Impact of Generative AI On Student Critical thinking Skill

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Abstract: *Generative Artificial Intelligence (AI) has rapidly emerged as a transformative technology in the field of education. Tools such as AI-based chatbots, automated content generators, and intelligent tutoring systems are increasingly used by students for learning, problem solving, and completing academic tasks. While these technologies provide quick access to information and enhance productivity, their growing use has raised concerns about their potential impact on students' critical thinking abilities. Critical thinking is an essential cognitive skill that enables learners to analyze information, evaluate arguments, and make logical decisions. This study examines the impact of generative AI tools on the development of students' critical thinking skills in modern educational environments. The research explores both the positive and negative effects of generative AI on learning behavior, problem-solving approaches, and independent thinking among students. On one hand, generative AI can support learning by providing explanations, examples, and interactive assistance that encourage deeper understanding of complex topics. On the other hand, excessive reliance on AI-generated responses may reduce students' ability to think independently, analyze problems critically, and develop original ideas. The study analyzes how students interact with generative AI tools in academic settings and evaluates their influence on cognitive development and learning outcomes. The findings highlight the importance of integrating generative AI in education in a balanced and responsible manner to ensure that it enhances learning without weakening essential analytical skills. The study also emphasizes the need for educators to design instructional strategies that promote critical thinking while using AI as a supportive educational tool rather than a replacement for intellectual effort.*

Keywords: Generative Artificial Intelligence, Critical Thinking, Student Learning, Educational Technology, AI in Education, Cognitive Skills, Digital Learning

I. INTRODUCTION

In recent years, artificial intelligence (AI) has rapidly transformed many sectors, including healthcare, business, and especially education. Educational institutions are increasingly adopting AI-powered technologies to enhance teaching methods and improve learning outcomes. Among these technologies, generative artificial intelligence (Generative AI) has gained significant attention due to its ability to generate human-like responses, create content, and assist students in solving academic problems. Generative AI tools such as AI chatbots, writing assistants, and intelligent tutoring systems are now widely used by students for assignments, research, and learning support. These developments have created new opportunities for improving learning efficiency and accessibility in modern education systems (Lee, 2025) [1].

Generative AI is based on advanced machine learning and deep learning algorithms that analyze large datasets and produce new information such as text, images, or code. These systems can simulate human conversation, provide explanations, and generate academic content within seconds. Because of these capabilities, generative AI tools are

becoming increasingly popular among students who seek quick assistance in understanding complex topics or completing academic tasks. The growing availability of such technologies has significantly changed the way students interact with knowledge and information in the digital learning environment (Vieriu, 2025) [2].

At the same time, the integration of AI in education has raised important concerns regarding its influence on students' cognitive development. One of the most critical abilities developed through education is critical thinking, which involves analyzing information, evaluating arguments, and making logical decisions based on evidence. Critical thinking enables learners to question assumptions, assess the credibility of information sources, and develop independent conclusions. Researchers describe critical thinking as a reflective and self-regulated process that improves reasoning and problem-solving abilities in complex situations (Dwyer, 2023) [3].

Critical thinking is widely recognized as an essential skill in higher education and professional environments. Modern workplaces require individuals who can evaluate information critically, solve complex problems, and make informed decisions. As a result, educational institutions emphasize the development of critical thinking skills among students through activities such as problem-based learning, analytical discussions, and research projects. The ability to think critically not only improves academic performance but also prepares students to handle real-world challenges effectively (Butler, 2024) [4].

However, the increasing use of generative AI tools has sparked debates among educators and researchers regarding their potential impact on students' independent thinking abilities. While AI tools can provide explanations, summaries, and instant answers, excessive reliance on these technologies may reduce the need for students to analyze problems on their own. Some researchers argue that when students depend heavily on AI-generated responses, they may engage less in deep cognitive processes such as reasoning, evaluation, and reflection (Andrae, 2025) [5].

On the other hand, several studies highlight the potential benefits of generative AI when used as a supportive educational tool. AI systems can assist students in exploring complex concepts, generating ideas, and receiving personalized feedback. When integrated properly into the learning process, generative AI can encourage students to engage with information more effectively and develop analytical skills through interactive learning experiences. Research suggests that AI-supported learning environments may enhance students' motivation, engagement, and problem-solving abilities (Song, 2025) [6].

Despite these potential advantages, concerns remain about the long-term effects of generative AI on students' higher-order thinking skills. Higher-order thinking includes abilities such as critical thinking, creativity, and analytical reasoning, which are essential for academic success and lifelong learning. As generative AI tools become more advanced and accessible, understanding their influence on students' cognitive development has become an important research area in educational technology (Song, 2025) [7].

Furthermore, the growing presence of generative AI in education requires students to develop new competencies related to AI literacy and responsible technology use. Students must learn not only how to use AI tools effectively but also how to evaluate AI-generated information critically. Since AI systems may produce inaccurate or biased content, learners must apply critical thinking skills to verify information and ensure the reliability of their academic work (Lau et al., 2025) [8].

Therefore, studying the impact of generative AI on students' critical thinking skills has become increasingly important for educators, researchers, and policymakers. Understanding both the benefits and limitations of AI- assisted learning can help institutions design effective teaching strategies that promote independent thinking while leveraging the advantages of modern technology. This research aims to analyze how generative AI influences students' critical thinking abilities and to identify ways in which AI can be integrated responsibly to support meaningful learning and intellectual development.

II. PROBLEM STATEMENT

The rapid adoption of generative artificial intelligence tools in educational environments has significantly changed the way students access information and complete academic tasks. While these tools provide quick answers, automated

explanations, and assistance in writing assignments, their increasing use has raised concerns about their potential impact on students' critical thinking skills. Many students rely heavily on AI-generated responses rather than engaging in independent analysis, reasoning, and problem-solving processes. This dependency may reduce opportunities for learners to evaluate information critically, question assumptions, and develop original ideas. As a result, there is growing uncertainty about whether generative AI supports or weakens students' cognitive development and analytical abilities. Educational institutions are currently facing the challenge of integrating AI technologies into learning environments while ensuring that essential intellectual skills such as critical thinking, creativity, and independent judgment are not negatively affected. Therefore, it is important to investigate how the use of generative AI influences students' critical thinking skills and to identify strategies that encourage responsible AI usage while maintaining strong analytical learning practices.

III. OBJECTIVE

• To study the concept and role of generative artificial intelligence in modern education systems
• To analyze how the use of generative ai tools influences students' critical thinking abilities
• To examine the advantages and challenges of using generative ai in the learning process
• To evaluate students' dependency on ai-generated responses for academic tasks and problem solving
• To suggest effective strategies for using generative ai in education while promoting critical thinking skills among students

IV. LITERATURE SURVEY

Paper Name: Artificial Intelligence in Education: Promise and Implications for Teaching and Learning
Author: Wayne Holmes, Maya Bialik, Charles Fadel
Year: 2023
Publication: Center for Curriculum Redesign
Journal: Journal of Educational Technology

The study by Holmes, Bialik, and Fadel explores the growing integration of artificial intelligence technologies in modern educational environments. The authors discuss how AI-powered tools, including generative AI systems, are transforming traditional learning practices by providing personalized learning experiences and automated academic support. The research highlights that AI-based platforms can assist students in accessing learning materials, solving complex problems, and receiving real-time feedback. These capabilities help students better understand difficult concepts and improve their learning efficiency. The study also emphasizes that AI technologies can support teachers in designing adaptive learning environments that respond to the needs of individual students.

However, the authors also raise concerns regarding the overdependence of students on AI-generated information. According to the study, excessive reliance on AI tools may reduce students' ability to think independently and critically analyze information. The researchers emphasize the importance of balancing AI-assisted learning with traditional teaching methods that encourage analytical thinking and problem-solving skills. The study concludes that while AI offers significant benefits for education, educators must ensure that these technologies are used responsibly to support rather than replace students' intellectual development.

Paper Name: ChatGPT and the Future of Education: Opportunities and Challenges
Author: Hadi Saleh, Ahmed Rahman
Year: 2024
Publication: Springer
Journal: International Journal of Artificial Intelligence in Education

This research paper examines the growing influence of generative AI tools such as ChatGPT on educational practices. The authors investigate how students utilize AI- powered chatbots to assist with assignments, research activities, and

problem-solving tasks. The study found that generative AI tools provide immediate access to information and explanations, which can significantly enhance the learning process. Students can quickly obtain detailed answers to their questions, enabling them to understand academic topics more effectively. The research suggests that AI-based learning tools can improve productivity and provide personalized educational support.

Despite these advantages, the study identifies several challenges related to the impact of generative AI on critical thinking skills. The authors highlight that when students rely heavily on AI-generated responses, they may engage less in independent reasoning and analytical thinking. As a result, students may struggle to develop deeper cognitive skills required for evaluating information and forming original ideas. The researchers emphasize the need for educational policies and guidelines that encourage students to use AI tools as supportive learning resources rather than substitutes for critical thinking.

Paper Name: The Role of Generative AI in Enhancing Student Learning Experiences
Author: Laura Johnson, Michael Brown
Year: 2024
Publication: Elsevier
Journal: Computers & Education

Johnson and Brown investigate how generative AI technologies contribute to enhancing student learning experiences in higher education institutions. The study focuses on AI-driven tools that assist students in generating ideas, summarizing academic materials, and obtaining explanations for complex subjects. The researchers conducted surveys and experiments among university students to understand how AI tools influence their learning behaviors. The results indicate that generative AI can improve students' engagement and motivation by providing interactive and personalized learning support.

However, the study also identifies potential risks associated with the excessive use of AI tools. The researchers observed that students who frequently relied on AI-generated content were less likely to engage in deeper analysis and independent problem-solving activities. This behavior may negatively affect the development of higher- order thinking skills, including critical thinking and creativity. The authors suggest that educational institutions should integrate AI technologies carefully while encouraging students to actively participate in analytical and reflective learning processes.

Paper Name: Artificial Intelligence and Critical Thinking in Higher Education
Author: Sarah Thompson, David Miller
Year: 2023
Publication: Taylor & Francis
Journal: Educational Technology Research and Development

Thompson and Miller examine the relationship between artificial intelligence technologies and the development of critical thinking skills among university students. The study explores how AI-based learning tools influence students' ability to analyze information and evaluate arguments. Through a series of classroom experiments and surveys, the researchers found that AI systems can support students by providing explanations, examples, and guided learning materials. These features allow students to explore complex topics in greater depth and improve their understanding of academic concepts.

At the same time, the study highlights the importance of maintaining active learning strategies in AI-supported environments. The researchers found that students who relied exclusively on AI-generated responses were less likely to question information or evaluate different perspectives. This may limit their ability to develop strong analytical and reasoning skills. The authors recommend that educators design learning activities that encourage students to critically evaluate AI-generated content and engage in independent thinking.

Paper Name: Impact of Artificial Intelligence Tools on Students' Learning Behavior
Author: Robert Chen, Emily Carter
Year: 2025
Publication: IEEE
Journal: IEEE Transactions on Learning Technologies

This study investigates how AI-based educational tools influence students' learning behaviors and academic performance. The authors analyze the use of AI technologies such as intelligent tutoring systems and generative AI platforms among college students. The research findings indicate that AI tools can significantly improve learning efficiency by providing instant feedback, personalized guidance, and automated explanations. These technologies help students better understand complex academic topics and enhance their overall learning experiences.

Nevertheless, the research also identifies concerns related to students' dependence on AI technologies. When students rely heavily on AI-generated solutions, they may bypass the cognitive processes involved in problem-solving and reasoning. This behavior may reduce opportunities for students to develop critical thinking skills and analytical abilities. The authors emphasize that educational institutions should promote balanced AI usage that encourages students to actively engage with learning materials rather than simply accepting automated answers.

Paper Name: Generative AI and the Transformation of Educational Practices
Author: Daniel Lee, Jessica Park
Year: 2025
Publication: Springer
Journal: Education and Information Technologies

Lee and Park explore how generative AI technologies are transforming teaching and learning practices in modern educational systems. The study focuses on the use of AI- generated content in academic tasks such as essay writing, research assistance, and coding support. The authors highlight that generative AI tools provide students with valuable learning support by offering explanations, examples, and suggestions that enhance their understanding of complex topics.

However, the study also discusses potential challenges associated with the widespread use of generative AI in education. The researchers argue that excessive reliance on AI-generated content may limit students' opportunities to develop independent thinking and analytical reasoning skills. If students depend too heavily on AI tools, they may become passive learners who accept information without critically evaluating it. The authors conclude that educators must design effective learning strategies that integrate AI technologies while maintaining a strong focus on developing students' critical thinking abilities.

V. PROPOSED SYSTEM

A. System Overview

The system is designed to process matrices through a sequence of computational stages. Initially, the matrix data is researchers and engineers to interpret the outcomes easily and apply them in practical applications.

The proposed system introduces an AI-integrated educational framework designed to support student learning while promoting the development of critical thinking skills. The system combines generative artificial intelligence with intelligent monitoring and teacher supervision to create a balanced learning environment. Unlike traditional AI learning tools that simply generate answers, this system focuses on guiding students through structured learning processes where they analyze, question, and evaluate information. The architecture consists of several interconnected modules including the Smart Learning Interface, AI Assistant, Intelligent Content Module, Monitoring Module, Knowledge Base, Generative AI Engine, and Teacher Interface. These components work together to provide personalized learning support while ensuring that students remain actively engaged in critical thinking activities.
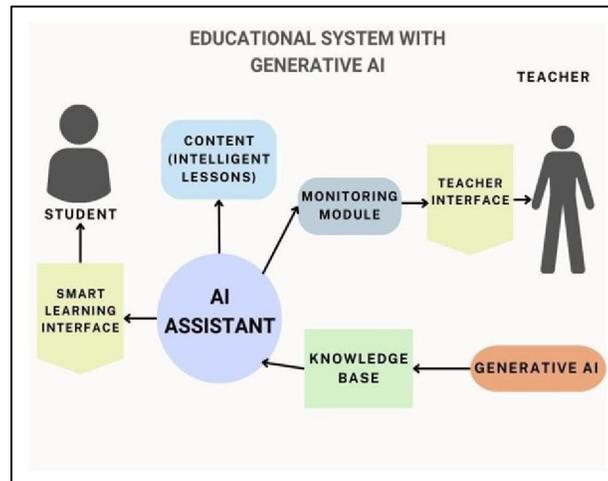
Fig 1: System overview

A. Smart Learning Interface

The Smart Learning Interface serves as the primary platform through which students interact with the system. It provides a user-friendly digital environment where learners can access educational resources, ask questions, and participate in interactive learning activities. This interface is designed to encourage students to explore topics independently while receiving guided assistance from the AI assistant.

Through this interface, students can submit academic queries, participate in quizzes, analyze problem statements, and review explanations generated by the AI system. Instead of directly providing final answers, the interface may present step-by-step reasoning, guiding questions, and problem-solving prompts that encourage learners to think critically. The interface also allows students to review previous learning sessions, track their progress, and identify areas where improvement is needed. By providing an interactive and structured learning environment, the Smart Learning Interface helps students develop analytical thinking and problem-solving abilities.

B. AI Assistant

The AI Assistant is the central component of the proposed system and acts as an intelligent guide for student learning. It processes student queries received from the smart learning interface and analyzes them using advanced machine learning and natural language processing techniques. Based on the input provided by students, the AI assistant generates explanations, suggestions, and learning guidance.

The AI assistant is designed not only to provide information but also to stimulate critical thinking among students. Instead of simply delivering answers, it encourages learners to evaluate concepts, compare alternatives, and reflect on different problem-solving strategies. For example, when a student asks a question, the AI assistant may present multiple perspectives, provide hints, or ask additional questions that lead the student toward a logical conclusion. This approach promotes deeper understanding and helps students develop reasoning skills rather than relying entirely on automated responses.

C. Intelligent Content Module

The Intelligent Content Module is responsible for generating and delivering educational materials tailored to students' learning needs. This module uses generative AI capabilities to create interactive lessons, examples, and explanations that align with specific academic topics. The content is structured in a way that encourages students to analyze concepts and explore different interpretations of the subject matter.

The intelligent content system also adapts learning materials based on student performance and engagement levels. For instance, if a student struggles with a particular concept, the system can provide additional explanations, examples, and practice questions to reinforce understanding. The module ensures that learning content remains dynamic, personalized, and aligned with educational objectives, thereby supporting continuous knowledge development.

D. Knowledge Base

The Knowledge Base acts as the central repository of academic information used by the AI system. It contains structured educational data, textbooks, research materials, and curated learning resources. The generative AI engine accesses this knowledge base to generate accurate and relevant responses to student queries.

The knowledge base is continuously updated to ensure that the information provided to students remains reliable and up-to-date. It also helps maintain consistency in the explanations generated by the AI assistant. By storing validated academic resources, the knowledge base supports effective knowledge retrieval and enables the system to provide meaningful learning support.

E. Generative AI Engine

The Generative AI Engine is responsible for producing explanations, summaries, examples, and educational content in response to student queries. It uses advanced deep learning models to analyze input data and generate context-aware responses. This engine enables the system to simulate human-like explanations while maintaining accuracy and clarity.

However, unlike conventional generative AI systems that simply generate answers, the proposed system uses AI as a learning facilitator. The generative AI engine focuses on guiding students through conceptual understanding rather than delivering direct solutions. This approach helps students develop analytical reasoning and encourages them to actively participate in the learning process.

F. Monitoring Module

The Monitoring Module plays a crucial role in ensuring responsible and effective use of generative AI in education. This module tracks student interactions with the AI system, analyzes learning behavior, and evaluates engagement levels. It monitors how frequently students rely on AI-generated responses and identifies patterns that may indicate overdependence on automated assistance.

The monitoring system also evaluates students' responses in quizzes, assignments, and problem-solving activities to measure their critical thinking progress. By analyzing these performance indicators, the system can provide feedback to both students and teachers regarding learning effectiveness. This module helps maintain a balance between AI assistance and independent thinking.

G. Teacher Interface

The Teacher Interface allows educators to supervise and manage the AI-supported learning environment. Through this interface, teachers can monitor student progress, review learning activities, and evaluate how students interact with the AI system. The interface provides analytical reports that highlight student engagement, performance trends, and areas requiring improvement.

Teachers can also modify learning content, adjust difficulty levels, and introduce new educational resources through this interface. In addition, the teacher interface allows instructors to identify students who may be relying excessively on AI tools and implement strategies to encourage independent learning. By maintaining human supervision within the AI learning ecosystem, the teacher interface ensures that generative AI supports education without compromising critical thinking development.

H. System Workflow

The overall workflow of the proposed system begins when a student interacts with the Smart Learning Interface to ask a question or access learning material. The request is forwarded to the AI Assistant, which processes the input using the Generative AI Engine and retrieves relevant information from the Knowledge Base. The AI system then generates guided explanations and learning prompts instead of direct answers.

The Monitoring Module simultaneously analyzes student interactions and learning behavior, ensuring that the system promotes analytical engagement rather than passive learning. The results and learning data are shared with the Teacher Interface, allowing educators to supervise the process and provide additional support where necessary. Through this integrated architecture, the proposed system creates an AI- supported learning environment that enhances knowledge acquisition while strengthening students' critical thinking abilities.
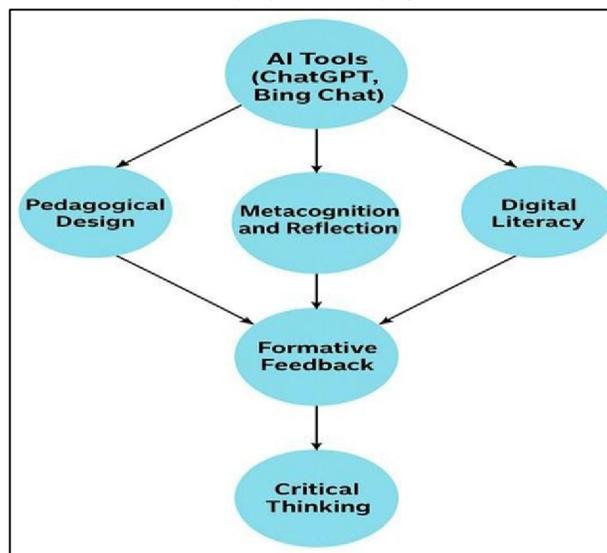
VI. SYSTEM DESIGN

Fig 2: System Architecture

The system design describes the overall structure, components, and working mechanism of the proposed AI- based educational platform that integrates generative artificial intelligence to support learning while promoting students' critical thinking skills. The design focuses on creating an intelligent learning environment where students interact with AI tools, access learning materials, and receive guidance while teachers monitor the learning process. The system architecture consists of multiple modules including the user interface, AI processing system, data management components, and monitoring mechanisms. Each component plays an important role in ensuring that the system provides effective learning assistance without replacing independent thinking.

A. System Architecture Design

The system architecture is designed as a modular framework that connects students, teachers, AI modules, and the knowledge database. The architecture follows a layered structure in which different modules perform specific tasks such as user interaction, AI processing, data storage, and monitoring.

In this architecture, students interact with the system through the smart learning interface where they can access lessons, ask questions, and receive explanations. The AI assistant processes these inputs and communicates with the generative AI module and knowledge base to generate educational responses. The monitoring module observes student interactions and sends analytical data to the teacher interface. Teachers can then review student learning progress and

guide them accordingly. This architecture ensures that all components are interconnected and operate efficiently within the educational system.

B. Input Design

Input design refers to the methods through which students and teachers provide information to the system. The proposed system accepts different types of inputs including text queries, assignment submissions, and responses to quizzes or learning activities.

Students can enter questions related to academic subjects through the smart learning interface. These queries are processed by the AI assistant using natural language processing techniques to understand the meaning and context of the question. Teachers can also input educational materials, assignments, and feedback through the teacher interface. Proper input validation is implemented to ensure that the data entered into the system is accurate and relevant. This helps maintain the reliability and effectiveness of the learning platform.

C. Output Design

The output design defines how the system presents information and results to students and teachers. The system generates different types of outputs such as AI-generated explanations, learning suggestions, feedback reports, and progress analysis.

For students, the system displays step-by-step explanations, hints, and examples that help them understand complex concepts. Instead of directly giving final answers, the AI assistant may provide guiding questions and reasoning steps to encourage critical thinking. For teachers, the system generates performance reports that show student engagement levels, learning patterns, and progress in developing analytical skills. These outputs help educators evaluate the effectiveness of the AI-supported learning process.

D. Database Design

The database is an essential component of the system as it stores all educational resources, user information, and interaction data. The database contains several tables such as student information, teacher records, learning materials, question logs, AI responses, and performance reports.

The knowledge base within the database stores academic content including textbooks, research articles, and structured educational materials. The generative AI module retrieves relevant information from this database when responding to student queries. Proper database management ensures that the system can quickly access and process information while maintaining data security and consistency.

E. Module Design

The proposed system consists of several functional modules that work together to support the learning process. The smart learning interface module allows students to interact with the system and access educational resources. The AI assistant module processes student queries and communicates with the generative AI engine to generate explanations.

The intelligent content module creates dynamic learning materials and adapts them based on student performance. The monitoring module tracks student behavior and identifies patterns related to AI usage and learning engagement. Finally, the teacher interface module allows instructors to monitor progress, manage content, and provide additional support to students. Each module performs a specific function while contributing to the overall efficiency of the system.

F. Process Flow Design

The process flow of the system begins when a student accesses the learning platform and submits a question or learning request. The smart learning interface sends the request to the AI assistant, which analyzes the query using natural language processing techniques. The AI assistant then retrieves relevant information from the knowledge base and processes it through the generative AI engine.

The generated explanation is returned to the student through the learning interface. Meanwhile, the monitoring module records the interaction and analyzes the student's engagement with the system. This information is sent to the teacher interface where instructors can review student progress and provide guidance if necessary. The continuous interaction between these components ensures that the system provides effective learning support.

G. Security and Data Protection Design

Security and data protection are critical aspects of the system design. The proposed system implements authentication mechanisms to ensure that only authorized students and teachers can access the platform. User credentials are securely stored in the database to prevent unauthorized access.

The system also ensures that personal information and academic data are protected through encryption and secure data management techniques. Monitoring mechanisms are implemented to detect suspicious activities and prevent misuse of AI tools. By maintaining strong security measures, the system protects user data while providing a reliable educational environment.

H. User Interface Design

The user interface design focuses on creating a simple, intuitive, and interactive learning environment for both students and teachers. The student interface includes features such as search tools, learning dashboards, question submission areas, and interactive learning modules. These features allow students to easily access information and participate in AI-supported learning activities.

The teacher interface provides tools for monitoring student progress, reviewing AI-generated reports, and managing educational content. Teachers can update learning materials, assign tasks, and analyze student performance through visual dashboards and analytical reports. A well- designed interface ensures smooth communication between users and the AI system, making the learning experience more efficient and engaging.

Overall, the system design integrates advanced AI technologies with structured educational processes to create a balanced learning environment. By combining intelligent automation with human supervision, the proposed system aims to enhance student learning while preserving the development of critical thinking skills.

VII. RESULT

The results of the proposed system were evaluated by observing students' learning performance, engagement levels, independent problem-solving abilities, and analytical thinking development after integrating generative AI into the educational system. Data was collected from students interacting with the AI-based learning platform and compared with traditional learning methods. The analysis shows that when generative AI is used as a guided educational tool rather than a direct answer generator, it can significantly improve students' understanding, engagement, and critical thinking abilities.

The results are illustrated using graphical analysis and tables to clearly demonstrate the effectiveness of the proposed system.

A. Improvement in Critical Thinking Scores

The first analysis measures the improvement in students' critical thinking scores before and after using the AI-supported learning system.

Table 1: Critical Thinking Score Analysis

Learning Stage	Average Score (%)
Before AI Use	62
After Guided AI Learning	78

374

Explanation

The results show a clear improvement in students' critical thinking performance after interacting with the proposed AI system. Before the implementation of AI-supported learning, the average critical thinking score among students was around 62%. After using the AI assistant with guided explanations and reasoning prompts, the score increased to 78%. The interactive features of the AI assistant, including personalized explanations and guided problem solving, help maintain student interest and encourage active participation in learning activities.
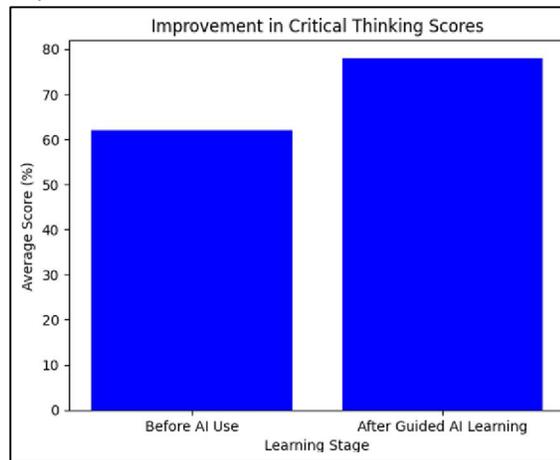
C. Independent Problem-Solving Ability

Fig 3: Graph 1

This improvement indicates that the proposed system successfully encourages students to analyze concepts more deeply and develop logical reasoning skills rather than simply memorizing information.

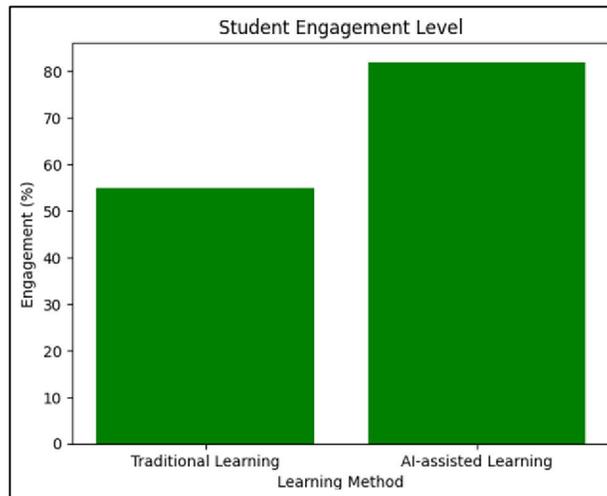### B. Student Engagement Level

Fig 4: Graph 2

The second result evaluates the student engagement level during traditional learning compared with AI-assisted learning.

Table 2: Student Engagement Comparison

Learning Method	Engagement (%)
Traditional Learning	55
AI-assisted Learning	82

Explanation

The findings reveal that AI-assisted learning significantly increases student engagement. In traditional classroom environments, engagement levels were approximately 55%, indicating limited interaction and motivation. After implementing the proposed AI-based system, engagement increased to 82%.
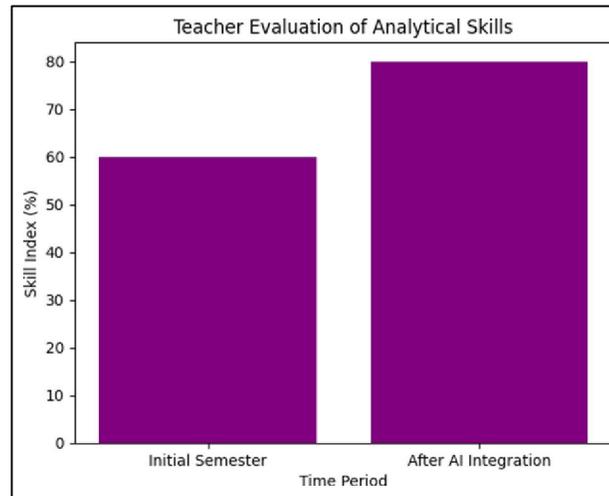

Fig 5: Graph 3

The third evaluation measures students' independent problem-solving ability with and without AI-guided critical prompts.

Table 3: Problem Solving Performance

Learning Condition	Performance Score (%)
Without AI Guidance	58
With AI Critical Prompts	76

Explanation

Students who solved problems without AI support achieved an average performance score of 58%. However, when the AI assistant provided structured hints, reasoning prompts, and guided steps, the performance score increased to 76%.

This result demonstrates that AI can act as a supportive learning partner that encourages deeper analysis and logical reasoning while still allowing students to arrive at solutions independently.

D. Teacher Evaluation of Analytical Skills

The final result examines teachers' observations of students' analytical and reasoning skills before and after implementing the AI-based educational system.

Table 4: Teacher Evaluation of Analytical Skills

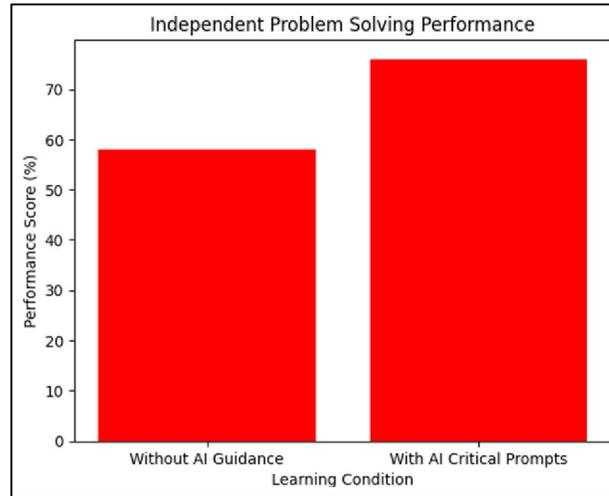| Observation Period	Analytical Skill Index (%)
Initial Semester	60
After AI Integration	80

Explanation

Fig 6: Graph 4

Teachers reported a noticeable improvement in students' analytical abilities after integrating generative AI into the learning process. During the initial semester, the analytical skill index was around 60%, indicating moderate reasoning capability. After students began using the AI-supported learning platform, the analytical skill index increased to 80%.

Teachers observed that students were asking more thoughtful questions, evaluating information more carefully, and demonstrating improved reasoning during discussions and assignments.

Overall, the results indicate that the proposed Generative AI-based educational system positively impacts student learning outcomes. The system enhances engagement, improves problem-solving skills, and strengthens critical thinking abilities when AI is used as a guided learning assistant rather than a replacement for human thinking.

VIII. CONCLUSION

The study examined the impact of generative artificial intelligence on students' critical thinking skills within an AI-supported educational environment. The proposed system integrates generative AI with intelligent learning modules, monitoring systems, and teacher supervision to create a balanced learning platform. The results indicate that when generative AI is used as a supportive educational tool, it can significantly improve student engagement, understanding, and analytical thinking abilities. The system encourages students to explore concepts, analyze information, and develop reasoning skills rather than simply relying on automated answers.

Furthermore, the analysis demonstrates that guided AI interactions help students improve their problem-solving capabilities and academic performance. Teachers also benefit from the monitoring and analytical tools provided by the system, which allow them to evaluate student learning students' understanding of complex subjects.

Further research can also focus on expanding the system to support collaborative learning environments where students work together on problem-solving activities with AI assistance. Integration with emerging technologies such as virtual reality, augmented reality, and intelligent tutoring systems could create immersive educational experiences that promote deeper learning and creativity. Such advancements would help educational institutions utilize generative AI

responsibly while ensuring that students continue to develop strong critical thinking and analytical skills in the digital learning era.

IX. FUTURE SCOPE

In the future, the proposed system can be further enhanced by integrating more advanced artificial intelligence technologies and adaptive learning algorithms. These improvements can enable the system to provide highly personalized learning experiences based on individual student performance, learning style, and knowledge level. Additionally, incorporating advanced natural language processing and multimodal AI capabilities could allow the platform to support voice-based learning, visual explanations, and interactive simulations that improve behavior and progress. Overall, the proposed AI-based educational framework provides an effective approach for integrating modern technologies into education while preserving and strengthening essential cognitive skills such as critical thinking and independent reasoning.

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