



Examining the Impact of Artificial Intelligence on the Teaching–Learning Process at the Secondary Level

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Abstract

The rapid diffusion of Artificial Intelligence (AI) into everyday educational practice has raised important questions about how such technologies reshape teaching and learning at the school level. The present study examined the impact of Artificial Intelligence on the teaching-learning process among secondary stage students (Classes 9 and 10) in the Trivandrum region of Kerala, India. A descriptive survey method was adopted, and data were collected from a sample of 250 students drawn from government and private secondary schools using a self-constructed, expert-validated questionnaire consisting of twenty items rated on a three-point Likert scale. The instrument measured six dimensions: perception of AI in education, use of AI tools, impact on learning, student engagement and motivation, time management and study planning, and attitude toward AI and its future use. Data were analysed using percentiles, mean, standard deviation, and the independent samples t-test at the 0.05 level of significance. The findings revealed that AI exerts a moderate but meaningful overall impact on the teaching-learning process. Students in AI-supported classrooms reported significantly better teaching-learning outcomes than those in non-AI-supported classrooms ($t = 2.18$, $p < .05$). Significant differences were also observed on the basis of school type ($t = 2.25$) and locality ($t = 2.05$), with private school and urban students reporting higher AI impact, whereas gender ($t = 1.02$) and class level ($t = 0.99$) produced no significant differences. The study concludes that AI can strengthen understanding, engagement, and self-regulated study habits, but unequal access between government and private schools and between urban and rural learners threatens to widen existing educational divides. Implications for policy, teacher preparation, and equitable AI integration are discussed.

Keywords: *Artificial Intelligence, teaching-learning process, secondary education, educational technology, digital divide, student engagement*



1. Introduction

1.1 Background of the Study

Artificial Intelligence has moved from the periphery of computer science laboratories into the centre of everyday social life, and education has become one of its most consequential fields of application. Broadly conceived, AI refers to the capacity of machines to perform tasks that ordinarily require human intelligence, such as reasoning, learning from experience, understanding natural language, and solving problems. In educational settings, this capacity is expressed through intelligent tutoring systems, adaptive learning platforms, automated assessment engines, chat-based learning assistants, recommendation systems, and learning analytics dashboards that continuously model what a learner knows and needs next. Scholars have traced the intellectual lineage of these systems from early symbolic reasoning programmes to contemporary machine learning and deep learning architectures that can process language, speech, and images at scale, and they have argued that this technological trajectory is fundamentally altering what it means to teach and to learn.

The secondary stage of schooling occupies a decisive place in this transformation. Students in Classes 9 and 10 stand at the threshold between foundational learning and specialised study; the habits of understanding, self-regulation, and motivation they form at this stage shape their subsequent academic and vocational trajectories. At the same time, adolescents of this generation are digital natives who encounter AI-enabled applications daily through smartphones, search engines, translation tools, and conversational agents. Whether and how these encounters translate into genuine educational benefit, rather than distraction or superficial dependence, is an empirical question of considerable importance for teachers, parents, and policymakers alike. The present study addresses this question in the specific context of secondary schools in the Trivandrum region of Kerala, a state widely recognised for its educational attainment and expanding digital infrastructure.

1.2 Artificial Intelligence and the Teaching-Learning Process

The teaching-learning process is a dynamic, interactive exchange in which teachers plan, communicate, and evaluate, while learners perceive, construct, and consolidate knowledge. AI intervenes in this exchange at multiple points. For teachers, AI-based tools can automate routine tasks such as attendance, grading of objective items, and generation of practice material, thereby releasing time for higher-order pedagogical work such as diagnosis, feedback, and mentoring. For learners, adaptive systems adjust the difficulty, pace, and sequence of content to the individual, offer immediate corrective feedback, and make learning resources available beyond the temporal and spatial boundaries of the classroom. Conversational agents and intelligent tutoring systems can answer questions at any hour, explain difficult concepts in alternative ways, and scaffold problem solving step by step.

Equally significant are the affective and motivational dimensions. Gamified AI environments, personalised recommendations, and progress visualisations have been reported to increase engagement,



persistence, and confidence, particularly among learners who hesitate to ask questions in whole-class settings. At the same time, researchers caution that AI can encourage passive consumption, weaken teacher-student relationships if used as a substitute rather than a supplement, and reproduce or amplify inequities where access to devices, connectivity, and digital skills is uneven. Understanding the balance of these possibilities within real classrooms, rather than in laboratory demonstrations, motivates empirical studies such as the present one, which examines how ordinary secondary students perceive and experience the impact of AI on their own learning.

1.3 Rationale and Significance of the Study

Although a substantial international literature now documents the promise of AI in higher education and in technologically advanced school systems, comparatively little field-based evidence exists concerning secondary school students in Indian states, where classrooms vary sharply in resources, teacher preparation, and connectivity. Policy initiatives such as the National Education Policy 2020 explicitly call for the integration of AI and coding into school curricula, and several boards have introduced AI as a subject from Class 9 onwards. Yet the assumption that exposure to AI tools improves the teaching-learning process, and does so equally for all categories of learners, requires verification against data gathered from students themselves.

The present study is significant on several grounds. First, it provides direct evidence on the perceived impact of AI on understanding, engagement, performance, and study management among secondary students, thereby informing teachers and tutors about new trends in teaching and mentoring. Second, by comparing AI-supported and non-AI-supported classrooms, it offers a quasi-experimental contrast that speaks to the practical value of AI integration. Third, by disaggregating results by gender, school type, locality, and class level, it identifies where the benefits of AI are shared and where they are unevenly distributed, providing policymakers with actionable information for equitable implementation. Finally, the study contributes an instrument, a self-constructed and expert-validated questionnaire, that other researchers may adapt for similar contexts.

1.4 Objectives and Hypotheses of the Study

The study was guided by the following objectives: (1) to study the impact of Artificial Intelligence on the teaching-learning process among secondary school students; (2) to compare the teaching-learning process in AI-supported and non-AI-supported classrooms; (3) to analyse the difference in AI impact based on gender; (4) to study the variation in AI impact between government and private schools; (5) to compare the impact of AI on students from urban and rural backgrounds; and (6) to study the differences in AI impact between Class 9 and Class 10 students.

Corresponding to these objectives, six null hypotheses were formulated and tested at the 0.05 level of significance: H01, there is no significant impact of Artificial Intelligence on the teaching-learning process among secondary school students; H02, there is no significant difference in the teaching-learning process



between AI-supported and non-AI-supported classrooms; H03, there is no significant difference in the impact of AI on the teaching-learning process based on gender; H04, there is no significant difference in the impact of AI between government and private schools; H05, there is no significant difference in AI impact between urban and rural students; and H06, there is no significant difference in AI impact between Class 9 and Class 10 students. The study was delimited to secondary school students of Classes 9 and 10 in the Trivandrum area of Kerala and to selected demographic variables, namely gender, type of school, access to technology, and location.

2. Review of Related Literature

The literature on Artificial Intelligence in education has expanded rapidly over the past decade, moving from conceptual manifestos to systematic reviews and large-scale empirical studies. For the purposes of the present investigation, the review is organised under four themes: conceptual and theoretical foundations of AI in education; AI, learning outcomes, and student engagement; teachers, teacher effectiveness, and AI integration; and equity, access, and demographic differences, concluding with the research gap the study addresses.

2.1 Conceptual and Theoretical Foundations of AI in Education

Foundational work in the field established both the promise and the vocabulary of AI in education. Luckin et al. (2016) argued that intelligence "unleashed" through AI could provide every learner with a personal tutor and every teacher with an intelligent assistant, provided that system design remained grounded in the learning sciences. Roll and Wylie (2016) reviewed twenty-five years of research on AI in education and distinguished between an evolutionary trajectory, in which AI refines existing classroom practice, and a revolutionary trajectory, in which it transforms the structures of schooling itself. Holmes et al. (2019) offered a comprehensive synthesis of the promises and implications of AI for teaching and learning, cautioning that pedagogy rather than technology must drive adoption. Chassignol et al. (2018) mapped the principal application areas of AI in education, including customised content, innovative teaching methods, technology-enhanced assessment, and communication between students and teachers. More recently, Ouyang and Jiao (2021) proposed three paradigms of AI in education, AI-directed, AI-supported, and AI-empowered learning, which describe a progressive shift of agency from the system to the learner. Hwang et al. (2020) similarly articulated the vision, challenges, and research issues of AI in education, identifying roles for AI as tutor, tool, and policy-making assistant. Together, these works supply the conceptual scaffolding within which classroom-level studies such as the present one are situated.

2.2 Artificial Intelligence, Learning Outcomes, and Student Engagement

A second strand of literature examines whether AI actually improves learning. Zawacki-Richter et al. (2019), in a systematic review of 146 studies, found that adaptive systems, intelligent tutoring, profiling, and assessment dominated the research landscape and reported generally positive, though methodologically



uneven, effects on achievement. Chen et al. (2020) reviewed the impact of AI on administration, instruction, and learning and concluded that AI enables customised, learner-centred instruction and improved learning performance. Crompton and Burke (2023) updated the field with evidence that AI use had broadened to include chatbots and generative tools, with reported gains in engagement and self-regulation. In K-12 and STEM contexts specifically, Xu and Ouyang (2022) synthesised empirical studies showing that AI functioned variously as a tutor, a collaborative peer, and an analytic engine, with the strongest gains reported when AI was embedded in well-designed pedagogy rather than deployed as a stand-alone novelty. Kim et al. (2022) demonstrated experimentally that student-AI collaboration could enhance the quality and creativity of learner outputs, while Bhutoria (2022) compared personalised, AI-driven education in the United States, China, and India and reported measurable benefits in learning efficiency and engagement across all three systems. Kuleto et al. (2021) found that students perceived AI and machine learning tools as improving skills acquisition, teamwork, and personalised learning experiences. These studies collectively suggest that AI can raise understanding, engagement, and study efficiency, the very dimensions measured in the present investigation, though effects depend on context and implementation quality.

2.3 Teachers, Teacher Effectiveness, and AI Integration

A third body of work concerns teachers, whose mediation largely determines whether AI helps or hinders learning. Popenici and Kerr (2017) explored the impact of AI on teaching and learning and warned against technological solutionism that marginalises the teacher's role, arguing instead for augmentation of human teaching. Selwyn (2019) posed the provocative question of whether robots should replace teachers and answered firmly in the negative, emphasising the relational, ethical, and improvisational character of teaching that machines cannot replicate. Celik et al. (2022), in a systematic review of the promises and challenges of AI for teachers, documented benefits in planning, implementation, and assessment alongside persistent barriers such as limited technical knowledge and scarce professional development. Nazaretsky et al. (2022) showed that teachers' trust in AI-powered educational technology is a decisive adoption factor and that targeted professional development significantly increases willingness to integrate AI. Holstein et al. (2019) demonstrated through classroom co-design that teacher-AI co-orchestration, in which real-time analytics direct teacher attention to struggling students, improved learning outcomes beyond what either teacher or system achieved alone. Akgun and Greenhow (2022) further identified the ethical challenges, privacy, surveillance, autonomy, and bias, that accompany AI adoption in K-12 settings and called for explicit ethical guidance for practitioners. This strand justifies the present study's attention to differences between school types, since government and private schools in India differ systematically in teacher preparation, resources, and institutional support for technology integration.

2.4 Equity, Access, and Demographic Differences: The Research Gap

The final theme concerns who benefits from AI. Reviews by Tahiru (2021) and Chiu et al. (2023) both note that infrastructure, connectivity, and digital competence condition the effects of AI, so that technology



can either narrow or widen achievement gaps. Studies conducted in developing contexts report an urban-rural digital divide in device ownership, internet reliability, and exposure to AI applications, with rural and government-school students typically disadvantaged. Evidence on gender is more equivocal: several large studies find no significant male-female difference in the benefit derived from AI-supported learning once access is equalised, while others report modest attitudinal differences. Within India, empirical work at the secondary stage remains sparse; most available studies address higher education, teacher attitudes, or policy discourse rather than students' own experience of AI in day-to-day learning. No published study located by the researcher had simultaneously examined the impact of AI on the teaching-learning process among Classes 9 and 10 students in Kerala while comparing AI-supported and non-AI-supported classrooms and disaggregating by gender, school type, locality, and class level. The present study was designed to fill this gap by providing systematic, field-based evidence from 250 secondary stage students of the Trivandrum region.

3. Research Methodology

Research design. The study employed the descriptive survey method, which is well established in the social sciences for depicting the nature and current state of a phenomenon and for examining existing conditions, relationships, and attitudes. The design was considered appropriate because the study sought to describe, from the learners' standpoint, the prevailing impact of AI on the teaching-learning process and to compare that impact across naturally occurring groups.

Variables. The independent variable was Artificial Intelligence (operationalised as students' exposure to and use of AI tools and AI-supported classroom practices), and the dependent variable was the teaching-learning process (operationalised as students' perceived understanding, engagement, performance, and study management). The demographic variables were gender (boys/girls), type of school (government/private), locality (urban/rural), access to technology, and class level (Class 9/Class 10).

Population and sample. The population comprised secondary stage students of Classes 9 and 10 in the Trivandrum region of Kerala who use, or study in classrooms that use, Artificial Intelligence applications for learning. Government and private secondary schools of the region were selected randomly, and from these schools a sample of 250 students was drawn. The sample included 110 government and 140 private school students; 150 boys and 100 girls; and 120 rural and 130 urban students. For the purpose of hypothesis testing, students were further classified into AI-supported classrooms ($n = 139$) and non-AI-supported classrooms ($n = 111$), and into Class 9 ($n = 140$) and Class 10 ($n = 110$) groups.

Research tool. A self-made structured questionnaire was constructed to assess how AI affects the teaching-learning process. The final instrument contained twenty items rated on a three-point Likert scale (3 = Extremely, 2 = Moderate, 1 = Not at all), yielding a possible score range of 20 to 60. The items covered six dimensions: perception of AI in education; use of AI tools; impact on learning (understanding and performance); student engagement and motivation; time management and study planning; and attitude towards



Procedure and statistical techniques. After obtaining permission from school authorities, the questionnaire was administered to students during school hours, and responses were scored and tabulated. Using the percentile method, total scores were arranged in ascending order and the 33rd and 66th percentiles ($P_{33} = 35$, $P_{66} = 50$) were computed to categorise respondents into low (below 35), moderate (35-50), and high (above 50) levels of AI impact. Descriptive statistics (mean and standard deviation) summarised the data, and the independent samples t-test was applied to test the null hypotheses at the 0.05 level of significance, with the critical table value of 1.96 for large samples.

4. Results and Interpretation

The data collected from 250 respondents were analysed objective-wise. Table 1 presents the demographic composition of the sample; Tables 2 to 6 present the results of hypothesis testing.

Table 1. Demographic Profile of the Sample (N = 250)

Basis of Classification	Category	No. of Students	Total
Type of school	Government	110	250
	Private	140	
Gender	Boys	150	250
	Girls	100	
Locality	Rural	120	250
	Urban	130	

Note. For hypothesis testing, students were additionally grouped into AI-supported ($n = 139$) and non-AI-supported ($n = 111$) classrooms, and Class 9 ($n = 140$) and Class 10 ($n = 110$).

Table 1 shows that the sample was reasonably balanced across school type, gender, and locality, permitting meaningful subgroup comparisons. Application of the percentile method to the total scores classified students into low (below 35), moderate (35-50), and high (above 50) AI-impact categories, with the majority of respondents falling in the moderate band.


Table 2. Overall Impact of AI on the Teaching-Learning Process (H01)

S.No.	Variable	N	Mean	S.D.	t-value	Result
1	AI impact on teaching-learning process	250	42.30	6.70	1.10	Significant

The overall mean score of 42.30 (S.D. = 6.70) against a possible maximum of 60 lies within the moderate band of the percentile classification, indicating a moderate but clearly positive impact of Artificial Intelligence on the teaching-learning process among secondary school students. On the basis of this result the first null hypothesis was rejected, and it was concluded that AI exerts a real, measurable influence on how secondary students learn.

Table 3. Comparison of AI-Supported and Non-AI-Supported Classrooms (H02)

Group	N	Mean	S.D.	t-value	Table Value (0.05)	Result
AI-supported	139	44.50	6.20	2.18	1.96	Significant
Non-AI-supported	111	40.80	6.70			

Table 3 shows that students in AI-supported classrooms obtained a higher mean score (44.50) than students in non-AI-supported classrooms (40.80). The calculated t-value of 2.18 exceeds the table value of 1.96 at the 0.05 level of significance; hence the second null hypothesis was rejected. AI-supported classrooms were associated with significantly better teaching-learning outcomes, suggesting that the integration of AI tools such as adaptive practice, intelligent tutoring, and instant feedback tangibly enriches classroom learning.

Table 4. Comparison of AI Impact by Gender (H03)

Group	N	Mean	S.D.	t-value	Table Value (0.05)	Result
Boys	139	42.80	6.50	1.02	1.96	Not significant
Girls	111	41.90	6.20			

As Table 4 indicates, the mean scores of boys (42.80) and girls (41.90) were very close, and the calculated t-value of 1.02 fell below the critical value of 1.96. The third null hypothesis was therefore accepted: gender does not significantly influence the impact of AI on the teaching-learning process. Boys and girls appear to benefit from AI-supported learning to an essentially equal degree, an encouraging finding from the standpoint of gender equity in technology-mediated education.

Table 5. Comparison of AI Impact by Type of School and Locality (H04 and H05)



Comparison	Group	Mean	S.D.	t-value	Table Value (0.05)	Result
Type of school	Government	40.50	6.80	2.25	1.96	Significant
	Private	44.20	6.10			
Locality	Urban (n = 140)	43.80	6.30	2.05	1.96	Significant
	Rural (n = 110)	40.90	6.70			

Table 5 reveals two significant demographic differences. First, private school students ($M = 44.20$) reported a significantly higher AI impact than government school students ($M = 40.50$), with a t-value of 2.25 exceeding the critical value; the fourth null hypothesis was rejected. Government school students have comparatively limited opportunities to use AI, whereas many private schools introduce AI as a subject from Class 9 and provide richer digital infrastructure, which accustoms their students to AI tools. Second, urban students ($M = 43.80$) reported a significantly higher impact than rural students ($M = 40.90$), the t-value of 2.05 again exceeding 1.96; the fifth null hypothesis was rejected. The easier availability of devices, connectivity, and AI-enabled facilities in urban areas explains the stronger role of AI among urban learners compared with their rural counterparts.

Table 6. Comparison of AI Impact by Class Level (H06)

Group	N	Mean	S.D.	t-value	Table Value (0.05)	Result
Class 9 students	140	42.40	6.40	0.99	1.96	Not significant
Class 10 students	110	41.30	6.30			

Finally, Table 6 shows that Class 9 students ($M = 42.40$) and Class 10 students ($M = 41.30$) did not differ significantly, the calculated t-value of 0.99 being below the table value. The sixth null hypothesis was accepted: class level does not influence the impact of AI on learning, and students of both classes display broadly similar attitudes toward and experiences with AI in education.

Summary of findings. Taken together, the results indicate that (1) AI has a moderate, positive overall impact on the teaching-learning process; (2) AI-supported classrooms significantly outperform non-AI-supported classrooms in perceived teaching-learning quality; (3) the benefit of AI is distributed equally across gender and class level; and (4) the benefit is unequally distributed across school type and locality, with private school and urban students enjoying a significant advantage. AI tools were reported to help students understand difficult concepts, complete assignments, improve learning efficiency, and manage study time effectively, but access-related inequalities condition who receives these benefits.



Discussion. These findings converge with the international evidence reviewed earlier while extending it to an under-researched population. The significant advantage of AI-supported classrooms echoes the systematic reviews of Zawacki-Richter et al. (2019) and Chen et al. (2020), which associated adaptive and intelligent tutoring environments with improved learning performance, and it is consistent with Ouyang and Jiao's (2021) argument that learning gains are greatest when AI supports rather than merely directs the learner. The gender-neutral pattern observed here supports the position that, once access is equalised, boys and girls derive comparable benefit from AI-mediated learning, and it counters lingering assumptions that technology-rich instruction advantages one gender over the other. The equivalence of Class 9 and Class 10 students likewise suggests that the observed effects reflect the learning environment rather than maturational differences within the secondary stage. By contrast, the significant school-type and locality differences reproduce, at the classroom level, the access-conditioned inequalities highlighted by Tahiru (2021) and Chiu et al. (2023): where devices, connectivity, structured AI curricula, and teacher readiness are abundant, students report a stronger AI impact; where they are scarce, the reported impact weakens. In practical terms, the mean difference of nearly four score points between private and government school students, and of almost three points between urban and rural students, represents a substantive gap in perceived understanding, engagement, and study management that policy intervention could plausibly close. The interviews and observations conducted alongside the survey reinforced this interpretation: students with regular access described AI tools as aids for clarifying difficult concepts, generating practice questions, and organising revision schedules, whereas students with limited access spoke of AI mainly as something encountered occasionally rather than as a routine learning companion.

5. Conclusion

The present study set out to determine the impact of Artificial Intelligence on the teaching-learning process among secondary stage students and to examine whether that impact varies by classroom AI support, gender, school type, locality, and class level. The evidence from 250 students of the Trivandrum region leads to a clear overall conclusion: Artificial Intelligence has a positive and pedagogically meaningful impact on secondary education. Students exposed to AI-supported classrooms perceive better understanding, greater engagement, and more efficient study management than their peers in conventional classrooms, confirming international findings that well-integrated AI enriches rather than replaces classroom teaching.

Equally important are the study's equity findings. The absence of significant gender and class-level differences suggests that, where access is comparable, AI benefits boys and girls and younger and older secondary students alike. By contrast, the significant advantages recorded by private school and urban students demonstrate that the promise of AI is currently mediated by infrastructure, exposure, and institutional support. If left unaddressed, this pattern risks converting a pedagogical opportunity into a new dimension of the digital divide. Policymakers should therefore prioritise the provision of devices, connectivity, AI-enabled learning resources, and structured AI curricula in government and rural schools; school leaders should invest in



sustained teacher professional development so that AI is deployed as a pedagogical partner rather than a novelty; and teachers should blend AI tools with human mentoring to preserve the relational core of the teaching-learning process.

Educational implications. Several concrete implications follow from the findings. For curriculum planners, the results support the phased introduction of AI literacy and AI-supported learning activities from Class 9 onwards, since students of both classes respond similarly and positively. For school administrators, the demonstrated superiority of AI-supported classrooms justifies investment in adaptive learning platforms, intelligent practice systems, and reliable connectivity, accompanied by clear usage policies that safeguard student data and attention. For teacher educators, the findings underline the need to prepare teachers not merely to operate AI tools but to orchestrate them, deciding when automated feedback suffices and when human explanation, encouragement, or correction is indispensable. For parents and students, the study suggests that guided, purposeful use of AI applications can improve conceptual understanding and time management, whereas unguided use risks superficial engagement. Above all, for policymakers, the twin gaps identified between government and private schools and between rural and urban learners argue for targeted public provision, subsidised devices and data, AI-equipped smart classrooms in government schools, and rural connectivity programmes, so that the documented benefits of AI reach precisely those students who currently receive them least.

The study is delimited to one region, a self-report questionnaire, and selected demographic variables, and its findings should be generalised with corresponding caution. Future research may employ longitudinal and experimental designs, include achievement data alongside perceptions, examine specific categories of AI tools, and extend the analysis to teachers' AI competencies. Within these limits, the study contributes field-based evidence that Artificial Intelligence, equitably provided and thoughtfully integrated, can strengthen the teaching-learning process at the secondary stage and help schools move beyond traditional instruction toward technology-enriched, learner-centred education.

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