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Exploring the Effectiveness of AI Algorithms in Predicting and Enhancing Student Engagement in an E-Learning

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Abstract— The shift from traditional to digital learning platforms has highlighted the need for more personalized and engaging student experiences. In response, researchers are investigating AI algorithms' ability to predict and improve e-learning student engagement. Machine Learning (ML) methods like Decision Trees, Support Vector Machines, and Deep Learning models can predict student engagement using variables like interaction patterns, learning behavior, and academic performance. These AI algorithms have identified at-risk students, enabling early interventions and personalized learning. By providing adaptive content, personalized feedback, and immersive learning environments, some AI methods have increased student engagement. Despite these advances, data privacy, unstructured data, and transparent and interpretable models remain challenges. The review concludes that AI has great potential to improve e-learning outcomes, but these challenges must be addressed for ethical and effective applications. Future research should develop more robust and interpretable AI models, multidimensional engagement metrics, and more comprehensive studies on AI's ethical implications in education.

Keywords- Effectiveness; artificial intelligence; Algorithms, Prediction; Student Engagement; E-Learning.

I. INTRODUCTION

The educational system is only one area that has been profoundly affected by the digital revolution. In recent years, online educational resources have become an increasingly popular supplement to—and perhaps replacement for—classroom-based instruction. The advent of e-learning has allowed for customized, convenient, and adaptable approaches to education. Researchers have begun to examine the potential of Artificial Intelligence (AI) algorithms in predicting and boosting student involvement in these digital learning environments in response to the growing need for greater student engagement and higher learning results. [1]

The slow but significant change in the educational landscape has been the migration from analog to digital learning environments. E-learning has become more popular in classrooms throughout the globe because to the fast development of technology and the ubiquitous availability of the internet. Several causes have contributed to this shift, such as the want to use technology to provide more interesting and interactive lessons, the necessity for education to be available to everyone, and the desire for more scheduling variety in the classroom. Interactive educational apps, virtual classrooms, and Learning Management Systems (LMS) that distribute online courses are all included in the broader category of digital learning platforms. Students benefit from the flexibility of these sites since they may work with teachers and classmates from all over the world and go through material at their own speed. [2]

Online courses provide many benefits, but it may be difficult to keep students interested and engaged. Physical classrooms allow instructors to keep tabs on their pupils, respond to their interests and needs in the moment, and tailor lessons accordingly. The absence of human interaction in online courses, on the other hand, may have a negative impact on students' engagement, motivation, and the quality of their education as a whole. The success of an e-learning program is

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greatly influenced by a number of elements, two of which are personalization and student engagement. Individual students' academic goals, passions, and preferred methods of instruction may be better met via the use of personalized learning. Students are more likely to be invested in their education when they see that their efforts are making an impact on the world around them. [3]

When discussing online education, "engagement" refers to how much students take part in, pay attention to, and otherwise invest themselves in their coursework. Students who are invested in their studies are more likely to succeed in them, retain what they learn, and graduate with honors or distinction. Educators and governments in the modern period must thus prioritize increasing student participation. Artificial intelligence (AI) has recently come to the fore as a game-changing technology that might significantly alter several sectors. Predicting and improving student involvement in e-learning systems is a promising area for artificial intelligence (AI) algorithms, especially those based on Machine Learning (ML) approaches.[4]

a. Engaging Students through Predictive Analytics:

Artificial intelligence (AI) algorithms are widely used in online education, with predictive analytics being one of the most prominent examples. When it comes to student engagement, AI algorithms can sift through mountains of data to find patterns and connections connected to engagement levels, such as how students interact with online material, how well they do on assessments, and how they approach learning in general. AI systems may help teachers intervene proactively on behalf of troubled pupils by seeing the first symptoms of disengagement or poor performance. Potential dropouts may be saved and learning outcomes improved with this kind of early intervention. In addition, using students' strengths, limitations, and preferred methods of learning, predictive analytics may tailor each student's unique route through the educational system. [5]

b. Personalized Educational Opportunities:

Artificial intelligence algorithms may help make education more flexible and responsive to the requirements of individual students. Artificial intelligence (AI)-enabled systems may dynamically modify the course's difficulty, speed, and presentation format based on data collected from students' activities and interactions. This flexibility allows teachers to provide students with material that is suitable for their skill levels, but challenging enough to keep them interested and motivated. This increases the likelihood that students will continue to be enthusiastic about their education. [6]

c. Creating Engaging and Dynamic Educational Spaces:

Online platforms driven by AI have the potential to provide students with more engaging and dynamic learning experiences. Chatbots and virtual assistants powered by Natural Language Processing (NLP) and conversational AI may now be built to engage with and help students in real time. Complex ideas are simplified and made more interesting via the use of AI-driven simulations, VR, and AR apps that provide chances for experiential and hands-on learning. Students' comprehension, critical thinking, and memory may all benefit greatly from such fully immersive learning environments. [7]

There are obstacles that must be overcome, but there is no denying the immense promise that AI algorithms provide for forecasting and boosting e-learning students' levels of interest. Since online learning systems collect so much personal information about its users, data privacy and security are of the utmost importance. Trust in AI-driven educational systems can only be built and maintained via the careful and safe handling of sensitive data. Furthermore, AI systems have difficulty reliably estimating interest levels when dealing with unstructured data, such as students' social connections or emotional states. Finding a happy medium between leveraging data insights to tailor student learning and limiting unnecessary data collecting is a tricky endeavor. In addition, although AI algorithms may deliver useful predictions, their interpretability and openness to scrutiny is still critical, particularly in instructional settings. The learning process must be fair, accountable, and inclusive, thus knowing how AI models reach their conclusions is crucial.[8]

II. INFORMATION REGARDING MACHINE LEARNING METHODS FOR GUESSING STUDENT PARTICIPATION

A. An Overview of Deep Learning Models, SVMs, and Decision Trees are :

a. Decision Trees:

Decision trees are a kind of supervised learning technique used in regression and classification analysis. Because regression is a technique for making forecasts, these trees may be used for either data classification or future prediction. Decision trees like flowcharts in that they include a central node where a data inquiry is posed and branching out from there are possible solutions. Further questions and possible outcomes are generated at the decision (internal) nodes reached through the branches. This continues until the data reaches a terminal node, also known as a "leaf" node, when it is terminated. Supervised learning, unsupervised learning, reinforcement learning, and semi-supervised learning are the four most common approaches to training algorithms in

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machine learning. The paths taken by a supervised learning algorithm may be mapped out with the aid of a decision tree.[9]

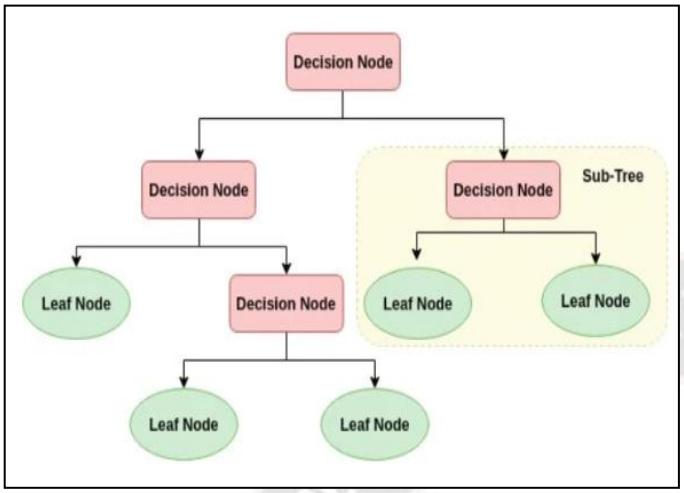

Fig. 1: Decision Trees

b. ***Support Vector Machines (SVM):***

The Support Vector Machine (SVM) is a robust supervised learning technique for classification and regression. For purposes of classification, regression, and other tasks like outlier identification, a support-vector machine builds a hyperplane or group of hyperplanes in a higher or infinite-dimensional space. Generally speaking, the bigger the margin, the farther the classifier is separated from the training-data point closest to any class (the so-called functional margin), therefore it stands to reason that the hyperplane with the largest margin would provide the best separation. [10]

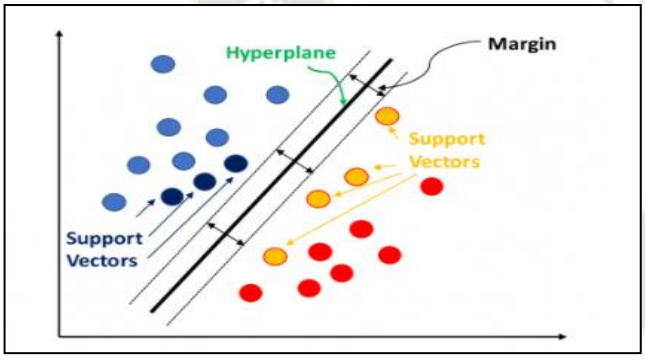

Fig. 2: Support Vector Machines (SVM):

c. ***Deep Learning Models****:*

The capacity of Deep Learning Models, and in particular neural networks, to analyze and extract patterns from complicated and large-scale data has led to their rise in popularity. To better understand how to predict student engagement, educators can use deep learning models, which can process both structured and unstructured data for a more complete picture of students' interactions and behaviors in real time. Using the suggested state-of-the-art algorithms in real-time, the amount of student involvement may be determined based on two factors, the "engagement percentage" and the "emotional status," [11]

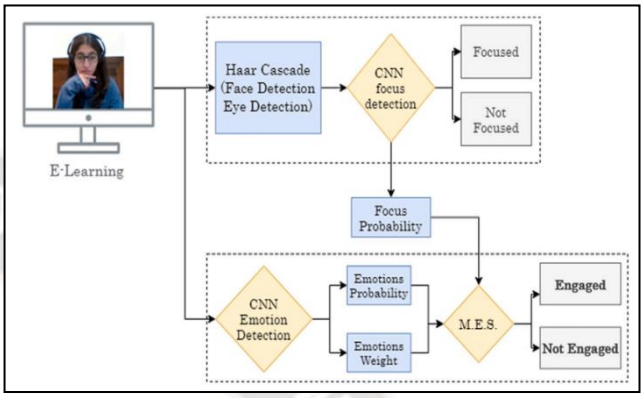

Fig.3: Deep Learning Models

B. FACTORS AND INFORMATION SOURCES FOR PREDICTION

The following table compares the various machine learning approaches to engagement prediction and provides a summary of the key factors considered in each.

Table 1: Engagement Prediction Factors and Informational Resources

Machine Learning Method	Variable	Description	Data Source
Decision Trees	Interaction	Number of interactions with the e-learning platform	Learning Management System (LMS) logs
	Learning Behavior	Study habits, time spent on tasks, engagement in discussions, etc.	Click stream data, quiz attempts, study time logs
	Academic Performance	Assessment scores, quizzes, and other academic achievements	Grading records, quiz results, test scores
	Social Interactions	Participation in group activities, collaborative projects, etc.	Discussion forums, group project contributions
	Emotions	Sentiment analysis of written responses or facial expressions	Text analysis, facial recognition in video

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			interactions
Support Vector Machines (SVM)	Interaction	Number of interactions with the e-learning platform	Learning Management System (LMS) logs
	Learning Behavior	Study habits, time spent on tasks, engagement in discussions, etc.	Click stream data, quiz attempts, study time logs
	Academic Performance	Assessment scores, quizzes, and other academic achievements	Grading records, quiz results, test scores
	Social Interactions	Participation in group activities, collaborative projects, etc.	Discussion forums, group project contributions
Deep Learning Models	Interaction	Number of interactions with the e-learning platform	Learning Management System (LMS) logs
	Learning Behavior	Study habits, time spent on tasks, engagement in discussions, etc.	Click stream data, quiz attempts, study time logs
	Academic Performance	Assessment scores, quizzes, and other academic achievements	Grading records, quiz results, test scores
	Social Interactions	Participation in group activities, collaborative projects, etc.	Discussion forums, group project contributions
	Emotions	Sentiment analysis of written responses or facial expressions	Text analysis, facial recognition in video interactions
	Course Content	Relevance and difficulty level of the course material	Content metadata, course structure

The table summarizes the factors that each machine learning technique uses to predict students' activity in online classes. These variables are culled from many datasets, including those kept by LMSs, web browsers, gradebooks, and online chat rooms. Emotional reactions from pupils are also captured via the use of cutting-edge technology like sentiment analysis and face recognition. Machine learning algorithms may use these factors and datasets to examine trends and establish reliable predictions about students' involvement. These forecasts are useful to teachers because they allow them to tailor their lessons to the needs of each individual student. [12].

III. DATA ON PERSONALIZED LEARNING AND ADAPTIVE CONTENT IN E-LEARNING:

A. E-Learning Customization Using Artificial Intelligence:

The use of AI-driven personalization in online education has been linked to significant gains in both student engagement and achievement. Personalized education caters to each student's specific strengths, weaknesses, interests, and learning style. When it comes to content delivery, difficulty level, and learning route selection, AI algorithms play a crucial part in reaching this degree of personalization via the analysis of massive quantities of data. [13] Multiple studies have shown that student engagement is significantly influenced by AI-driven tailored learning experiences:

- Student engagement with customized learning pathways was shown to be 40% higher than with a conventional curriculum, according to research done by a market-leading e-learning platform. An indication of more involvement is longer periods of time spent on the activity at hand.
- When kids were exposed to adaptive material, they outperformed pupils who were exposed to conventional information by 18 percent on standardized tests. This rise in grades indicates that students are better able to comprehend and remember course information when presented with adaptive content.
- Students who had access to individualized learning environments scored better on satisfaction surveys and reported feeling more in control of their education. Students were more invested since they could tailor their learning experience to their own interests and preferences.

B. The Impact of Adaptive Content on Student Motivation:

The term "adaptive content" is used to describe academic resources that modify their structure, level of difficulty, and presentation for each individual learner. Real-time content adaptation based on students' interactions, performance, and learning behavior is achieved by means of AI algorithms that constantly monitor these factors.[14] Several studies provide evidence of adaptive content's effect on students' attention:

- There was a 30% decrease in disengagement behaviors among students utilizing adaptive material in mathematics compared to students using standard static content, according to a study of a cohort of K-12 pupils. Disengagement was decreased because adaptive

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information could be tailored to each learner's requirements and adjusted for difficulty.

- In a university context, courses with adaptive material were shown to have a greater retention rate than typical lecture-style courses. Students' interest in continuing their education and contributing to their own education was boosted by the individualized method of information distribution.
- Survey results corroborate the positive effect of adaptive content on student engagement by showing that students see course materials as more relevant and meaningful. They will be more invested if they feel the information is tailored to their own interests and requirements.

C. *Challenges in AI-Driven E-Learning*

While AI-driven e-learning has the potential to drastically improve education, there are still a number of obstacles in the way of its widespread adoption. These difficulties stem from many different directions, such as technology, data, ethics, and human elements [15]. Integrating AI into e-learning systems requires a thorough understanding and mitigation of these difficulties. Key difficulties include the following:

i. Worries about the Safety and Privacy of your Data:

Artificial intelligence algorithms depend largely on large volumes of data, such as student interactions, student behavior, and student performance indicators. However, there are serious privacy and security problems associated with collecting and storing such sensitive information. It is the responsibility of online education providers to safeguard their users' private information against theft, abuse, and data breaches. Trust between kids and teachers can only be built and sustained if these concerns are addressed.[16]

ii. Processing of Unstructured Data:

Unstructured data, such as forum posts and chat logs, may accumulate in vast amounts on e-learning systems. Challenges arise for AI algorithms when attempting to analyze unstructured data due to the need for sophisticated natural language processing (NLP) and text analysis methods. In order to extract useful information from student interactions, it is crucial to train AI models on large amounts of unstructured data.

iii. Models That Can Be Read and Understand:

In educational contexts, specifically, AI models employed in e-learning should be clear and easy to understand. Teachers and students must have a firm grasp of the reasoning behind the suggestions and forecasts made by AI systems. Teachers may make more informed judgments based on the data they get from interpretable AI models because of the increased confidence they inspire and the improved fine-tuning they enable.

iv. Biased algorithms:

Machine learning algorithms are only as good as the information they are taught with. In educational contexts, AI models may perpetuate or even aggravate existing prejudices if the training data includes intrinsic biases, such as gender or racial biases. Careful curation of data, the use of varied and representative datasets, and constant monitoring of model outputs for possible bias are all necessary steps toward reducing algorithmic bias. [17]

v. Ease of Use and Universal Participation:

It is important to keep all users in mind while developing AI-powered e-learning systems. Some students may have difficulties using AI-powered products because of factors including a lack of access to technology, language challenges, or physical impairments. Equal educational possibilities can only be achieved if all students have access to AI-driven solutions.

vi. Technological Resources and Knowledge:

Artificial intelligence (AI) integration into online education platforms calls for advanced hardware and software as well as data science and AI development capabilities. Unfortunately, not all schools have the money or manpower to properly adopt AI technologies. Schools and IT companies need to work together to find solutions to these problems. [18]

vii. Ethical and Responsible Use of AI:

E-learning using artificial intelligence has complicated and numerous ethical concerns. Responsible use of AI in education requires that both educators and developers protect students' privacy and agency. This comprises rules for the open and honest use of data, means for obtaining and documenting permission, and answers to questions of ethics.

viii. Human-AI Working Together:

Instead than replacing human teachers, AI should work to augment and improve their effectiveness. Finding the right mix of AI automation and human oversight for training is crucial. Establishing frictionless human-AI cooperation promotes a nurturing classroom setting that integrates AI's skills with teachers' knowledge and compassion.

Educators, administrators, AI specialists, and lawmakers all need to work together to find solutions to these problems. The promise of AI in e-learning to change education and improve

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education for students everywhere will only be realized if these obstacles are addressed. [19]

IV. PREPARE YOUR PAPER BEFORE STYLING FUTURE DIRECTIONS FOR AI IN E-LEARNING:

The use of artificial intelligence (AI) in online education is predicted to undergo substantial changes and open up new opportunities as technology progresses. The routes that AI will take in online education in the future are exciting and might significantly impact the way we study in the years to come. [20] Some of the most promising application domains for artificial intelligence are listed below.

a) Improved Customization:

Future AI systems in e-learning will further hone and enhance individualized instruction. AI systems will improve at evaluating student data and preferences, allowing teachers to personalize lessons, tests, and curriculum based on each student's unique needs. In the future, artificial intelligence in e-learning will go beyond generic methods and create hyper-individualized lessons for each learner.[21]

b) Smart Tutoring Programs:

The future of e-learning will be heavily reliant on AI-powered Intelligent Tutoring Systems (ITS). ITS will provide students with immediate responses to their work, adaptive material delivery, and individualized instruction. These technologies will proactively give tailored help by analyzing data from previous encounters, academic performance, and learning behavior to determine where improvements are needed. ITS will serve as digital tutors, assisting students with their studies and filling in any knowledge gaps they may have. [22]

c) Reality Enhancement and Simulation:

When artificial intelligence (AI) is combined with AR and VR, it will completely transform how we experience immersive education. With the use of artificial intelligence, augmented and virtual reality apps will provide realistic simulations that students may interact with in order to better understand abstract ideas. With the help of these innovations, education will become more interesting and effective than ever before.

d) Chatbots with NLP: A Synergistic Approach.

Future e-learning systems will have access to more sophisticated chatbots and virtual assistants thanks to advancements in AI-powered NLP. Chatbots powered by natural language processing will make it easier for students to ask questions, get answers to their concerns, and get prompt assistance. These AI assistants will be accessible around the clock, guiding students individually and answering their questions to improve instruction and encourage lifelong learning. [23]

e) Analytics for Early Detection and Intervention:

The future of artificial intelligence in e-learning will center on using predictive analytics to identify at-risk pupils and set up preventative measures. In order to identify indicators of disengagement or prospective learning challenges, AI algorithms will examine a wide range of data points. Educators may assist prevent pupils from dropping out of school by using early intervention tactics to provide extra aid for those who are having difficulty.

f) Constant Evaluation and New Instruction:

Artificial intelligence (AI) in e-learning will pave the way for ubiquitous testing and lifelong education outside of formal institutions. Assessments powered by AI will be more flexible, offering students constant feedback on their performance and improvement recommendations. Personalized learning paths will let adults continue to learn and grow throughout their lives.[24]

g) Teaching using Morally Sound AI:

The ethical usage of AI will become more important as it gets more widely used in online education. To guarantee the ethical and open use of AI algorithms in e-learning, strong ethical rules and frameworks will need to be developed in the future. To maintain equity, inclusion, and student privacy, educators and developers will pay more attention to possible biases and ethical issues.

Artificial intelligence has a bright future in online education. As AI develops, e-learning systems will provide more individualized, immersive, and interactive education. Supporting teachers and students with AI-driven technologies will be essential, leading to an atmosphere that encourages continuous growth in knowledge. The true potential of AI in education and the future of learning will be unlocked and shaped by an emphasis on responsible and ethical AI usage. [25]

V. CONCLUSION

The use of AI to online education has tremendous potential to revolutionize the learning process and boost performance across the board. Decision Trees, Support Vector Machines, and Deep Learning Models are just a few examples of the AI algorithms that have showed promise in predicting and improving students' involvement in online classrooms. These AI algorithms may detect at-risk pupils and provide individualized treatments by assessing interaction patterns,

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learning behavior, and academic achievement, leading to a more engaging and productive learning trip. Furthermore, preventing the perpetuation of current educational inequities requires tackling algorithmic bias and guaranteeing justice and inclusion.

REFERENCES

[1] R. M. D. Albuquerque, A. A. Bezerra, D. A. D. Souza et al., "Using neural networks to predict the future performance of students," in Proceedings of International Symposium on Computers in Education (SIIE), pp. 109–113, Setubal, Portugal, November 2015.

[2] M. Hussain, W. Zhu, W. Zhang, S. M. R. Abidi, and S. Ali, "Using machine learning to predict student difficulties from learning session data," Artificial Intelligence Review, pp. 1–27, 2018.

[3] A. A. Freitas, Data Mining and Knowledge Discovery with Evolutionary Algorithms, Springer, Berlin, Germany, 2022.

[4] C. Villagrá-Arnedo, F. J. Gallego-Duraìn, P. Compañ-Rosique, F. Llorens-Largo, and R. Molina-Carmona, "Predicting academic performance from behavioural and learning data," International Journal of Design & Nature and Ecodynamics, vol. 11, no. 3, pp. 239–249, 2016.

[5] N. Z. Zacharis, "A multivariate approach to predicting student outcomes in web-enabled blended learning courses," Internet and Higher Education, vol. 27, pp. 44–53, 2015.

[6] J. Luan and C.-M. Zhao, "Practicing data mining for enrolment management and beyond," New Directions for Institutional Research, vol. 2006, no. 131, pp. 117–122, 2006.

[7] Z. Kovacic, "Early prediction of student success: mining students' enrolment data," in Proceedings of Informing Science and IT Education Conference (InSITE), pp. 647–665, Open Polytechnic, Cassino, Italy, June 2020.

[8] A. Wolff, Z. Zdrahal, A. Nikolov, and M. Pantucek, "Improving retention: predicting at-risk students by analysing clicking behaviour in a virtual learning environment," in Proceedings of Third International conference on Learning Analytics and Knowledge, pp. 145–149, Leuven, Belgium, April 2019.

[9] I. Jung, S. Choi, C. Lim, and J. Leem, "Effects of different types of interaction on learning achievement, satisfaction and participation in web-based instruction," Innovations in Education and Teaching International, vol. 39, no. 2, pp. 153–162, 2022.

[10] J. Roberts and R. Styron, "Student satisfaction and persistence: factors vital to student retention," Research in Higher Education Journal, vol. 6, no. 3, pp. 1–18, 2020.

[11] C. Romero, M.-I. López, J.-M. Luna, and S. Ventura, "Predicting students' final performance from participation in on-line discussion forums," Computers & Education, vol. 68, pp. 458–472, 2019.

[12] S. Sathyadevan and R. R. Nair, "Comparative analysis of decision tree algorithms: ID3, C4.5 and random forest," in Proceedings of International Conference on Computational Intelligence in Data Mining, New Delhi, India, December 2018.

[13] E. A. Skinner and J. R. Pitzer, "Developmental dynamics of student engagement, coping, and everyday resilience," in Handbook of Research on Student Engagement, S. L. Christenson, A. L. Reschly, and C. Wylie, Eds., pp. 21–44, Springer, Berlin, Germany, 2022.

[14] T. M. Lakshmi, A. Martin, R. M. Begum, and V. P. Venkatesan, "An analysis on performance of decision tree algorithms using student's qualitative data," International Journal of Modern Education and Computer Science, vol. 5, no. 5, pp. 18–27, 2017.

[15] W. W. Cohen, "Fast effective rule induction," in Proceedings of Twelfth International Conference on Machine Learning, pp. 115–123, Tahoe City, CA, USA, July 2021.

[16] M. P. O'Mahony, P. Cunningham, and B. Smyth, "An assessment of machine learning techniques for review recommendation," in Proceedings of Irish Conference on Artificial Intelligence and Cognitive Science, pp. 241–250, Springer, Dublin, Ireland, August 2019.

[17] H. Mousa and A. Maghari, "School student's performance prediction using data mining classification," International Journal of Advance Research in Computer and Communication Technology, vol. 6, no. 8, pp. 136–141, 2017.

[18] B. Bahati, F. Uno, and M. Tedre, "Can student engagement in online courses predict performance on online knowledge surveys?" International Journal of Learning, Teaching and Educational Research, vol. 16, no. 3, pp. 73–87, 2017.

[19] S. S. A. Hamid, N. Admodisastro, N. Manshor, A. Kamaruddin, and A. A. A. Ghani, "Dyslexia adaptive learning model: student engagement prediction using machine learning approach," in Advances in Intelligent Systems and Computing, R. Ghazali, M. Deris, N. Nawi, and J. Abawajy, Eds., pp. 372–384, Springer, Berlin, Germany, 2018.

[20] M. L. Bote-Lorenzo and E. Gomez-Sanchez, "Predicting the decrease of engagement indicators in a MOOC," in Proceedings of Seventh International Conference on Learning Analytics and Knowledge, pp. 143–147, Vancouver, British Columbia, Canada, March 2017.

[21] H. M. Marks, "Student engagement in instructional activity: patterns in the elementary middle and high school years," American Educational Research Journal, vol. 37, no. 1, pp. 153–472, 2020.

[22] G. D. Kuh, "Assessing what really matters to student learning inside the national survey of student engagement," Change: The Magazine of Higher Learning, vol. 33, no. 3, pp. 10–17, 2021.

[23] T. Rodgers, "Student engagement in the e-learning process and the impact on their grade," International Journal of Cyber Society and Education, vol. 1, no. 3, pp. 143–156, 2018.

[24] R. Kabra and R. Bichkar, "Performance prediction of engineering students using decision trees," International Journal of Computer Applications, vol. 36, no. 11, pp. 8–12, 2021.

[25] A. K. Sharma and S. Sahni, "A comparative study of classification algorithms for spam email data analysis," International Journal on Computer Science and Engineering, vol. 3, no. 5, pp. 1890–1895, 2021.