International Journal of Computer Science and Engineering Development
Volume 1, Issue 5 | November - December 2026 | www.ijcsed.com
ISSN: **3139-0862**

Impact of Artificial Intelligence on Teaching–Learning Processes among Secondary School Students: Opportunities and Challenges

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Abstract
Artificial Intelligence (AI) is increasingly transforming the field of education by introducing new approaches to teaching, learning, assessment, and academic support. The integration of AI-based technologies, such as ChatGPT, intelligent tutoring systems, adaptive learning platforms, and automated assessment tools, has created new opportunities for improving educational experiences among secondary school students. These technologies can support personalized learning, provide immediate feedback, enhance student engagement, and help teachers identify individual learning needs. However, the use of AI in education also raises several concerns, including excessive dependence on technology, academic dishonesty, inaccurate information, data privacy, digital inequality, and reduced independent thinking.
The present study aims to examine the impact of Artificial Intelligence on teaching–learning processes among secondary school students, with particular emphasis on its educational opportunities and associated challenges. It focuses on the potential contribution of AI to students' academic performance, learning motivation, critical thinking, problem-solving abilities, and classroom participation. The study also considers the role of teachers in promoting responsible and effective use of AI-based educational tools. A review-based research approach is proposed, drawing upon relevant academic literature, research articles, and reports published on Artificial Intelligence in education. The findings from the reviewed literature suggest that AI can serve as a valuable supplementary educational resource when appropriately integrated into teaching and learning activities. Nevertheless, its effectiveness depends on proper guidance, digital literacy, ethical awareness, teacher involvement, and equitable access to technology. The study concludes that Artificial Intelligence should complement, rather than replace, teachers and conventional educational practices. Responsible integration of AI may contribute to a more interactive, inclusive, and student-centred learning environment in secondary education.

Keywords: Artificial Intelligence, Secondary School Students, Teaching–Learning Process, ChatGPT, Educational Technology, Personalized Learning, Academic Performance, Digital Literacy.

1. Introduction
Artificial Intelligence (AI) has emerged as one of the most influential technological developments of the twenty-first century. It is increasingly being used in different fields, including healthcare, business, communication, science, and education. In the educational sector, AI is creating new opportunities to improve teaching methods, support student learning, provide academic assistance, and enhance educational management. The integration of AI-based technologies has gradually changed the traditional teaching–learning process by introducing more interactive, flexible, and technology-supported learning environments (Chen et al., 2020; Chiu et al., 2023). According to Martin et al. (2024), artificial intelligence is increasingly being applied in school education through intelligent tutoring systems, educational chatbots, learning applications, and other technology-based tools.

ISSN: **3139-0862**

The development of generative artificial intelligence has further expanded the possibilities of using AI in education. Tools such as ChatGPT and other AI-powered applications can generate explanations, answer questions, summarize information, provide writing assistance, and support students in understanding difficult concepts (Kasneci et al., 2023; Tlili et al., 2023). These technologies can be particularly useful for secondary school students because this educational stage involves the development of critical thinking, problem-solving, independent learning, and subject-related knowledge. Students can use AI-based tools to obtain additional explanations, practise academic tasks, improve language skills, and receive immediate responses to their questions. Albadarin et al. (2024) reported that students have used ChatGPT for personalized learning, understanding academic concepts, completing learning activities, and improving writing skills.

One of the major advantages of Artificial Intelligence in education is its potential to promote personalized learning. Students differ in their learning abilities, interests, academic backgrounds, and levels of understanding. Traditional classroom teaching may not always provide sufficient individual attention to every student. AI-supported educational systems can help address this limitation by providing customized learning materials, adaptive exercises, and immediate feedback according to students' learning requirements (Wang et al., 2024; Létourneau et al., 2025). Such applications may help students identify their learning difficulties, revise lessons, and progress at their own pace. Almasri (2024), in a systematic review of empirical research on AI in science education, highlighted the potential of AI-powered tools to improve learning environments, support assessment, provide educational resources, and help teachers monitor students' academic progress.

Artificial Intelligence may also support teachers in planning and delivering effective classroom instruction. AI-based applications can assist in preparing lesson materials, developing quizzes, generating examples, assessing certain types of student work, and providing additional learning resources. These functions may reduce some routine academic tasks and allow teachers to devote more time to student interaction, classroom activities, and individual guidance (Tan et al., 2025). Research by Martin et al. (2024) indicates that AI applications in K–12 education have been used for curriculum development, academic performance prediction, learning support, and improvement of educational environments. Therefore, AI can be considered a supportive educational resource for both teachers and students.

Despite these opportunities, the use of Artificial Intelligence in education also presents several challenges. One important concern is the possibility of students becoming overly dependent on AI-generated answers instead of developing their own understanding and problem-solving abilities. Students may also receive inaccurate, incomplete, or misleading information from AI applications. Other concerns include academic dishonesty, plagiarism, data privacy, unequal access to digital technology, and the reliability of AI-generated content (Miao & Holmes, 2023; Kasneci et al., 2023). Albadarin et al. (2024) emphasized that excessive use of ChatGPT may negatively influence certain aspects of learners' innovation and collaborative learning competencies. Similarly, Zhang et al. (2026) identified concerns related to inaccurate information, technological dependence, privacy infringement, and insufficient AI literacy in K–12 education.

The responsible integration of AI in secondary education therefore requires appropriate guidance, digital literacy, ethical awareness, and active teacher involvement (Miao & Holmes, 2023; Bohara & Rana, 2024). Students need to understand that AI-generated information should be critically examined and verified rather than accepted without evaluation. Teachers also have an important responsibility to guide students in using AI tools for educational purposes while maintaining academic honesty, independent thinking, creativity, and meaningful classroom interaction. AI should not be considered a replacement for teachers or traditional educational practices; rather, it should function as a

ISSN: **3139-0862**

supplementary resource that strengthens the overall teaching–learning process.

Although research on Artificial Intelligence in education is expanding, further attention is required to understand its practical implications for secondary school students. Existing research has examined AI applications in different educational settings, including school-level learning, science education, and general academic activities (Crompton et al., 2024; Almasri, 2024; Martin et al., 2024). However, the long-term effects of AI use on students' learning habits, academic performance, critical thinking, motivation, and independent learning require further investigation. Zhang et al. (2026) also highlighted the need for more longitudinal research to understand the long-term implications of generative AI in K–12 education.

In this context, the present review paper, entitled "Impact of Artificial Intelligence on Teaching–Learning Processes among Secondary School Students: Opportunities and Challenges," aims to examine the growing role of AI in secondary education. It focuses on the educational opportunities offered by AI-based tools, their potential contribution to teaching and learning, and the major challenges associated with their use. The paper also highlights the importance of responsible AI integration, teacher guidance, digital literacy, and ethical practices to promote effective and meaningful learning experiences among secondary school students.

2. Objectives of the Study

The present study aims to examine the impact of Artificial Intelligence on teaching–learning processes among secondary school students, with special reference to its educational opportunities and challenges.

Specific Objectives

1. To examine the role of Artificial Intelligence in improving teaching–learning processes among secondary school students.
2. To identify the major AI-based tools and technologies used in secondary education.
3. To analyse the potential benefits of Artificial Intelligence in personalized learning, academic performance, and student engagement.
4. To examine the influence of AI-based educational tools on students' critical thinking, creativity, and problem-solving abilities.
5. To identify the major challenges associated with the use of Artificial Intelligence in secondary education, including academic dishonesty, privacy concerns, and technological dependence.
6. To explore the role of teachers in promoting the responsible and effective use of Artificial Intelligence in the classroom.
7. To suggest strategies for the ethical, inclusive, and effective integration of Artificial Intelligence into secondary education.

3. Literature Review

3.1 Development and Applications of Artificial Intelligence in Education

Artificial Intelligence (AI) has gradually become an important component of modern education. Its development in the educational sector has transformed the ways in which teaching, learning, assessment, and academic support are provided. Initially, AI applications in education were mainly associated with computer-assisted instruction, expert systems, and intelligent tutoring systems. Over time, advancements in machine learning, natural language processing, data analytics, and generative AI have expanded the role of technology in educational environments. Today, AI-based systems can analyse students' learning activities, provide academic assistance, generate educational content, and support teachers in instructional planning. Wang et al. (2024), in their systematic literature review, identified several major applications of AI in education, including adaptive learning, personalized tutoring, intelligent assessment, student profiling, and educational management.

In recent years, AI-based educational tools have become increasingly accessible to teachers and students. These tools include intelligent tutoring systems (ITS), educational chatbots, automated assessment applications, adaptive learning

ISSN: **3139-0862**

platforms, and generative AI tools. Intelligent tutoring systems are designed to provide individualized guidance by analysing students' responses and identifying their learning difficulties. Similarly, educational chatbots can interact with learners, answer academic questions, explain concepts, and provide additional learning support. Kuhail et al. (2023), in their systematic review of educational chatbots, highlighted their potential to support learner engagement, personalize learning activities, and assist educators. These developments indicate that AI is not limited to providing digital information but can also contribute to interactive and responsive educational experiences.

The introduction of generative AI tools, particularly ChatGPT, has further expanded the applications of AI in education. ChatGPT can generate explanations, summarize educational materials, answer questions, assist with writing activities, and provide examples of complex concepts. Such applications may help secondary school students understand difficult topics and obtain additional academic support outside regular classroom hours. Albadarin et al. (2024) reviewed empirical studies on ChatGPT in education and identified its applications in academic writing, personalized learning, student support, and educational activities. However, the authors also highlighted concerns related to the reliability of generated information, academic integrity, and the responsible use of AI.

The application of AI in school education has also received increasing research attention. Martin et al. (2024), in their systematic review of research on AI in K–12 education published between 2017 and 2022, examined 66 studies and identified applications such as intelligent tutoring systems, educational chatbots, educational games, AI robots, and other learning-support technologies. Their review demonstrated that AI has the potential to support both students and teachers in school-level education. More recently, Létourneau et al. (2025) reviewed 28 studies involving 4,597 students to examine the effectiveness of AI-driven intelligent tutoring systems in K–12 education. Their findings indicated generally positive effects on students' learning and academic performance, although the effectiveness varied according to the comparison conditions and study designs.

Therefore, the development of Artificial Intelligence has introduced new possibilities for improving the teaching–learning process in secondary education. AI-based applications can provide additional learning resources, facilitate communication between students and educational systems, support assessment, and assist teachers in classroom activities. Nevertheless, their educational value depends on appropriate implementation, teacher supervision, and the ability of students to use these technologies critically and responsibly.

3.2 Artificial Intelligence and Personalized Learning

Personalized learning refers to an educational approach in which teaching methods, learning materials, activities, and support are adjusted according to students' individual needs, abilities, interests, and learning progress. In a traditional classroom, students may differ considerably in their academic backgrounds, learning speeds, levels of understanding, and educational requirements. As a result, a single teaching approach may not always address the needs of every learner. Artificial Intelligence offers opportunities to reduce this gap by analysing students' learning patterns and providing learning experiences that are more closely aligned with their individual requirements. Wang et al. (2024) identified adaptive learning and personalized tutoring as important areas of AI application in education.

One of the major contributions of AI to personalized learning is its ability to support individual learning needs and abilities. AI-based educational platforms can analyse students' responses, identify areas of difficulty, and recommend appropriate learning activities. For example, a student who experiences difficulty in mathematics may receive additional practice questions, simplified explanations, and step-by-step guidance. Similarly, students who demonstrate better understanding may be provided with more advanced learning activities. Such approaches can help teachers recognize differences in students' learning progress and provide more

ISSN: **3139-0862**

appropriate academic support. Létourneau et al. (2025) found that intelligent tutoring systems in K–12 education can provide individualized instructional support and contribute positively to students' learning outcomes.

AI-supported adaptive learning systems also promote self-paced learning. These systems can adjust the difficulty level, sequence, and presentation of learning materials according to students' performance and progress. Students may revisit difficult topics, practise specific skills, and move to more advanced content when they demonstrate sufficient understanding. This flexibility can be particularly useful for secondary school students who have different levels of preparation and learning requirements. Martin et al. (2024) identified adaptive learning technologies and intelligent tutoring systems among the important applications of AI in K–12 education. Similarly, Létourneau et al. (2025) reported that AI-driven tutoring systems can provide structured guidance and individualized feedback to school students, although further research is required to establish their long-term effectiveness.

Another important feature of personalized learning is the provision of customized educational content and immediate feedback. AI-powered applications can generate explanations, examples, practice exercises, summaries, and learning suggestions according to students' questions and academic requirements. For instance, ChatGPT can explain a difficult scientific concept in simpler language, provide additional examples, and help students revise classroom lessons. Educational chatbots can also respond to students' questions and support learning beyond regular classroom hours. Kuhail et al. (2023) observed that educational chatbots have the potential to support personalized learning interactions and provide academic assistance to learners. Furthermore, Albadarin et al. (2024) identified personalized learning and immediate academic support among the important applications reported in empirical studies of ChatGPT in education.

The potential benefits of AI-supported personalized learning should, however, be considered alongside certain limitations. AI-generated explanations and recommendations may not always be accurate or appropriate for a student's actual learning needs. Excessive reliance on automated assistance may also reduce opportunities for independent thinking if students simply accept generated answers without understanding them. Therefore, teachers should guide students in evaluating AI-generated information, selecting suitable learning resources, and developing independent learning skills. Personalized learning through AI should be viewed as a supportive approach that complements classroom instruction rather than replacing the educational role of teachers.

Overall, Artificial Intelligence has the potential to make learning more flexible, responsive, and learner-centred. By supporting individual learning needs, adaptive instruction, self-paced study, and customized feedback, AI-based technologies may contribute to improved learning experiences among secondary school students. However, their effectiveness depends on responsible use, appropriate teacher involvement, reliable educational content, and equal access to digital resources.

3.3 Impact of AI on Students' Academic Performance

Academic performance is an important indicator of students' learning progress and educational achievement. It generally includes subject knowledge, examination results, understanding of concepts, assignment performance, and the ability to apply acquired knowledge in different situations. The increasing use of Artificial Intelligence in education has created new possibilities for supporting students' academic development. AI-based educational tools can provide explanations, practice exercises, immediate feedback, and additional learning resources, which may help students improve their understanding of academic subjects. Deng et al. (2025), in a systematic review and meta-analysis of experimental studies, reported a positive overall effect of ChatGPT interventions on students' academic performance. However, most of the studies included in their review were

ISSN: **3139-0862**

conducted at the university level, indicating the need for further research specifically involving secondary school students.

AI-supported educational systems can also contribute to improved learning outcomes by providing students with additional opportunities to practise and understand academic concepts. Intelligent tutoring systems and adaptive learning platforms can identify students' learning difficulties and offer appropriate exercises and explanations. Wang et al. (2024), in their meta-analysis of 45 independent studies, found that AI-enabled adaptive learning systems had a medium-to-large positive effect on students' cognitive learning outcomes, with an overall effect size of g = 0.70. Similarly, Létourneau et al. (2025), in a systematic review of 28 studies involving 4,597 K–12 students, found generally positive effects of AI-driven intelligent tutoring systems on students' learning and academic performance. Nevertheless, the authors noted that the benefits were reduced when these systems were compared with other non-intelligent tutoring approaches. These findings suggest that AI can support academic achievement, although its effectiveness may depend on the quality of instructional design and the learning environment.

Another important contribution of AI is its potential to improve students' subject knowledge and conceptual understanding. Students sometimes experience difficulties in understanding complex topics, particularly in subjects such as mathematics, science, and language. AI-based applications can provide simplified explanations, relevant examples, step-by-step solutions, and additional practice materials according to students' academic requirements. For instance, students can use ChatGPT to understand scientific concepts, clarify mathematical procedures, summarize lessons, and explore different approaches to solving academic problems. Martin et al. (2024), in their review of AI research in K–12 education, identified intelligent tutoring systems, educational chatbots, and adaptive learning technologies as important applications for supporting school-level learning. Such tools may provide additional academic assistance and strengthen students' understanding of subject-related concepts. However, the accuracy and educational suitability of AI-generated explanations must be carefully examined.

Artificial Intelligence has also influenced the way students complete homework, assignments, and other academic activities. AI-based tools can assist students in identifying relevant information, organizing ideas, preparing outlines, correcting grammatical errors, and understanding difficult questions. These applications may help students complete academic tasks more efficiently and develop better approaches to independent study. Albadarin et al. (2024), in their systematic review of empirical research on ChatGPT in education, identified academic writing, personalized assistance, and learning support among its major educational applications. Similarly, Kasneci et al. (2023) discussed the potential of large language models to support students through explanations, feedback, and individualized academic assistance.

Despite these benefits, the use of AI for homework and assignments also raises important educational concerns. Students may become dependent on AI-generated answers and submit work without developing their own understanding. Copying AI-generated content without proper evaluation may reduce opportunities for independent learning, originality, and academic skill development. Therefore, teachers should encourage students to use AI as a learning assistant rather than as a substitute for their own academic efforts. Assignments should also include activities that require explanation, critical analysis, personal understanding, and practical application of knowledge. Overall, Artificial Intelligence can contribute positively to students' academic performance when it is used appropriately, supported by teacher guidance, and integrated with meaningful learning activities.

3.4 AI and Students' Cognitive and Learning Skills

Cognitive and learning skills are essential components of students' intellectual development and educational progress. These skills include critical thinking, problem-solving, creativity,

ISSN: **3139-0862**

independent learning, decision-making, and analytical reasoning. Secondary school education is an important stage for developing these abilities because students gradually move from basic knowledge acquisition towards higher levels of understanding, reasoning, and application. Artificial Intelligence provides new opportunities to support these cognitive processes through interactive learning activities, explanations, questioning, and problem-solving assistance. However, its influence depends largely on how students use AI-based technologies and how teachers integrate them into educational activities.

One important area of cognitive development is critical thinking. Critical thinking involves examining information, identifying assumptions, evaluating evidence, comparing different viewpoints, and reaching logical conclusions. AI-based tools can support these abilities by providing alternative explanations, presenting different perspectives, and generating questions that encourage further investigation. Students can use AI applications to compare arguments, identify errors, and explore possible solutions to academic problems. Deng et al. (2025), in their meta-analysis of experimental studies, reported a positive effect of ChatGPT interventions on higher-order thinking propensities. Similarly, Zhao et al. (2025), in a meta-analysis of 29 experimental and quasi-experimental studies, found a moderate positive effect of generative AI on students' higher-order thinking skills, particularly problem-solving and critical thinking. However, these findings should be interpreted carefully because the studies covered different educational settings and do not establish the same level of effectiveness specifically among secondary school students.

Artificial Intelligence may also support the development of problem-solving abilities by providing students with step-by-step explanations, examples, hints, and alternative approaches to solving questions. In subjects such as mathematics and science, students can use AI tools to understand problem-solving procedures, examine possible solutions, and identify errors in their reasoning. Intelligent tutoring systems can provide guidance according to students' responses and learning difficulties. Zhao et al. (2025) reported that problem-solving showed the strongest improvement among the higher-order thinking dimensions examined in their meta-analysis. These findings indicate that generative AI may serve as a useful supplementary resource for developing problem-solving abilities when students actively participate in the learning process rather than simply accepting ready-made answers.

Creativity and independent learning are also important dimensions of students' cognitive development. Creativity involves generating new ideas, exploring alternative possibilities, and developing original solutions, whereas independent learning refers to students' ability to take responsibility for their own learning activities. AI applications can assist students in brainstorming ideas, preparing project outlines, exploring different topics, and developing creative approaches to academic assignments. They can also support self-directed learning by providing explanations and learning resources beyond regular classroom instruction. Zhao et al. (2025) found that generative AI had a positive but comparatively smaller effect on creativity than on problem-solving and critical thinking. This suggests that the educational benefits of AI may vary across different cognitive abilities. Students should therefore be encouraged to develop their own ideas and use AI-generated suggestions as starting points for further exploration rather than as final answers.

Decision-making and analytical abilities are additional skills that may be supported through the appropriate use of Artificial Intelligence. Decision-making involves selecting suitable alternatives after considering available information, while analytical ability refers to examining information, identifying relationships, and understanding complex situations. AI-based applications can present different explanations, compare possible solutions, and organize information in ways that help students examine academic problems from multiple perspectives. For example, students can use AI tools to compare scientific explanations, analyse historical events, and evaluate different solutions to

ISSN: **3139-0862**

mathematical or practical problems. Such activities may encourage logical reasoning and evidence-based decision-making. However, students must learn to verify AI-generated information and make their own judgments because AI systems may sometimes provide incorrect or misleading responses.

Although AI offers opportunities for cognitive development, excessive dependence on these technologies may create challenges for students' intellectual independence. Lo et al. (2024), in a systematic review of 72 empirical studies on ChatGPT and student engagement, found broad but relatively weak evidence concerning cognitive engagement. Their review also identified concerns related to overreliance on AI and reduced critical thinking in some learning situations. Similarly, Kasneci et al. (2023) emphasized that large language models can support educational activities but also require careful consideration of accuracy, bias, and students' independent thinking. Therefore, the use of AI should be accompanied by classroom discussions, independent problem-solving exercises, project-based activities, and teacher supervision.

In conclusion, Artificial Intelligence has the potential to support the development of students' cognitive and learning skills, particularly critical thinking, problem-solving, creativity, independent learning, and analytical abilities. However, these benefits are not automatic and depend on the nature of learning activities, students' digital literacy, and the guidance provided by teachers. Responsible integration of AI should encourage students to question, analyse, evaluate, and create rather than simply depend on AI-generated information. In this way, Artificial Intelligence can function as a supportive educational resource for strengthening students' intellectual development and lifelong learning abilities.

3.5 AI and Student Engagement in Teaching–Learning Processes

Student engagement is an important factor in the teaching–learning process because it influences students' participation, motivation, interest, and overall learning experiences. It refers to the extent to which students actively participate in educational activities and demonstrate behavioural, emotional, and cognitive involvement in learning. The integration of Artificial Intelligence (AI) into education has introduced new opportunities to make learning more interactive, responsive, and interesting. AI-based educational applications, such as ChatGPT, intelligent tutoring systems, educational chatbots, and adaptive learning platforms, can provide personalized explanations, interactive exercises, and immediate responses to students' questions. Heung and Chiu (2025), in their systematic review and meta-analysis of 17 empirical studies involving 1,735 students, found a medium positive effect of ChatGPT-supported learning on overall student engagement. Their findings also indicated positive effects on behavioural, cognitive, and emotional engagement.

One important aspect of student engagement is learning motivation and interest. Motivation encourages students to participate in academic activities, develop curiosity, and continue learning despite difficulties. AI-based applications can support learning motivation by presenting information in different formats, providing interactive explanations, and offering learning activities according to students' interests and abilities. For example, students can use AI tools to explore scientific concepts, practise language skills, solve mathematical problems, and obtain additional explanations outside the classroom. Marzano (2025), in a systematic review of generative AI in K–12 teaching and learning, identified opportunities for AI to personalize learning experiences, motivate students, and introduce innovative teaching practices. Similarly, a systematic review of AI education in K–12 classrooms by Kim et al. (2024) reported that AI education can promote students' motivation, positive attitudes towards technology, interest in learning, and career aspirations.

Classroom participation is another important dimension of student engagement. Active participation involves asking questions, responding to teachers, discussing ideas, completing classroom activities, and sharing knowledge with classmates.

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AI-based educational tools can encourage participation by creating opportunities for students to ask questions without hesitation, receive additional explanations, and engage in interactive learning activities. Educational chatbots may provide a supportive environment in which students can clarify doubts and practise academic concepts. Lo et al. (2024), in their systematic review of 72 empirical studies, examined the influence of ChatGPT on student engagement and identified both positive engagement and possible disengagement in AI-supported learning. Their findings suggest that the educational contribution of ChatGPT depends on how it is incorporated into learning activities and how actively students interact with the technology.

Artificial Intelligence can also support interactive and collaborative learning. Interactive learning involves active communication between students, teachers, and educational resources, whereas collaborative learning encourages students to work together, exchange ideas, and solve problems collectively. AI-based tools can assist group discussions, generate project ideas, support collaborative writing, and provide information for classroom activities. For instance, students working on a science project may use AI tools to explore different explanations, organize information, and compare possible solutions before discussing their findings with classmates. The systematic review by Heung and Chiu (2025) identified content generation and collaboration as important roles of ChatGPT in supporting student engagement. Furthermore, the review by Martin et al. (2024) identified educational chatbots, intelligent tutoring systems, and educational games among the applications of AI in K–12 education.

However, increased interaction with AI does not necessarily mean meaningful engagement with learning. If students depend excessively on AI-generated answers, their direct interaction with teachers and classmates may be reduced. Therefore, AI-supported activities should be designed to encourage discussion, questioning, group work, and independent thinking. Teachers should ensure that AI functions as a supportive learning resource rather than replacing meaningful classroom communication. Overall, Artificial Intelligence has the potential to improve students' motivation, interest, classroom participation, and collaborative learning when it is integrated with appropriate teaching strategies and teacher guidance.

3.6 Opportunities of Artificial Intelligence in Secondary Education

Artificial Intelligence offers several opportunities for improving the quality, accessibility, and effectiveness of secondary education. The increasing availability of AI-based educational tools has created new possibilities for students to access learning materials, receive academic assistance, develop digital skills, and participate in more flexible learning environments. These technologies can also assist teachers in preparing instructional materials, evaluating students' progress, and providing additional academic support. Crompton et al. (2024), in their systematic review of 169 studies on AI in K–12 education, identified important educational opportunities related to pedagogy, personalization, administrative support, and subject-content development. These findings indicate that AI can contribute to different aspects of school education when appropriately implemented.

One major opportunity is improved access to educational resources. AI-powered applications can help students access explanations, summaries, examples, practice questions, and supplementary learning materials across different subjects. Students can use these tools to clarify difficult concepts, revise classroom lessons, and explore topics beyond their prescribed textbooks. Generative AI applications can also present information in simplified language and provide alternative explanations according to students' learning requirements. UNESCO (2023) highlighted the potential of generative AI to expand educational opportunities while emphasizing the importance of human-centred and responsible implementation. Such applications may be particularly useful for students who have limited access to additional academic guidance outside

ISSN: **3139-0862**

school hours. Nevertheless, access to AI tools depends on internet connectivity, digital devices, affordability, and the availability of reliable educational content.

Another important opportunity is the promotion of inclusive and accessible education. Students may differ in their learning abilities, language backgrounds, educational needs, and physical conditions. AI-based technologies can help address some of these differences by providing text-to-speech facilities, speech recognition, language translation, simplified explanations, and alternative formats of educational content. Such features may support students who experience difficulties with conventional learning materials and help make educational resources more accessible. UNESCO (2023) emphasized that the use of generative AI in education should promote inclusion and equity while protecting the rights and interests of learners. However, AI cannot automatically ensure inclusive education; its effectiveness depends on appropriate design, accessibility, affordability, and consideration of students' individual requirements.

Immediate feedback and academic support represent another significant opportunity of Artificial Intelligence in secondary education. In traditional classrooms, teachers may not always have sufficient time to provide detailed individual feedback to every student. AI-based educational systems can analyse students' responses, identify common errors, and provide explanations or additional exercises. Intelligent tutoring systems can offer step-by-step guidance, while educational chatbots can respond to academic questions and help students revise difficult topics. Létourneau et al. (2025), in their systematic review of 28 studies involving 4,597 K–12 students, reported generally positive learning effects associated with AI-driven intelligent tutoring systems. These findings suggest that AI-supported feedback and individualized academic assistance may contribute to students' learning progress. However, feedback generated by AI should be reviewed when accuracy and subject-specific understanding are important.

Artificial Intelligence also provides opportunities to assist teachers and students in different educational activities. Teachers can use AI tools to prepare lesson plans, generate classroom questions, develop teaching materials, create quizzes, and obtain ideas for instructional activities. AI may also help teachers organize learning resources and identify areas in which students require additional support. Tan et al. (2025), in their systematic review of AI in teaching and teacher professional development, examined the applications of AI and the importance of teachers' knowledge and professional preparation for its effective integration. For students, AI can provide supplementary explanations, support independent study, and help organize academic tasks. These applications may reduce certain routine activities and allow teachers to devote greater attention to classroom interaction, individual guidance, and students' overall development.

In the context of secondary education, these opportunities are particularly important because students are developing academic knowledge, digital literacy, independent learning habits, and skills required for higher education and future employment. AI-supported learning may help students become more familiar with emerging technologies and develop the ability to use digital resources for educational purposes. However, the benefits of AI should not be considered equally available to all students. Schools require suitable technological infrastructure, teacher training, clear institutional guidelines, and awareness of ethical issues to ensure effective implementation. Overall, Artificial Intelligence can serve as a valuable supplementary resource for improving access to educational materials, supporting inclusive learning, providing immediate feedback, and assisting both teachers and students in secondary education.

3.7 Challenges and Ethical Issues in the Use of AI

Although Artificial Intelligence offers several opportunities for improving teaching and learning, its increasing use in education also creates important challenges and ethical concerns. The effectiveness of AI-based educational technologies depends not only on their technical capabilities but also on how responsibly they are used by students, teachers, and

ISSN: **3139-0862**

educational institutions. In secondary education, these concerns are particularly important because students are still developing their academic abilities, independent thinking, digital literacy, and understanding of ethical responsibilities. Marzano (2025) identified ethical concerns, privacy issues, the need for teacher training, and the lack of practical implementation guidelines as important challenges in the integration of generative AI into K–12 education.

One major concern is the overdependence of students on AI-based tools. Applications such as ChatGPT can provide immediate answers, explanations, summaries, and solutions to academic questions. However, excessive dependence on these tools may discourage students from independently reading, analysing information, solving problems, and developing their own ideas. When students regularly depend on AI-generated answers without understanding the underlying concepts, their independent learning and reasoning abilities may be affected. Zhang et al. (2026), in their systematic review of generative AI in K–12 education, identified students' dependence on technology as one of the important challenges associated with AI-supported learning. Therefore, students should be encouraged to use AI as a supplementary learning resource rather than as a substitute for their own intellectual efforts.

Academic dishonesty and plagiarism are other significant challenges associated with the use of Artificial Intelligence in education. Students may use AI tools to generate complete assignments, essays, reports, and answers without making sufficient personal contributions. Submitting AI-generated content as original work may weaken academic honesty, originality, and the development of genuine academic skills. Kasneci et al. (2023) discussed the opportunities and challenges of large language models in education, including concerns about academic integrity, reliability, and the appropriate use of generated content. Educational institutions therefore need clear guidelines regarding acceptable AI assistance, proper acknowledgement of AI-generated material, and the assessment of students' actual understanding. Teachers should also design assignments that encourage original thinking, personal reflection, classroom discussion, and practical application of knowledge.

Data privacy and security represent another important ethical issue in AI-supported education. AI-based applications may collect, process, and store personal information, including students' names, academic records, learning activities, questions, and other digital information. Since secondary school students are generally minors, the protection of their personal information requires particular attention. Sharing personal details, examination records, photographs, or sensitive educational information with unverified AI platforms may create privacy and security risks. Miao and Holmes (2023), in UNESCO's guidance for generative AI in education and research, emphasized the importance of protecting human data, ensuring age-appropriate use, and establishing appropriate regulatory frameworks. Schools and teachers should therefore guide students in using trusted educational platforms and avoiding the unnecessary sharing of personal or confidential information.

Digital inequality and inaccurate information are also important limitations of AI integration in education. Not all students have equal access to computers, smartphones, reliable internet connections, and appropriate digital learning resources. Students from rural areas and economically disadvantaged backgrounds may experience greater difficulties in accessing AI-based educational tools. In addition, AI-generated responses may contain incorrect, outdated, biased, or misleading information. Students who lack sufficient subject knowledge or digital literacy may find it difficult to identify such errors. UNESCO (2023) emphasized that the use of generative AI should promote equity, inclusion, and meaningful educational opportunities rather than increase existing inequalities. Thus, equal access to technology and the development of digital literacy are essential for the effective use of AI in schools.

Ethical and responsible use of Artificial Intelligence requires cooperation among students, teachers,

ISSN: **3139-0862**

parents, school administrators, and policymakers. Important principles include transparency, fairness, accountability, privacy protection, academic honesty, and human supervision. Students should understand the limitations of AI-generated information and develop the ability to verify facts, evaluate responses, and make independent decisions. Teachers should also receive appropriate training to identify suitable AI applications and integrate them into classroom activities responsibly. UNESCO (2023) recommended a human-centred approach to generative AI in education, emphasizing safe, equitable, age-appropriate, and meaningful use. Therefore, AI should support educational development while maintaining the essential human role of teachers and the intellectual independence of students.

In conclusion, the challenges associated with Artificial Intelligence should not be ignored while considering its educational benefits. Overdependence, academic dishonesty, privacy risks, digital inequality, and inaccurate information can affect the quality and fairness of AI-supported education. Addressing these concerns through appropriate institutional policies, teacher guidance, student awareness, and ethical practices is essential for ensuring that Artificial Intelligence contributes positively to secondary education.

3.8 Research Gap and Need for the Present Study

The increasing use of Artificial Intelligence in education has attracted considerable attention from researchers, educators, and policymakers. Existing studies have examined the applications of AI in personalized learning, academic performance, student engagement, intelligent tutoring systems, and educational assessment. However, despite the growing body of literature, several areas still require further investigation, particularly in relation to secondary school students and the practical integration of AI into school-level teaching and learning.

One important research gap concerns the limited availability of studies focusing specifically on secondary school students. A considerable proportion of early research on generative AI and ChatGPT in education has focused on higher education, university students, and adult learners. Yusuf et al. (2024), in their systematic mapping review of 407 publications, identified a shortage of research and discussion specifically related to generative AI in K–12 education. They also highlighted the limited availability of experimental studies examining the actual impact of generative AI on learning. Although recent systematic reviews have expanded the evidence base on school education, further research is needed to understand how secondary school students use AI tools and how these technologies influence their academic and cognitive development.

Another important gap is the need to examine both the opportunities and challenges of Artificial Intelligence within the same educational framework. Several studies have highlighted the benefits of AI, including personalized learning, academic assistance, immediate feedback, and improved student engagement. Other studies have focused on challenges such as overdependence, academic dishonesty, inaccurate information, privacy concerns, and digital inequality. However, a balanced understanding of AI in secondary education requires the examination of both its positive contributions and potential limitations. Marzano (2025) identified the need for further practical studies and appropriate guidelines to ensure the effective and ethical integration of generative AI in K–12 education. Therefore, the present review considers both the educational benefits and the challenges associated with AI-supported teaching and learning.

A further research gap relates to the need for stronger empirical evidence on students' learning outcomes. Although existing studies suggest that AI-based educational tools may support academic achievement, conceptual understanding, critical thinking, and student engagement, the findings are not equally established across all educational levels and subject areas. Létourneau et al. (2025), in their systematic review of AI-driven intelligent tutoring systems in K–12 education, reported generally positive effects on learning and academic performance but also emphasized the need for

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longer interventions, larger samples, and more diverse research settings. Similarly, Zhang et al. (2026) highlighted the need for longitudinal research to understand the long-term effects of generative AI on school students. These findings indicate the importance of further investigating the relationship between AI use and students' academic, cognitive, and learning outcomes.

The need for research in developing countries, particularly Nepal, is also significant. Educational institutions in developing countries may face specific challenges related to technological infrastructure, internet connectivity, digital literacy, teacher preparation, and unequal access to educational resources. In Nepal, Bohara and Rana (2024) examined school teachers' awareness and proficiency in using Artificial Intelligence and highlighted both the opportunities for pedagogical improvement and the challenges associated with teachers' preparedness. Similarly, the AI4Ed Nepal research programme reported that many school teachers were already experimenting with generative AI for lesson planning, worksheets, differentiated learning materials, and multilingual resources. However, concerns regarding unreliable internet connectivity, inadequate infrastructure, limited professional development, and the absence of clear guidelines remained important barriers to effective implementation.

Recent Nepal-based research has also begun to provide empirical evidence regarding AI use in school education. Joshi et al. (2025) examined the relationship between secondary school students' acceptance of AI in mathematics learning and their academic achievement through a survey involving 804 students from 13 schools in Kathmandu District. Their findings indicated a significant relationship between students' acceptance of AI and mathematics achievement. This study represents an important contribution to understanding AI adoption among Nepali school students. Nevertheless, further research is required to examine AI use across different subjects, geographical settings, and dimensions of the teaching–learning process, including student engagement, independent learning, critical thinking, and ethical awareness.

In addition, the educational context of Nepal highlights the importance of examining digital inequality and the availability of technological resources. The World Bank (2025) reported that, by the end of 2024, 41.8% of Nepal's community schools lacked computers and 56.9% did not have broadband internet. Such infrastructure limitations may influence the extent to which students and teachers can benefit from AI-based educational applications. Therefore, research on AI integration in Nepal should consider differences in school resources, geographical location, socioeconomic conditions, and digital readiness.

In view of these research gaps, the present review paper, entitled "Impact of Artificial Intelligence on Teaching–Learning Processes among Secondary School Students: Opportunities and Challenges," aims to provide a balanced understanding of the role of AI in secondary education. It examines the applications of AI in teaching and learning, its potential influence on academic performance and cognitive development, its contribution to student engagement, and the opportunities it offers to students and teachers. It also discusses the challenges associated with AI use, including technological dependence, academic integrity, privacy, digital inequality, and ethical responsibilities. By bringing together relevant international literature and emerging evidence from Nepal, the study seeks to contribute to a better understanding of the responsible and effective integration of Artificial Intelligence into secondary school education.

4. Research Methodology

4.1 Research Design

The present study adopts a review-based research approach to examine the impact of Artificial Intelligence (AI) on teaching–learning processes among secondary school students, with particular emphasis on its educational opportunities and challenges. The study is based on the examination and analysis of existing academic literature, research articles, systematic reviews, and relevant

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educational reports related to the use of AI in education. A narrative review approach has been followed to bring together findings from previous studies and develop an overall understanding of the role of AI in secondary education. This approach is appropriate for examining the different applications, potential benefits, limitations, and ethical considerations associated with AI-supported teaching and learning.

4.2 Sources of Literature

The literature for the present review was identified from academic and educational sources relevant to Artificial Intelligence and its applications in teaching and learning. The proposed search sources include Google Scholar, ERIC, Scopus, Web of Science, ScienceDirect, SpringerLink, and relevant academic journal websites. Reports and policy documents published by recognized educational organizations, particularly UNESCO, were also considered where relevant. Priority was given to peer-reviewed journal articles, systematic reviews, meta-analyses, and research reports addressing AI applications in school education and related educational contexts.

4.3 Search Strategy and Keywords

Relevant literature was identified using combinations of keywords related to Artificial Intelligence, secondary education, and teaching–learning processes. The main search terms included:

- "Artificial Intelligence in Education"
- "Artificial Intelligence in Secondary Education"
- "AI and Secondary School Students"
- "Generative AI and School Education"
- "ChatGPT in Education"
- "AI and Personalized Learning"
- "AI and Academic Performance"
- "AI and Student Engagement"
- "AI and Critical Thinking"
- "AI in K–12 Education"
- "Opportunities and Challenges of AI in Education"
- "Ethical Issues of AI in Education"

Boolean operators such as AND and OR may be used to combine search terms and identify relevant publications. The literature search period for this review is intended to cover publications from 2019 to November 2026, including relevant earlier foundational studies where necessary. The final search date and databases actually searched should be reported accurately.

4.4 Inclusion and Exclusion Criteria

To maintain the relevance of the review, literature was selected according to its relationship with the objectives of the study.

Inclusion criteria:

1. Studies and publications focusing on Artificial Intelligence and its applications in education.
2. Research related to secondary education, K–12 education, school students, and teaching–learning processes.
3. Studies examining personalized learning, academic performance, student engagement, cognitive skills, and educational support through AI.
4. Publications discussing the opportunities, challenges, limitations, and ethical issues associated with AI in education.
5. Peer-reviewed research articles, systematic reviews, meta-analyses, and relevant reports published in English.
6. Relevant studies and educational reports providing information about AI integration in developing countries, particularly Nepal.

Exclusion criteria:

7. Publications unrelated to Artificial Intelligence or educational applications.
8. Studies focusing exclusively on technical development of AI without relevant educational implications.
9. Publications without sufficient relevance to the objectives of the present review.
10. Duplicate publications and sources containing insufficient information for meaningful analysis.
11. Unverified online content and non-academic materials without clear supporting evidence.

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4.5 Selection and Organization of Literature

The identified publications were examined for their relevance to the objectives and scope of the study. Initially, titles and abstracts were considered to identify potentially relevant sources. The full texts of selected publications were then examined to determine their suitability for inclusion in the review. Relevant information was organized according to the educational themes addressed in the study. Particular attention was given to the educational level, AI applications, major findings, and limitations reported in the selected literature.

Studies conducted specifically in secondary education or K–12 settings were given particular attention. Research involving higher education or mixed educational populations was also considered when it provided relevant insights into AI-supported learning. However, findings from such studies were interpreted carefully and were not treated as direct evidence of effects among secondary school students.

4.6 Data Analysis and Thematic Synthesis

The collected literature was analysed through a qualitative thematic approach. Relevant findings from the selected publications were compared, interpreted, and organized into major themes according to the objectives of the study. The analysis focused on the following areas:

1. Development and applications of Artificial Intelligence in education.
2. AI-supported personalized learning.
3. Influence of AI on students' academic performance.
4. AI and students' cognitive and learning skills.
5. AI and student engagement in teaching–learning processes.
6. Educational opportunities of AI in secondary education.
7. Challenges and ethical issues associated with AI use.
8. Research gaps and the need for further investigation, particularly in developing countries such as Nepal.

Thematic synthesis helped identify common findings, differences in research outcomes, emerging trends, and areas requiring further investigation. The findings were interpreted in relation to the objectives of the present review.

4.7 Methodological Considerations and Limitations

The present study is based on previously published literature and does not involve primary data collection from students or teachers. Therefore, it does not report original experimental findings or statistical results. The conclusions are based on the evidence and interpretations presented in the selected publications. Since the reviewed studies may differ in educational level, subject area, research design, sample characteristics, and AI applications, their findings should be interpreted with appropriate caution. In particular, evidence from higher education or general K–12 research may not always be directly applicable to secondary school students. Furthermore, the rapid development of AI technologies means that new applications and research findings may emerge after the completion of the literature search. These considerations should be taken into account when interpreting the findings of the review.

5. Findings and Discussion

The reviewed literature indicates that Artificial Intelligence (AI) has the potential to support teaching and learning in secondary education. However, its effectiveness depends on appropriate use, teacher guidance, and access to digital resources.

5.1 Improvement in Teaching–Learning Processes

AI-based educational tools can support teaching through interactive learning activities, automated feedback, and intelligent tutoring systems. Létourneau et al. (2025), in a systematic review of 28 studies involving 4,597 K–12 students, reported generally positive effects of intelligent tutoring systems on student learning and academic performance. However, the effects varied across studies and learning conditions.

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5.2 Personalized Learning and Academic Performance

One important contribution of AI is its ability to provide learning support according to students' individual needs and learning progress. AI-based systems can offer different levels of exercises, explanations, and immediate feedback. Marzano (2025) also identified personalized learning and improved assessment methods among the major opportunities of generative AI in K–12 education. Nevertheless, AI should support rather than replace classroom teaching.

5.3 Student Engagement and Learning Skills

AI can make learning more interactive through personalized assistance, content generation, and collaborative activities. A systematic review and meta-analysis by Heung and Chiu (2025) found a medium positive effect of ChatGPT-based learning on overall student engagement. Similarly, Lee and Kwon (2024) reported that AI education in K–12 classrooms can support AI literacy, problem-solving skills, motivation, and positive attitudes towards technology.

5.4 Challenges and Limitations

Despite its benefits, AI integration also creates challenges related to overdependence, academic dishonesty, data privacy, and unequal access to technology. Crompton et al. (2024) identified concerns regarding teachers' and students' technological skills, ethical issues, negative perceptions, and the usability of AI tools in K–12 education. These findings indicate that access to AI tools alone does not guarantee effective learning.

5.5 Implications for Secondary Education

The reviewed studies highlight the importance of teacher training, digital infrastructure, ethical guidelines, and responsible student use of AI. These requirements are particularly important in developing countries such as Nepal, where schools may differ in their access to computers, internet facilities, and trained teachers. Therefore, AI integration should be gradual, inclusive, and guided by educational objectives.

Overall, the findings suggest that AI can become a useful supportive resource in secondary education by improving learning opportunities, personalization, and student engagement. However, its educational value depends on responsible implementation and the active involvement of teachers.

6. Educational Implications and Recommendations

The findings of this review highlight the need for the responsible and effective integration of Artificial Intelligence (AI) into secondary education. The following recommendations may help schools, teachers, and policymakers make better use of AI in teaching and learning.

1. **Teacher Training:** Schools should organize regular training programmes to develop teachers' knowledge and skills in using AI-based educational tools. Research by Bohara and Rana (2024) highlights the need to improve AI awareness and proficiency among school teachers in Nepal.
2. **Curriculum Integration:** AI literacy should be gradually included in the school curriculum to help students understand AI technologies, their applications, and limitations.
3. **Responsible Use of AI:** Students should be guided to use AI for learning, problem-solving, and gaining knowledge rather than depending entirely on AI-generated answers.
4. **Ethical Guidelines and Data Protection:** Schools should establish clear guidelines regarding academic honesty, students' privacy, data security, and the responsible use of AI tools. UNESCO (Miao & Holmes, 2023) also emphasizes a human-centred approach to generative AI in education.
5. **Equal Access to Technology:** Educational institutions and policymakers should work to improve internet connectivity, digital infrastructure, and access to suitable devices, particularly in rural and resource-limited schools.
6. **Teacher-Guided Learning:** AI should be used as a supportive educational resource under teachers' guidance. It should not replace

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teachers' professional judgment, classroom interaction, or emotional support.

These recommendations suggest that successful AI integration requires cooperation among teachers, students, school administrators, parents, and policymakers. A balanced approach can help make AI-supported education more inclusive, ethical, and effective.

7. Conclusion

Artificial Intelligence is gradually becoming an important part of the teaching–learning process. The reviewed literature suggests that AI-based tools can support personalized learning, provide immediate feedback, improve student engagement, and assist teachers in educational activities. Research on AI in K–12 education has also identified opportunities for improving learning environments and supporting students' academic development (Martin et al., 2024). However, the benefits of AI are not automatic and may vary according to the educational context and manner of implementation. The review also highlights important challenges, including excessive dependence on technology, inaccurate information, academic dishonesty, privacy concerns, and unequal access to digital resources. Therefore, responsible AI integration requires teacher guidance, digital literacy, ethical awareness, and appropriate educational policies. As emphasized by UNESCO (Miao & Holmes, 2023), a human-centred approach is essential for the safe and meaningful use of generative AI.

It can be concluded that AI should complement, rather than replace, teachers and conventional teaching methods. Further empirical and longitudinal research is needed to examine its long-term effects on secondary school students' academic performance, critical thinking, creativity, and independent learning (Létourneau et al., 2025).

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