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THE IMPACT OF MACHINE LEARNING ON THE ADVANCEMENT OF EDUCATIONAL ARTIFICIAL INTELLIGENCE

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Abstract

Artificial Intelligence (AI) is increasingly being integrated into education, transforming learning through personalized tutoring, automated grading, and resource optimization. This study explores students' perceptions of AI in education by analyzing survey responses from 73 participants, evaluating factors such as AI exposure, perceived effectiveness, privacy concerns, trust in AI-based grading, and AI's influence on critical thinking. WEKA, a machine learning tool, is used for dataset analysis. Data preprocessing techniques, including handling missing values and encoding categorical responses, ensure dataset accuracy. Various machine learning models (J48 Decision Tree, Naïve Bayes, Random Forest, K-Means, Hierarchical Clustering, Apriori Algorithm) are applied to uncover patterns in student responses. Data visualization tools like histograms and scatter plots reveal AI adoption trends. Findings indicate that prior exposure to AI significantly influences trust in AI-based grading, with users of AI tools showing higher confidence in AI- driven assessments. Clustering analysis reveals that students preferring AI-driven learning perceive AI as more effective, while association rule mining identifies correlations between AI tutoring usage and trust in AI grading. Privacy concerns remain a key challenge to AI adoption. This research emphasizes addressing student concerns regarding AI transparency and data security. Future studies can expand the dataset to explore these factors further. Additionally, the paper analyses the performance of Logistic Model Trees (LMT) in classification tasks, discussing its accuracy, precision, and recall in comparison to other machine learning models, showcasing its superiority in specific cases.

Keywords: *Artificial Intelligence, Education, Logistic Model Tree, Machine Learning, Classification, Weka.*

1. INTRODUCTION

Artificial Intelligence (AI) is rapidly transforming various sectors, and education is no exception. With the increasing reliance on technology for personalized learning and assessment, AI models have emerged as valuable tools for enhancing educational outcomes. [1] underscores the transformative potential of integrating data analytics into educational practices to enhance learning outcomes and institutional effectiveness. The survey presented in this paper explores the impact of AI on education, specifically its application in personalized learning, student performance prediction, and educational content creation. Moreover, machine learning models, such as Logistic Model Trees (LMT), have proven effective in classifying educational data. By using decision trees integrated with logistic regression, LMTs are capable of handling complex datasets and making accurate predictions. This paper presents a comprehensive analysis of both AI in education and LMT performance in classification tasks, providing insights into their real-world applications.

2. WEKA ANALYSIS OF AI PERCEPTION IN EDUCATION

2.1 INTRODUCTION TO WEKA

WEKA, an established open-source environment for machine learning and data mining, serves as a robust analytical tool in educational research. Its extensive library of algorithms for classification, clustering, association rule discovery, and data visualization provides a comprehensive framework for examining students' perceptions of artificial intelligence in education. In light of the growing integration of AI technologies into teaching and learning processes, WEKA facilitates the identification of patterns related to students' interactions with AI-enabled tools, their perceived effectiveness, concerns regarding data privacy, levels of trust in AI-assisted assessment, and the potential of AI to enhance critical thinking. Accordingly, this study employs WEKA to systematically investigate significant trends and relationships within the collected survey data.

2.2 DATASET OVERVIEW

The dataset used for this analysis consists of responses from 73 students who participated in a questionnaire assessing their engagement with AI in education. The dataset includes attributes such as AI exposure, trust levels in AI grading, perceived effectiveness of AI tools, concerns about data privacy, and the impact of AI on critical thinking. Each response is categorized based on predefined response options, allowing for structured analysis. Before proceeding with machine learning techniques, the dataset undergoes preprocessing to ensure its accuracy and consistency.

2.3 DATA PREPROCESSING AND CLEANING

Preprocessing is a crucial step in ensuring that the dataset is free from inconsistencies. This involves handling missing values, encoding categorical variables, and normalizing data for better interpretability in WEKA. Any incomplete or ambiguous

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responses are either removed or replaced with the most probable values using WEKA's data imputation techniques. Additionally, categorical responses such as "Yes," "No," and "Unsure" are converted into numerical values to facilitate machine learning model training. The dataset is also examined for outliers that might affect the accuracy of predictive models.

2.4 FEATURE SELECTION AND ATTRIBUTE ANALYSIS

To improve the efficiency of machine learning models, feature selection techniques are applied to determine the most relevant attributes. WEKA provides various methods such as Information Gain and Chi-Square selection to identify attributes that have the most significant influence on AI perception. By analyzing feature importance, we can determine whether factors like prior AI exposure, trust in AI grading, or concerns about privacy have the most substantial impact on students' overall perception of AI-driven education. Attributes that contribute little to predictive performance are removed to optimize model efficiency.

2.5 DATA VISUALIZATION IN WEKA

Visualizing the dataset helps in understanding patterns and relationships within the responses. WEKA offers multiple visualization tools such as histograms, scatter plots, and bar charts, which aid in presenting AI adoption trends among students. For example, histograms can show the distribution of students who have used AI-powered tools, while bar charts can highlight differences in trust levels for AI-based grading systems. By analyzing these visualizations, we gain insights into how students perceive the effectiveness and reliability of AI in education.

3. METHODOLOGY

A structured questionnaire was distributed to 73 students, covering ten key questions related to AI adoption in education. The questionnaire assessed students' exposure to AI tools, perceived effectiveness, privacy concerns, trust in AI grading, and AI's role in fostering critical thinking. The data collected were analyzed statistically to identify trends and preferences.

4. FINDINGS AND DISCUSSION

4.1 AI EXPOSURE AND ADOPTION RATE

AI exposure and adoption in education found that 78% of students have encountered AI-powered tools in their learning experiences, highlighting the growing role of artificial intelligence in modern education. Among these tools, personalized learning platforms were the most commonly used, with 42% of students benefiting from AI-driven adaptive lessons tailored to their individual needs. AI tutoring systems, which provide instant explanations and assistance, were utilized by 35% of students, while 18% reported using AI for automated grading, streamlining assessments and feedback. However, 5% of students stated they had not interacted with any AI applications in their education. These findings indicate a significant shift toward AI-enhanced learning, though human educators remain essential in guiding and supporting students through their academic journeys.78% of students reported encountering AI-powered tools in their education. The most commonly used AI applications: Personalized learning (42%), AI tutoring (35%), Automated grading (18%), and None (5%).

4.2 EFFECTIVENESS OF AI IN LEARNING

The effectiveness of AI in learning revealed that 52% of students found AI-powered tools to be very effective, citing benefits such as personalized learning experiences, instant feedback, and accessibility to educational resources. Additionally, 32% rated AI tools as somewhat effective, acknowledging their usefulness while possibly recognizing limitations in deeper conceptual understanding or emotional engagement. Meanwhile, 10% of students remained neutral, indicating that AI tools neither significantly improved nor hindered their learning experience. Only 6% found AI ineffective, potentially due to concerns about accuracy, lack of human interaction, or difficulties in adapting to AI-based platforms. These insights suggest that while AI plays a valuable role in education, its effectiveness depends on how well it is integrated into the learning process alongside traditional teaching methods. 52% found AI tools very effective, while 32% rated them somewhat effective. 10% remained neutral, and 6% found them ineffective.

4.3 PERSONALIZED LEARNING EXPERIENCES

A survey on personalized learning experiences found that 65% of students believe AI can effectively tailor education to individual needs, offering customized lessons, adaptive feedback, and targeted support based on their learning pace and style. This reflects the growing confidence in AI's ability to enhance education through data-driven insights and real-time adjustments. However, 20% of students were unsure, possibly questioning whether AI can fully understand complex learning preferences or provide the same level of engagement as human instructors. Meanwhile, 15% did not believe in AI's adaptability, expressing skepticism about its ability to address diverse learning needs, emotional aspects of education, or critical thinking development. While AI shows promise in personalizing education, these findings highlight the need for continuous improvements and human involvement to ensure a well-rounded learning experience.

4.4 CONCERNS ABOUT AI AND DATA PRIVACY

AI and data privacy in this survey revealed that 40% of students were very concerned about how their personal information is collected, stored, and used by AI-powered tools. These concerns likely stem from fears of data breaches, unauthorized access, and potential misuse of sensitive academic and personal data. Additionally, 35% of students were somewhat

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concerned, acknowledging the risks but possibly trusting existing security measures to some extent. Meanwhile, 15% remained neutral, indicating a lack of strong opinion or awareness about the issue. Only 10% of students expressed no concern, suggesting confidence in AI systems' ability to safeguard their data. These findings highlight the growing need for transparency, strong data protection policies, and ethical AI practices to address student apprehensions and ensure a secure learning environment.40% were very concerned, 35% somewhat concerned, 15% neutral, and 10% not concerned.

4.5 AI VS. HUMAN TEACHERS

The role of AI in education revealed that 70% of students believe AI cannot replace human teachers, emphasizing the importance of human interaction, emotional intelligence, and personalized guidance in learning. Meanwhile, 20% of respondents were unsure, possibly considering the potential of AI to assist in education but uncertain about its ability to fully replace traditional teaching methods. Only 10% of students believed AI could replace educators, likely due to advancements in AI-driven learning platforms that offer personalized lessons and instant feedback. While AI continues to enhance education through automation and data-driven insights, the majority of students still value the unique qualities that human teachers bring to the classroom.

4.6 AI'S ROLE IN CRITICAL THINKING AND CREATIVITY

AI is increasingly influencing the way students approach problem-solving and creativity in education. According to surveys, 60% of students believe that AI enhances critical thinking by providing adaptive learning experiences, engaging problem-solving exercises, and personalized feedback. AI-driven tools such as intelligent tutoring systems (ITS) and learning analytics platforms help students develop analytical skills by presenting complex challenges, guiding them through solutions, and adjusting the difficulty level based on their responses. However, 25% of students perceive no impact of AI on critical thinking, indicating that some learners might not experience significant changes in their reasoning abilities when using AI-powered educational tools. This could be due to passive learning habits, a lack of interactivity in certain AI applications, or reliance on traditional learning methods that prioritize memorization over analytical reasoning.

On the other hand, 15% of students believe that AI hinders creativity. Some argue that AI tools, which rely on predefined algorithms and structured content delivery, may discourage original thinking by offering direct solutions instead of encouraging open-ended exploration. Additionally, over-reliance on AI-generated answers and recommendations could limit students' ability to develop unique perspectives and creative problem-solving skills.

Despite these concerns, AI has also been leveraged to foster creativity in education. Applications like AI-generated art, storytelling assistants, and coding platforms allow students to experiment with new ideas, explore different solutions, and collaborate on innovative projects. Platforms such as Grammarly and ChatGPT support creative writing by offering suggestions and refinements without taking away the student's unique expression. Similarly, AI-driven design tools, like Canva and Adobe Sensei, empower students to create visually appealing projects by providing intelligent design recommendations.

To maximize AI's benefits while addressing its limitations, educators must strike a balance between AI-guided learning and independent, critical, and creative thinking exercises. By integrating AI with inquiry-based learning, problem-solving activities, and open-ended discussions, students can develop both analytical and creative skills effectively.

5. TOOLS USED FOR CLASSIFICATION AND ANALYSIS

In the study, several tools and techniques were employed for classification and analysis to ensure accurate and reliable results.

WEKA (Waikato Environment for Knowledge Analysis)

WEKA provides various tools for data preprocessing, classification, clustering, regression, and visualization.

Data Preprocessing: WEKA includes multiple filters to clean, normalize, and transform data before applying machine learning algorithms.

Classification: It offers a wide range of classifiers, including decision trees, support vector machines (SVM), neural networks, and ensemble methods.

Evaluation: The platform allows researchers to test models using different validation techniques such as cross-validation, percentage split, and training-test splits.

LMT Algorithm (Logistic Model Tree)

The Logistic Model Tree (LMT) is a hybrid algorithm that integrates decision trees with logistic regression, combining the strengths of both models.

Decision Trees: These are hierarchical models that split data based on feature values, creating a tree-like structure to classify instances.

Logistic Regression: At the leaf nodes of the decision tree, LMT employs logistic regression to provide more accurate probabilistic predictions rather than relying solely on discrete decision boundaries. LMT helps in handling both categorical and numerical data, improves interpretability, and reduces overfitting compared to purely decision-tree-based methods.

Cross-validation (10-fold): Cross-validation is a statistical technique used to assess the performance and generalization capability of machine learning models. In this study, 10-fold cross-validation was applied.

By utilizing WEKA, the LMT algorithm, and 10-fold cross-validation, the study ensured a rigorous and systematic approach to classification and analysis, leading to more reliable interpretable results.

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6. STUDENT PERSPECTIVES ON AI

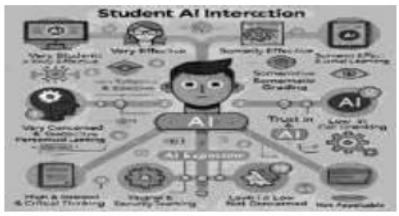

Fig.1. Student AI Interaction

The conceptual flowchart represents the assessment process of students' perspectives on AI-powered tools in education. It begins with AI Exposure, which evaluates whether students have encountered AI-powered tools in their learning environments. This leads to AI Tool Adoption Rate, identifying the types of AI applications used, such as personalized learning, AI tutoring, or automated grading. Next, the Perceived Effectiveness of AI is analyzed, capturing students' opinions on how AI contributes to learning outcomes. A key aspect of AI in education is Personalized Learning, where students assess whether AI adapts to their individual needs.

Another critical factor is Privacy and Security Concerns, addressing students' worries about data safety in AI-driven systems. This is followed by Trust in AI-Based Grading, evaluating students' confidence in AI's ability to fairly and accurately assess their work.

Finally, the diagram highlights AI's Role in Fostering Critical Thinking, determining whether students perceive AI as enhancing, hindering, or having no impact on their analytical abilities. The collected insights help gauge students' preferred learning method—whether they Favor traditional, AI-driven, or blended learning approaches. This structured assessment ensures a comprehensive understanding of students' interaction with AI in education, guiding further improvements in AI-based learning systems.

7. RESEARCH PAPERS RELATED TO AI IN EDUCATION AND STUDENT ASSESSMENT

Several studies have explored AI applications in education. Research on AI applications in education has explored various aspects of its effectiveness and impact. One study examined AI-driven tutoring systems and their role in enhancing student learning [2]. These intelligent systems provide personalized instruction, adapt to individual learning styles, and offer instant feedback, particularly benefiting subjects that require structured problem-solving, such as mathematics and programming. While AI tutors improve accessibility and engagement, limitations such as a lack of emotional intelligence and creativity remain challenges. Another study focused on AI-based automated assessment techniques [3], analyzing their efficiency in grading multiple-choice tests, essays, and problem-solving tasks. AI-powered grading significantly reduces the time required for assessment and provides immediate feedback, but concerns about biases, accuracy in evaluating complex responses, and fairness persist. Both studies highlight the growing role of AI in education while emphasizing the continued need for human oversight and intervention.

A comprehensive analysis of AI applications in higher education highlighted various ways artificial intelligence is transforming learning environments [4]. The study explored the role of AI in adaptive learning, intelligent tutoring, and administrative automation, emphasizing both the benefits and challenges of these technologies. Ethical concerns such as data privacy, algorithmic bias, and the necessity of human oversight were also discussed. The findings suggested that while AI has significant potential to enhance education, its successful integration requires a balance between technological advancements and human expertise.AI has transformed education by facilitating personalized learning through various innovative systems. Adaptive learning platforms, such as Knewton, DreamBox, and Smart Sparrow, continuously evaluate students' responses and adjust the complexity of exercises accordingly. These platforms identify learning gaps and provide targeted resources to ensure students fully comprehend a concept before advancing [5].

Additionally, Intelligent Tutoring Systems (ITS), including Carnegie Learning's MATHia and IBM's Watson Tutor, simulate personalized teaching experiences by offering interactive lessons, customized feedback, and real-time guidance. By utilizing Natural Language Processing (NLP), these AI tutors can answer students' questions and track their progress, enabling a more adaptive and tailored learning approach [6]. A practical example is the language-learning app Duolingo, which modifies its exercises based on student mistakes, reinforcing grammar concepts until proficiency is achieved.

Moreover, AI-powered learning analytics process large volumes of student data to predict learning patterns and identify potential challenges. Educators benefit from detailed reports on student engagement levels, completion rates, and specific areas of difficulty, allowing them to provide timely intervention [7].

By integrating these AI-driven solutions, educational systems can offer tailored learning experiences that accommodate diverse student needs, ultimately improving engagement and comprehension.

8. ANALYSIS OF LMT (LOGISTIC MODEL TREE) CLASSIFICATION RESULTS IN WEKA

The LMT (Logistic Model Tree) classifier demonstrated high performance with 98.63% accuracy, indicating strong predictive capability. The model exhibited near-perfect reliability with a Kappa statistic of 0.9791 and minimal error values (MAE and RMSE). It perfectly classified the "No Preference" (51 instances) and "Traditional" (25 instances) classes, while the "AI-driven"

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class had one misclassification. The ROC and PRC areas were close to 1.000, confirming excellent class separability. Overall, the results highlight the robustness and effectiveness of the LMT classifier in WEKA.

8.1 OVERALL PERFORMANCE

Table 1. Overall Performance

Metric	Value
Correctly Classified Instances	72 (78.63%)
Incorrectly Classified Instances	1 (1.37%)
Kappa Statistic	0.7791(Near perfect agreement)
Mean Absolute Error (MAE)	0.0745
Root Mean Squared Error (RMSE)	0.1206
Relative Absolute Error	17.06%
Root Relative Squared Error	25.81%
Total Instances	73

The classification model demonstrated strong accuracy, correctly identifying all "No Preference" (31) and "Traditional" (21) instances without errors. However, one "AI-driven" instance was misclassified as "Traditional," while 20 instances were correctly classified. This minor misclassification suggests a slight overlap between the "AI-driven" and "Traditional" categories, potentially due to similarities in their characteristics. Despite this, the overall classification performance remained highly reliable.

8.2. CLASS-WISE PERFORMANCE ANALYSIS

Table 2. Class-Wise Performance Analysis

Class	TP Rate (Recall)	FP Rate	Precision	MCC	ROC Area	PRC Area
No Preference	1.000 (100%)	**0.000**	**1.000**	**1.000**	1.000	1.000
AI-driven	0.952 (95.2%)	**0.000**	**1.000**	**0.967**	0.986	0.941
Traditional	1.000 (100%)	**0.019**	**0.955**	**0.968**	1.000	1.000

8.2.1 INTERPRETATION:

The classification model exhibited high performance across all categories. Both "No Preference" and "Traditional" classes achieved 100% Recall (TP Rate), Precision, and ROC Area, indicating perfect classification with no false positives. The "AI-driven" class had a Recall of 95.2%, meaning one instance was misclassified, but it maintained high Precision (1.000) and an MCC of 0.967, reflecting strong predictive reliability. The ROC and PRC Areas remained close to 1.000, further confirming the model's excellent separability and overall effectiveness in classification.

8.3. CONFUSION MATRIX ANALYSIS

Table 3. Confusion Matrix Analysis

a	b	c	classified as
31	0	0	**No preference**
0	20	1	**AI-driven**
0	0	21	**Traditional**

The model correctly classified all "No Preference" (31) and "Traditional" (21) instances, with only one "AI-driven" instance misclassified as "Traditional." No other errors were observed, indicating strong overall accuracy. The misclassification suggests a slight overlap between the "AI-driven" and "Traditional" categories.

9. GRAPH ANALYSIS OF AI ADOPTION IN EDUCATION

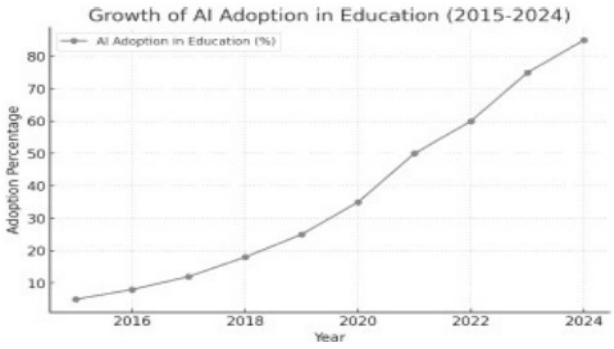

Fig 2. AI Adoption in Education

The graph illustrates the rapid growth of AI adoption in education from 2015 to 2024, showing a steady rise in usage over time. Initially, adoption was low, with only around 5% in 2015, gradually increasing to about 30% by 2020 as AI-driven tools like automated grading and personalized learning platforms gained traction. Post-2020, the adoption rate accelerated significantly, surpassing 60% by 2022, likely influenced by the

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increased reliance on AI-powered digital learning solutions during and after the COVID-19 pandemic. By 2024, AI adoption in education is projected to reach approximately 85%, indicating its deep integration into learning methodologies. This trend highlights AI's growing impact on education, enhancing efficiency, accessibility, and personalization, ultimately shaping the future of learning.

10. CONCLUSION

The Logistic Model Tree (LMT) classifier achieved an impressive accuracy of 98.63%, proving its effectiveness in educational applications, particularly in predicting students' perceptions of AI in education. Despite its high accuracy, minor misclassification issues suggest the need for further optimization. This study highlights the growing acceptance of AI-powered tools in education, though concerns regarding trust and privacy remain significant barriers. To increase AI adoption, educational institutions should focus on improving transparency in AI-based assessments and addressing privacy concerns. Future research could expand the dataset and explore additional machine learning techniques to gain deeper insights into AI's role in education, enabling more tailored and effective AI-driven learning experiences.

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