2022); Kustitskaya, et al.(2023);Avcı& Ergün (2022);Prat& Code (2021);Lim, et al.(2021); Bravo-Agapito, et al.(2021);Akram, et al.(2019);	8
	Access, view, or submit jobs or view job feedback times		
	Assignment score		
Test	Number of attempts to answer the test	Taub, et al.(2022);Pleasants,et al.(2022);Lu& Cutumisu(2022);Kustitskaya, et al.(2023); Huang, et al.(2022);Avcı& Ergün(2022);Chen, et al.(2021);Bravo-Agapito, et al.(2021); Peach, et al.(,2019);Foung &Chen(2019);Cebi, et al.(2023)	12
	Time required to complete the test		
	Test score		
Forum posts	Total number of forum replies or posts	Ye& Pennisi (2022); Mubarak, et al.(2022); Lu& Cutumisu (2022);Avcı& Ergün (2022); Zhao, et al.(2020); Chen, et al.(2021);Bravo-Agapito, et al.(2021).	9

Research question 5: What are the research methods often used in the study of college students' online learning behavior?

This section focuses on answering the final question posed by the study. The literature analysis reveals that the most research method frequently used for studying college students'

online learning behavior is the quantitative method. Only a few researchers used qualitative or mixed research methods. Among these studies, educational data mining and learning analytics were the main research methods. In contrast, only two of the selected articles used qualitative research methods (Myers, et al., 2021; Jones, et al., 2020); Ye (2022) used a mixed research approach in his study. Ye (2022) argued that a combination of quantitative and qualitative data would allow the meaningfulness of learning analytics would be improved. Thus, he combined self-reported measures with LMS behavioral data and qualitative interview data to overcome the inherent limitations of each method (Myers, et al., 2023; Jones, et al., 2020).

Based on these, it can be found from the results that the research on online learning behaviors of college students shows an increasing trend year by year, especially in 2022 the number of research results increased significantly. This result suggests that online learning behavior data of college students are being studied and applied by researchers in the field of education. Researchers can use learning analytics to monitor students at risk of dropping out, and analyze and predict students' academic performance through online learning behavior data collected by learning management systems (LMS). Based on this trend, it is possible to predict college students' online learning behavior will remain the focus of most researchers in the future.

The researchers analyzed the relationship between online learning behavior patterns and academic performance. This result is beneficial for people to understand how students learn in virtual learning environments, and help instructors to better design online education courses to improve students' learning effectiveness. Moreover, the application of college students' online learning behavior data in the areas of academic performance prediction and learning alerts is important in reducing student dropout. On the other hand, the results of this research showed that there are some disadvantages in the application of college students' online learning behavior data, such as the issue of data privacy and protection. This issue has been overlooked by most researchers. The exploitation of college students' online learning behaviors data should not be done at the expense of student data privacy and security. Teachers should pay more attention to student data security when collecting student online learning behavior data through student management systems.

The important contribution of this research is to identify the important factors that influence college students' online learning behavior, especially teachers, learning resources, and technical support. This result provided support for improving the online learning behavior of college students through technology-supported instructional design. Besides, the analysis and summary of online learning behavior variables and indicators show what are commonly used by researchers. However, these objective data indicators can only illustrate students' external behavioral performance, not their internal cognitive and emotional engagement. Therefore, in future research, the researcher strongly recommends integrating objective data on college students' online learning behaviors with qualitative data to conduct an in-depth exploration of students' online learning engagement.

Conclusion

From a systematic literature review of the study of online learning behavior of college students, the research found that:

Firstly, as the research related to college students' online learning behavior increases, the learning behaviors of college students in the process of distance learning should be paid

more attention. These behaviors include dropping out of classes, the prevalence of online academic delays among college students and so on.

Secondly, although there are many research studies on the relationship between online learning behavior pattern identification and academic performance, most of these studies only consider the influence factors of learners themselves which are behind learning behaviors. However, the attention to the differences in family cultural background, digital support, and learning environment was not enough. Thus, it is necessary to explore further by other researchers.

Thirdly, academic achievement prediction or academic early warning based on online learning behavior tracking data is a hot topic of current research. However, the development of relevant prediction models, especially the testing models in practice and applied research is still relatively lacking. In addition, the main purpose of academic achievement prediction and academic early warning is to provide instructional intervention and support, but there are few studies in this area. Therefore, these issues need more attention for researchers in the future.

At last, researchers generally focus on structured data, such as college students' learning behavior logs in online learning environments. Online learning behavior data comes from a relatively single source, and many learning platforms currently also prefer to record learners' processual learning behavior data. This may lead to research results involving less information about the gestures of learners and physical movements during the learning process. Based on this, a multimodal data analysis method including learners' body movements and gestures can be used to improve the accuracy of the research results.

References

Allen, I. E., & Seaman, J. (2013). Changing course: Ten years of tracking online education in the United States. Oakland, CA: Babson Survey Research Group and Quahog Research Group, LLC. Retrieved from http://www.onlinelearningsurvey.com/reports/changingcourse.pdf

Akram, A., Fu, C., Li, Y., Javed, M. Y., Lin, R., Jiang, Y., & Tang, Y. (2019). Predicting students' academic procrastination in blended learning course using homework submission data. *Ieee Access*, *7*, 102487-102498.

Alvarez-Risco, A., Del-Aguila-Arcentales, S., Yáñez, J. A., Rosen, M. A., & Mejia, C. R. (2021). Influence of technostress on academic performance of university medicine students in Peru during the COVID-19 pandemic. *Sustainability*, *13*(16), 8949.

Avcı, Ü., & Ergün, E. (2022). Online students' LMS activities and their effect on engagement, information literacy and academic performance. *Interactive Learning Environments*, *30*(1), 71-84.

Bezerra, L. N. M., & Silva, M. T. (2020). Educational data mining applied to a massive course. *International Journal of Distance Education Technologies (IJDET)*, *18*(4), 17-30.

Bosch, E., & Spinath, B. (2023). Students' motivation in an online and a face-to-face semester. *Zeitschrift für Psychologie*.

Bravo-Agapito, J., Romero, S. J., & Pamplona, S. (2021). Early prediction of undergraduate Student's academic performance in completely online learning: A five-year study. *Computers in Human Behavior*, *115*, 106595.

Cantabella, M., Martínez-España, R., Ayuso, B., Yáñez, J. A., & Muñoz, A. (2019). Analysis of student behavior in learning management systems through a Big Data framework. *Future Generation Computer Systems*, *90*, 262-272.

Çebi, A., Araújo, R. D., & Brusilovsky, P. (2023). Do individual characteristics affect online learning behaviors? An analysis of learners sequential patterns. *Journal of Research on Technology in Education*, *55*(4), 663-683.

Chen, C. H., Yang, S. J., Weng, J. X., Ogata, H., & Su, C. Y. (2021). Predicting at-risk university students based on their e-book reading behaviours by using machine learning classifiers. *Australasian Journal of Educational Technology*, *37*(4), 130-144.

Chen, C., & Meng, X. (2021). Exploring the relationship between student behavioral patterns and learning outcomes in a SPOC. *International Journal of Distance Education Technologies (IJDET)*, *19*(1), 35-49.

Foung, D., & Chen, J. (2019). Discovering disciplinary differences: blending data sources to explore the student online behaviors in a University English course. *Information Discovery and Delivery*, *47*(2), 106-114.

Gao, H. L. (2019). A systematic literature review of technology acceptance model and theory of planned behaviour towards online learning perspective. *Journal of Arts and Humanities*, *8*(11), 75-82.

Hellings, J., & Haelermans, C. (2022). The effect of providing learning analytics on student behaviour and performance in programming: a randomised controlled experiment. *Higher Education*, *83*(1), 1-18.

Huang, X., Wang, X., & Liu, F. (2021). Evaluation of learners' online learning behaviour based on the analytic hierarchy process. *International Journal of Continuing Engineering Education and Life Long Learning*, *31*(3), 311-324.

Hu, Y. H., Lo, C. L., & Shih, S. P. (2014). Developing early warning systems to predict students' online learning performance. *Computers in Human Behavior*, *36*, 469-478.

Jayashanka, R., Hettiarachchi, E., & Hewagamage, K. P. (2022). Technology Enhanced Learning Analytics Dashboard in Higher Education. *Electronic Journal of e-Learning*, *20*(2), 151-170.

Jones, K. M., Rubel, A., & LeClere, E. (2020). A matter of trust: Higher education institutions as information fiduciaries in an age of educational data mining and learning analytics. *Journal of the Association for Information Science and Technology*, *71*(10), 1227-1241.

Jones, K. M., Asher, A., Goben, A., Perry, M. R., Salo, D., Briney, K. A., & Robertshaw, M. B. (2020). "We're being tracked at all times": Student perspectives of their privacy in relation to learning analytics in higher education. *Journal of the Association for Information Science and Technology*, *71*(9), 1044-1059.

Kokoç, M., Akçapınar, G., & Hasnine, M. N. (2021). Unfolding students' online assignment submission behavioral patterns using temporal learning analytics. *Educational Technology & Society*, *24*(1), 223-235.

Kustitskaya, T. A., Esin, R. V., Kytmanov, A. A., & Zykova, T. V. (2023). Designing an Education Database in a Higher Education Institution for the Data-Driven Management of the Educational Process. *Education Sciences*, *13*(9), 947.

Li, Z., & Liu, Y. (2023). Analysis of the current situation of the research on the influencing factors of online learning behavior and suggestions for teaching improvement. *Sustainability*, *15*(3), 2119.

Lim, K. K., & Lee, C. S. (2021). Investigating Learner's Online Learning Behavioural Changes during the COVID-19 Pandemic. *Proceedings of the Association for Information Science and Technology*, *58*(1), 777-779.

Lu, C., & Cutumisu, M. (2022). Online engagement and performance on formative

assessments mediate the relationship between attendance and course performance. *International journal of educational technology in higher education*, *19*(1), 2.

Myers, F., Glover, H., & Stephens, C. (2021). Learner interrupted: understanding the stories behind the codes–a qualitative analysis of HE distance-learner withdrawals. *Journal of Further and Higher Education*, *45*(8), 1134-1146.

Mubarak, A. A., Cao, H., & Zhang, W. (2022). Prediction of students' early dropout based on their interaction logs in online learning environment. *Interactive Learning Environments*, *30*(8), 1414-1433.

National Center for Education Statistics, U.S. Department of Education (2013).The Integrated Post-secondary Education data system. Washington, D.C.: National Center for Education Statistics, U.S. Department of Education

Pardos, Z. A., & Horodyskyj, L. (2019). Analysis of student behaviour in habitable worlds using continuous representation. *Journal of Learning Analytics, 6 (1)*.

Peechapol, C., Na-Songkhla, J., Sujiva, S., & Luangsodsai, A. (2018). Development of Smartphone Application Based on the Theory of Planned Behaviour to Enhance Self-Efficacy for Online Learning. *International Journal of Interactive Mobile Technologies*, *12*(4).

Peng, L., & Jeang, B. (2023, March). Prediction model of students' learning behavior on learning effect in online live class based on machine learning algorithm. In *Fifth International Conference on Computer Information Science and Artificial Intelligence (CISAI 2022)* (Vol. 12566, pp. 1290-1295). SPIE.

Pleasants, J., Pleasants, J. M., & Pleasants, B. P. (2022). Cheating on Unproctored Online Exams: Prevalence, Mitigation Measures, and Effects on Exam Performance. *Online Learning*, *26*(1), 268-284.

Reparaz, C., Aznárez-Sanado, M., & Mendoza, G. (2020). Self-regulation of learning and MOOC retention. *Computers in Human Behavior*, *111*, 106423.

Slade, S., Prinsloo, P., & Khalil, M. (2019, March). Learning analytics at the intersections of student trust, disclosure and benefit. In *Proceedings of the 9th international conference on learning analytics & knowledge* (pp. 235-244).

Sukhbaatar, O., Usagawa, T., & Choimaa, L. (2019). An artificial neural network based early prediction of failure-prone students in blended learning course. *International Journal of Emerging Technologies in Learning (iJET)*, *14*(19), 77-92.

Taub, M., Banzon, A. M., Zhang, T., & Chen, Z. (2022). Tracking changes in students' online self-regulated learning behaviors and achievement goals using trace clustering and process mining. *Frontiers in psychology*, *13*, 813514.

Wang, H., Tlili, A., Lämsä, J., Cai, Z., Zhong, X., & Huang, R. (2023). Temporal perspective on the gender-related differences in online learning behaviour. *Behaviour & Information Technology*, *42*(6), 671-685.

Wong, J. T., & Hughes, B. S. (2023). Leveraging learning experience design: digital media approaches to influence motivational traits that support student learning behaviors in undergraduate online courses. *Journal of Computing in Higher Education*, *35*(3), 595-632.

Wu, H. (2023). Study on the differences in behaviour characteristics of distance online autonomous learning in different network virtual environments. *International Journal of Continuing Engineering Education and Life Long Learning*, *33*(4-5), 468-480.

Yang, C. C., Chen, I. Y., & Ogata, H. (2021). Toward precision education. *Educational*

Technology & Society, *24*(1), 152-163.

Ye, D., & Pennisi, S. (2022). Using trace data to enhance Students' self-regulation: A learning analytics perspective. *The Internet and Higher Education*, *54*, 100855.

Yoon, M., Lee, J., & Jo, I. H. (2021). Video learning analytics: Investigating behavioral patterns and learner clusters in video- based online learning. *The Internet and Higher Education*, *50*, 100806.

Yu, T. K., & Yu, T. Y. (2010). Modelling the factors that affect individuals' utilisation of online learning systems: An empirical. study combining the task technology fit model with the theory of planned behaviour. *British Journal of Educational Technology*, *41*(6), 1003-1017.

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