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The Impact of Machine Learning Technology on E-Learning Platforms on Student Learning Behavior

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Abstract
This study aims to determine the influence of Machine Learning Technology on the E-Learning Platform on student learning behavior. This research is a type of meta-analysis research. The data source comes from 10 national journals indexed by SINTA published in 2022-2024. Deep collection technique through direct observation. The process of searching for virgin sources through google scholar, ERIC, and IEEE. Data analysis is statistical data analysis by calculating the effect size value with the help of the JSAP application. The results of the study concluded that the average effect size value was 0.791 in the medium effect size category. These findings explain that there is a significant influence of machine learning technology on e-learning platforms on student learning behavior.

Keywords: Machine Learning; E-Learning; Learning Behavior; Effect Size

Introduction

The increasing use of E-Learning has become a significant global phenomenon in recent years. One of the main drivers of this growth is the advancement of digital technology that allows easy access to educational resources from anywhere and anytime (Waladi et al., 2023). In addition, the COVID-19 pandemic has accelerated the mass adoption of E-Learning, where educational institutions around the world are turning to online platforms to ensure the continuity of the teaching-learning process during the quarantine period (Troussas et al., 2021; Utomo et al., 2023; Nurtamam et al., 2023). E-Learning offers unparalleled flexibility, allowing students to learn at their own pace and access learning materials as per individual needs (Yeşilkanat, 2020). The variety of content formats, such as videos, interactive quizzes, and online discussions, makes E-Learning more interesting and effective than traditional learning methods.

In addition to technological factors and external conditions, the increasing use of E-Learning is also driven by the need to provide a more inclusive and accessible education. With E-Learning, geographical and economic barriers can be overcome, providing educational opportunities to individuals in remote areas or who do not have access to quality educational institutions (Levin et al., 2022; Çam & Özdağ, 2020). It also allows for lifelong learning, where professionals can access online courses to improve their skills without having to leave their jobs. As the demand for flexible and personalized education increases, E-Learning continues to evolve and adapt to the integration of advanced technologies such as artificial intelligence and machine learning, which has the potential to further enhance the learning experience and teaching effectiveness (Qiu et al., 2022).

The role of technology in education has become increasingly important along with the rapid development of information and communication technology. Technology has changed the way teaching and learning is done by providing innovative new tools that improve the accessibility and quality of education (Santosa et al., 2022; Hariyadi et al., 2023). With digital devices such as computers, tablets, and smartphones, as well as wider internet access, students now have direct access to unlimited educational resources, ranging from e-books, video tutorials, to online learning platforms. Technology also enables more interactive and engaging learning through simulations, educational games, and augmented reality (AR) and virtual reality (VR)-based learning apps, providing a more real and contextual learning experience (Zulkifli et al., 2022).

In addition, technology has paved the way for a more personalized and adaptive approach to learning. With the help of artificial intelligence (AI) and machine learning, learning systems can analyze student learning behavior data to offer content tailored to each individual's needs and learning styles (Saraswati et al., 2019). This allows teachers and instructors to monitor student progress in real-time and provide more targeted interventions when needed. Technology also supports collaborative learning, allowing students and teachers to communicate and collaborate through online platforms such as discussion forums, video conferences, and project management tools. Thus, technology is not only a supporting tool, but also a main driver in the transformation of education towards a more innovative and inclusive future (Rakić et al., 2020).

Machine learning (ML) is a branch of artificial intelligence (AI) that allows computer systems to learn and make decisions or predictions without being explicitly programmed. ML functions by analyzing large amounts of data to identify patterns and trends that are then used to make predictions or make decisions (Semerci & Goularas, 2020). These techniques include a variety of approaches, including supervised learning, unsupervised learning, and reinforcement learning, each with specific applications and advantages. For example, supervised learning is used when the training data includes the desired inputs and outputs, while unsupervised learning works with unlabeled data to find hidden structures or groups in the data (Troussas et al., 2021b). This technology has become very important in a variety of fields, from speech and image recognition to predictive analysis in business and scientific research.

In the context of education, machine learning offers great potential to improve the effectiveness of the teaching and learning process. With ML, learning systems can be automatically analyzed to assess student progress, identify areas where they may struggle, and recommend additional materials accordingly (Waladi et al., 2023). ML can also be used to personalize students' learning experiences by customizing learning content based on individual learning styles and their preferences. For example, ML algorithms can be used to analyze students' online learning behaviors, such as time spent on each topic or patterns of access to resources, to provide more relevant suggestions and increase student motivation and engagement. Thus, ML not only aids in managing and optimizing the educational experience, but also paves the way for more adaptive and responsive teaching methods to each student's needs (Mangaroska et al., 2021).

Previous research by Zawacki-Richter et al. (2019) found that the use of machine learning algorithms to personalize learning content can improve student engagement and motivation. By utilizing data about student interactions with E-Learning platforms, machine learning is able to recommend materials that best suit students' needs and level of understanding, making the learning experience more relevant and engaging. The study also underscores that personalization of learning through ML not only improves student engagement, but can also accelerate the achievement of learning goals by providing the right challenges according to students' abilities.

In addition, research by Aljohani et al. (2020) shows that machine learning can play a role in improving the effectiveness of monitoring and evaluation in E-Learning. Through the analysis of big data generated by student activities on E-Learning platforms, machine learning can identify patterns of behavior that may indicate a risk of decreased performance or inactivity. For example, ML systems can predict students who have potential academic difficulties based on their patterns of access and interaction with learning materials. The results of these predictions allow the instructor or platform to provide early interventions, such as the provision of supplemental materials or specialized support, aimed at helping students get back on track. This study emphasizes that machine learning not only functions as a technical tool, but also as an important component in adaptive learning strategies that are proactive and responsive to student needs. Based on this, this study aims to determine the influence of Machine Learning Technology on the E-Learning Platform on student learning behavior.

Research Methods

This research is a type of meta-analysis research. The data source comes from 10 national journals indexed by SINTA published in 2022-2024. Deep collection technique through direct observation. The process of searching for virgin sources through google scholar, ERIC, and IEEE.

Data analysis is statistical data analysis by calculating the effect size value with the help of the JSAP application. Furthermore, the effect size criteria can be seen in Table 1 (Zulyusri et al., 2023).

Table 1. Effect Size Criteria

Effect Size	Criteria
0.0≤ES≤ 0.2	Low
0.2≤ES≤ 0.8	Medium
ES≥ 0.8	High

Result and Discussion

From the results of data search through the database, 10 relevant journals were obtained. Furthermore, the data is calculated the effect size value which can be seen in Table 2.

Table 2. Effect Size Value 10 Research Journal

Kode Jurnal	Years	Effect Size	Criteria
P1	2024	0.82	High
P2	2024	1.03	High
P3	2024	0.42	Medium
P4	2024	0.49	Medium
P5	2023	0.91	High
P6	2022	1.14	High
P7	2023	0.86	High
P8	2022	0.71	High
P9	2024	0.52	Medium
P10	2024	0.87	High
Average Effect Size		0.78	Medium

Based on Table 2, the average effect size of the 10 studies ranged from 0.42 to 1.14. The average effect size value was 0.78 with the medium effect size category. These findings explain that there is a positive influence of machine learning technology on e-learning platforms on student learning behavior. Machine learning (ML) enables unprecedented levels of personalization in the context of E-Learning. With the ability to analyze student interaction data, ML can tailor learning materials according to individual needs. ML algorithms are able to identify learning preferences, such as visual or auditory learning styles, as well as students' level of understanding of a topic (Alsharhan et al., 2021). This means that students can receive content specifically designed to improve the effectiveness of their learning. For example, students who are quick to master the basic material may be directed to more challenging material, while students who need more time may be provided with additional material to strengthen their understanding. In this way, ML can increase student motivation and engagement, as they feel that learning is more relevant and tailored to their needs (Rasheed & Wahid, 2021).

ML technology can be used to predict students' engagement and academic achievement by analyzing their activity data on E-Learning platforms. This data can include access frequency, duration of study time, interaction with learning materials, and quiz or test results (Waladi et al., 2023). ML algorithms can identify patterns that indicate a risk of degraded performance, such as a decrease in login frequency or low participation rates in online discussions. With this early detection, instructors and E-Learning platforms can intervene in a timely manner, such as providing motivational encouragement or providing additional guidance. Additionally, the ability to predict learning outcomes allows educational institutions to dynamically adjust their curriculum and teaching methods, ensuring that each student gets the support they need to succeed.

Machine learning facilitates adaptive learning where the system can adapt to the needs of students over time (Oktarina et al., 2021; Tessema et al., 2024). For example, if an ML algorithm detects that a student is having difficulty with a particular concept, the platform may immediately recommend additional or alternative materials, such as explainer videos or practical exercises. This

allows for more responsive, solution-focused learning, rather than the one-size-fits-all approach often adopted in traditional education systems. In addition, with proactive interventions based on real-time data analysis, ML helps prevent students from feeling left behind or overwhelmed, which can ultimately improve student retention and reduce drop-out rates.

Conclusion

From the results of this study, it can be concluded that the average effect size value is 0.791 in the medium effect size category. These findings explain that there is a significant influence of machine learning technology on e-learning platforms on student learning behavior. The application of machine learning technology on E-Learning platforms has been proven to have a significant positive impact on student learning behavior. Through personalized learning, predictive analytics, and adaptive interventions, ML can improve student engagement, motivation, and learning outcomes. ML's ability to detect academic risks and provide real-time feedback helps create a responsive and supportive learning environment. Nonetheless, challenges such as data privacy concerns and the need for adequate infrastructure must be addressed to maximize the potential of this technology. With continued development, machine learning has the potential to further optimize the digital education experience and prepare students for future challenges more effectively

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