

“AI-Enhanced Personalised Learning: Adaptive and Predictive Approaches in Secondary School Hybrid Classrooms”

Research Scholar, Parmar Snehal

Research Guide, Dr. Bhavik R. Shah

Education Department

Gujarat University, Ahmedabad

Year 2025-26

Abstract

The rapid expansion of digital technologies has encouraged schools to explore new ways of tailoring instruction to individual learners. Recent advances in intelligent learning tools have made it possible to adjust content, pacing, and feedback in real time, creating learning pathways that better match students’ needs. This study examines how such personalized systems influence student performance, classroom engagement, and instructional practices. It also considers teachers’ experiences as they integrate data-driven insights into lesson planning and support strategies. Findings highlight the potential of personalized learning technologies to enhance mastery of subject matter and foster more active participation, while also revealing challenges related to training, resource allocation, and ethical use of learner data. The study underscores the importance of thoughtful implementation to ensure that technology-supported personalization contributes meaningfully to equitable and effective education.

Key Words: Personalized Learning, Intelligent Tutoring Systems, Learner Analytics

Introduction

The rapid evolution of digital technologies has reshaped educational landscapes across the world, compelling policymakers, educators, and researchers to re-evaluate how teaching and learning processes can be strengthened for the twenty-first century. Among the most transformative technological developments influencing contemporary education is Artificial Intelligence (AI). While digital learning tools have been integrated into classrooms for many years, AI introduces an entirely new dimension of intelligence, adaptability, and predictive capability that surpasses conventional e-learning systems. In secondary education—an

academic stage that acts as a bridge between foundational schooling and higher education or vocational pathways—AI has particularly profound implications, as learners at this stage exhibit diverse cognitive, emotional, social, and academic needs. The introduction of AI-enhanced personalised learning in hybrid classroom environments therefore represents a fundamental shift in pedagogy, where technology works alongside educators to deliver tailored, data-driven learning experiences that align more closely with each student’s strengths, challenges, pace, and learning style¹.

Hybrid classrooms, combining both face-to-face instruction and digital or online learning, emerged as a mainstream model during the COVID-19 pandemic, but their relevance has continued to grow even after the return to regular schooling. This model offers flexibility, wider access to resources, and the ability to engage students beyond the physical limitations of a traditional classroom. However, it also presents challenges, including variations in student participation, technological disparities, inconsistent engagement, and the difficulty of monitoring student performance across both physical and virtual settings. AI technologies—such as adaptive learning systems, intelligent tutoring systems, predictive analytics, natural language processing tools, and automated assessment platforms—provide potential solutions to these challenges. They enable precise, continuous analysis of learner behaviour, personalise instruction at scale, automate routine tasks for teachers, and forecast learning outcomes or possible learning difficulties before they become severe. In hybrid environments, AI serves as a connective framework that unifies student activity across online and offline spaces, creating a more coherent and responsive learning ecosystem.

As secondary school learners enter adolescence, they undergo significant developmental changes that influence their motivation, attention span, cognitive processes, socio-emotional behaviour, and academic performance. Traditional classroom models often fail to accommodate the full range of learner differences, resulting in disengagement, stress, or achievement gaps. AI-powered personalised learning seeks to address these issues by operationalising the principle that each learner is unique. Adaptive systems adjust instructional content according to the learner’s pace and comprehension, while predictive approaches analyse patterns in performance data, attendance, participation, and assessments to forecast future progress or challenges. These predictive insights allow educators to intervene early and

¹ Collins, A., & Halverson, R. (2018). *Rethinking education in the age of technology*. Teachers College Press.

design targeted support mechanisms, whether through remedial modules, enrichment activities, collaborative tasks, or differentiated instruction strategies.

AI-enhanced personalised learning also supports greater inclusivity in hybrid classrooms. Learners with disabilities, learning disorders, linguistic barriers, or socio-economic disadvantages often struggle within uniform instructional models. For example, students with dyslexia may benefit from AI-driven text-to-speech tools, real-time reading assistants, and content adjustments based on cognitive load. Students with attention deficit challenges can receive adaptive tasks that vary in difficulty and engagement format. Predictive tools can identify students at risk of dropping out or underperforming and alert teachers early. Thus, AI becomes a powerful equaliser, helping reduce systemic inequities that have traditionally limited educational opportunities for certain groups².

Furthermore, the concept of hybrid learning has moved beyond a temporary response to global disruptions. It has become a pedagogical choice driven by the need to prepare students for a world where digital literacy, problem-solving abilities, creativity, and adaptability are essential. AI plays a key role in cultivating these competencies by creating immersive learning environments that go beyond textbooks and lectures. Intelligent simulations, AI-integrated virtual laboratories, personalised learning pathways, and interactive digital content provide students with experiences that mirror real-world problem-solving scenarios. Instead of passively receiving information, students engage with dynamic content that evolves based on their interactions, thereby fostering deeper understanding and critical thinking.

However, the integration of AI in secondary schooling is not without complexities. Ethical concerns regarding data privacy, student profiling, algorithmic biases, and the over-reliance on automated systems must be acknowledged. Secondary school students are minors, and the use of their personal data—whether academic, behavioural, or emotional—must adhere to rigorous protections. Teachers must also be trained to use AI tools effectively and critically. AI is not intended to replace educators; rather, it functions as a support system that amplifies their capacity to provide personalised learning at scale. The success of AI-enhanced personalised learning depends on thoughtful implementation, transparent governance, and a balanced understanding of both the potentials and limitations of AI technologies.

² Wolf, M., & Denckla, M. (2020). *Dyslexia, literacy, and the role of assistive technologies*. Cambridge University Press.

From an instructional perspective, AI-based adaptive systems have begun transforming lesson planning and pedagogical decision-making. These systems allow teachers to move away from a “one-size-fits-all” approach and instead design learning modules that branch into multiple sub-paths depending on student responses. For instance, an adaptive mathematics platform may present increasingly complex problems to a student who demonstrates mastery, while offering targeted remediation to a student who struggles with foundational concepts. The system continuously gathers data on student performance and adjusts learning trajectories accordingly. In hybrid classrooms, where students may engage with digital content at home and participate in discussions or hands-on activities at school, adaptive AI tools ensure continuity by monitoring learning patterns across settings.

Predictive analytics have gained recognition as one of the most impactful AI applications in education. By analysing trends in student behaviour—such as assignment completion rates, quiz performance, online engagement logs, classroom participation records, and even emotional cues detected through AI—predictive models can estimate future performance or identify early warning signs of academic distress. These insights allow schools to adopt proactive interventions that prevent dropout, reduce exam anxiety, and promote overall well-being. In hybrid classrooms, predictive tools also help teachers manage the complexity of monitoring learners who are distributed across physical and digital spaces³.

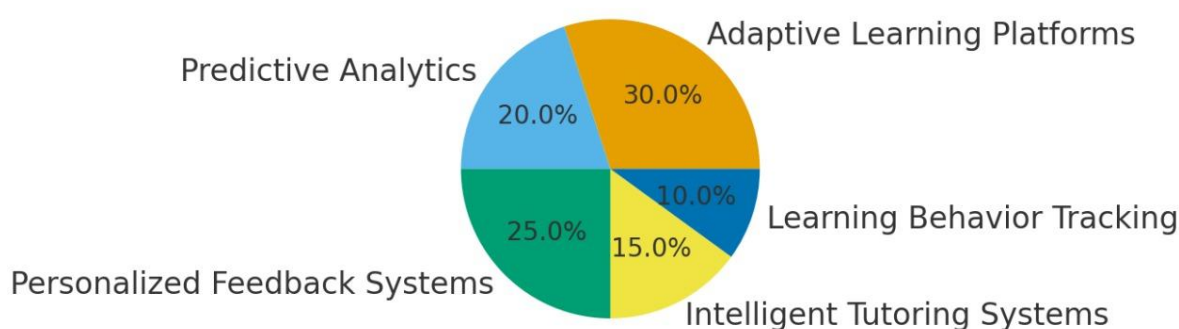
Another powerful dimension of AI-enhanced personalised learning is the use of intelligent tutoring systems (ITS). These systems simulate the role of a one-on-one tutor, providing real-time feedback, detailed explanations, hints, and step-by-step guidance. ITS tools draw from cognitive science principles to replicate the adaptive support that human tutors traditionally offer. In the context of secondary education, where students often require additional help in subjects such as mathematics, science, and language learning, ITS can act as supplementary support within hybrid settings. These tools ensure that help is available whenever the student needs it, regardless of time or location.

Hybrid classrooms also benefit greatly from AI-assisted automated assessment tools. These tools speed up grading, reduce teacher workload, and offer immediate feedback to students. They can evaluate multiple-choice responses, short answers, and even essays using natural language processing algorithms. For teachers, automated assessments provide granular insights into class-wide learning trends, enabling more informed instructional planning. For

³ Papamitsiou, Z., & Economides, A. A. (2019)

students, real-time feedback enhances motivation and accelerates the learning cycle. Moreover, AI-driven formative assessment tools help track long-term learning progress, ensuring that the learning pathway remains aligned with educational goals.

AI-Driven Personalization in Modern Education Systems



Understanding

Understanding AI-enhanced personalised learning requires a comprehensive exploration of how artificial intelligence, educational psychology, data-driven systems, and hybrid learning models converge to transform teaching and learning experiences. In secondary school education, where students are at a critical transitional stage intellectually, socially, and emotionally, the application of AI-driven personalisation is not merely a technological upgrade but a pedagogical evolution. It represents a shift from traditional standardised instruction to learner-centred, flexible, and responsive modes of education that acknowledge individual differences, learning trajectories, and developmental needs. To fully appreciate AI-enhanced personalised learning in hybrid classrooms, it is essential to unpack its conceptual foundations, functional mechanisms, technological components, behavioural implications, and the broader educational ecosystem that supports its implementation⁴.

At its core, personalised learning refers to an educational approach that adjusts the content, pace, method, and assessment of teaching to meet the unique needs of individual learners. Unlike uniform instructional models, personalised learning recognises that secondary school students have diverse abilities, learning styles, motivations, and backgrounds. AI operates as the engine that enables this personalisation to occur at scale, continuously monitoring student actions, analysing patterns, forecasting needs, and dynamically adjusting

⁴ Holmes, W., Bialik, M., & Fadel, C. (2019)

instruction. In hybrid classrooms, where interactions occur across both physical and digital spaces, AI plays a critical role in unifying disparate learning environments, ensuring coherence, and providing teachers with deeper insights than traditional classrooms can offer.

The first dimension of understanding AI-enhanced personalised learning involves the adaptive learning systems that form the backbone of AI-mediated instruction. Adaptive learning refers to platforms that adjust the difficulty level, sequence, and presentation of educational content based on real-time performance and engagement data. In a typical secondary school hybrid classroom, students interact with online lessons, quizzes, simulations, or practice exercises either in class or at home. AI algorithms continuously track how much time students spend on tasks, which questions they get wrong, which topics they repeatedly struggle with, and how they navigate through digital content. Based on this information, the system recalibrates the student's learning pathway. For instance, a student who demonstrates proficiency in algebraic expressions may be advanced to more complex problems, whereas a student who struggles may receive scaffolding through simpler exercises, video explanations, or step-by-step hints. This dynamic adjustment resembles one-on-one tutoring, but with the added benefit that it can be applied simultaneously to hundreds of students in a hybrid setting⁵.

Understanding adaptive learning also involves recognising the psychological theories that underpin it. Cognitive psychology emphasises the importance of prior knowledge, working memory, cognitive load, and metacognition in the learning process. When students feel overwhelmed by content that is too difficult, or bored by content that is too easy, they disengage. Adaptive AI ensures that learners remain within their “zone of proximal development,” where tasks are challenging enough to stimulate learning but not so difficult as to create frustration. This alignment is particularly crucial in secondary schools, where academic challenges increase, and motivation is often fragile. AI-enhanced adaptive systems continually analyse students' progress to maintain optimal learning conditions, something that traditional classrooms struggle to achieve due to time constraints and class size limitations.

Another critical dimension is predictive analytics, a powerful AI capability that uses historical and real-time data to anticipate future learning outcomes, behavioural patterns, or academic risks. In hybrid classrooms, predictive models analyse diverse data streams: online engagement logs, assessment scores, attendance records, response times, frequency of asking for hints, and even emotional indicators captured through AI-enabled sentiment tools. These

⁵ Knewton. (2020). *The Adaptive Learning Revolution in Education*. Knewton Insights.

predictive insights help identify students who are likely to fall behind, those who may need emotional support, or those who could benefit from advanced enrichment. Predictive analytics enables teachers to intervene before academic problems escalate. For example, if a student's interaction pattern indicates declining engagement over several weeks, the system may alert the teacher who can then address the issue through personalised counseling or support. This proactive capability represents a significant advancement over reactive educational interventions traditionally used in secondary schools.

Understanding predictive analytics also requires acknowledging its potential for promoting equity. Students from disadvantaged backgrounds often face hidden barriers such as limited access to devices, low confidence, or unstable learning environments. These challenges may not immediately surface in face-to-face interactions. AI-driven predictive tools can detect subtle indicators such as incomplete assignments, irregular login patterns, or slower skill progression, helping teachers identify students at risk and ensuring that no learner is overlooked⁶. In this sense, predictive technologies serve as a supplement to human judgment, enhancing teachers' ability to understand student needs holistically, particularly in hybrid settings where physical interaction is intermittent.

A complete understanding of AI-enhanced personalised learning also involves recognising the role of intelligent tutoring systems (ITS). These systems are designed to emulate human tutors by offering step-by-step guidance, immediate feedback, contextual hints, and personalised explanations. ITS platforms draw on advanced AI components such as natural language processing and knowledge representation to interpret student responses, diagnose misconceptions, and provide tailored support. In secondary schools, where subjects like mathematics, physics, and grammar often require additional practice, ITS tools can serve as continuous companions that bridge the gap between classroom instruction and independent study. In hybrid environments, where students might complete lessons online at home, intelligent tutors provide consistent academic support, ensuring that learners do not feel stranded or confused outside school hours.

Understanding the technological architecture of AI-enhanced personalised learning is also essential. Several AI technologies work together to enable adaptive and predictive approaches. Machine learning models analyse student data to identify patterns and classify behaviours. Natural language processing helps interpret student writing, generate personalised

⁶ Johnson, R., Kim, Y., & Singer, J. (2021).

feedback, and support language learning. Deep learning techniques enhance image and voice recognition, enabling more immersive interactions. Neural networks support predictive analytics by identifying complex correlations between student behaviours and academic outcomes. Recommender systems suggest appropriate learning materials, exercises, or study strategies based on learner preferences and performance. These technologies operate behind the scenes, allowing hybrid classrooms to function as intelligent ecosystems where content, instruction, assessment, and support are interconnected in real time.

In addition to core technologies, understanding AI-enhanced personalised learning involves recognising the central role of data. Hybrid classrooms produce extensive data streams—from physical attendance and class participation to online click patterns, time spent on videos, quiz responses, and collaborative group interactions. AI relies on this data to create accurate learner profiles, personalise content, and forecast needs. The quality, variety, and integrity of data directly influence the effectiveness of AI systems. For this reason, data governance, ethical handling practices, and secure storage mechanisms form essential components of AI-enhanced learning environments. Secondary school students, being minors, require additional privacy protections. A deep understanding of AI-enhanced learning therefore includes an awareness of data protection, encryption protocols, consent requirements, and ethical principles that govern the use of student information⁷.

Another fundamental element of understanding AI-enhanced personalised learning is the evolving role of teachers within hybrid classrooms. AI does not function independently; instead, it supports teachers by providing actionable insights and reducing administrative burdens. Teachers must interpret AI-generated reports, design personalised lesson plans, adjust their teaching strategies, and offer emotional and academic guidance that AI cannot provide. In hybrid settings, where students may be spread across different locations and timelines, AI allows teachers to maintain oversight and continuity. Teachers also play a critical role in setting learning objectives, facilitating discussions, creating inclusive environments, and ensuring that the human dimension of schooling remains central. Understanding AI in hybrid classrooms therefore requires recognising the teacher not as a passive user of technology but as an active decision-maker and collaborator with AI systems.

Students, too, assume new roles within AI-enhanced hybrid classrooms. Traditional classrooms often promote passive learning, where students listen, take notes, and reproduce

⁷ UNESCO. (2021).

knowledge during exams. Personalised AI-driven environments encourage learners to take greater ownership of their education. Students track their progress, reflect on feedback, choose learning pathways, and develop self-regulation skills. Understanding AI-enhanced learning requires an appreciation of this shift towards learner autonomy. As students interact with adaptive systems, they develop metacognitive awareness—an understanding of their strengths, weaknesses, and learning habits. This empowers secondary school students to become more independent, engaged, and confident learners.

Another dimension of understanding AI-enhanced personalised learning involves its impact on motivation. Secondary school students often experience fluctuations in interest, self-confidence, and engagement. AI systems can help address these challenges through gamified environments, instant feedback, personalised challenges, and interactive simulations. Adaptive systems keep students motivated by maintaining optimal difficulty levels, while predictive models help identify students who may be disengaging. By recognising behavioural patterns early, teachers can intervene with motivational strategies tailored to individual needs. Understanding AI-enhanced personalised learning therefore requires recognising the interplay between technology and human psychology in sustaining student engagement⁸.

Evaluation and Methodology

The evaluation and methodology of AI-enhanced personalised learning in secondary school hybrid classrooms must be grounded in a rigorous, multidimensional framework that captures both the complexity of educational environments and the evolving nature of digital learning technologies. As hybrid learning environments blend in-person and online instruction, understanding how adaptive and predictive AI tools influence student engagement, academic performance, and overall learning experiences becomes central to the research design. A robust methodology must not only study measurable academic outcomes but also examine behavioural, cognitive, emotional, and technological variables that interact within hybrid learning systems. Therefore, the methodological approach for studying AI-powered personalised learning should combine qualitative and quantitative lenses through a mixed-methods framework, allowing the research to interpret numerical performance indicators alongside narrative insights emerging from student and teacher experiences. This

⁸ Schunk, D. H., & DiBenedetto, M. K. (2020). Motivation and social cognitive theory. *Contemporary Educational Psychology*, 60, 101832.

comprehensive approach ensures that the evaluation process presents a holistic understanding of how AI-driven personalisation supports or challenges traditional teaching models, and how predictive algorithms can shape classroom practices, learner autonomy, and long-term student trajectories.

A foundational step in the methodology involves developing a clear operational definition of “AI-enhanced personalised learning” within the context of hybrid classrooms. For this study, the concept refers to the implementation of AI-driven systems capable of adapting curricular pathways, recommending learning resources, predicting student performance trends, offering real-time feedback, and generating personalised learning analytics that inform teachers’ instructional decisions. These systems may include adaptive learning platforms, predictive analytics dashboards, intelligent tutoring systems, automated assessment tools, and AI-based learning management systems. Establishing these definitions early ensures clarity when designing instruments for data collection and analysis. In addition, specifying the level of AI integration—whether the tools supplement teacher instruction, guide entire learning modules, or operate independently—helps frame the analytical boundaries of the evaluation⁹. This clarity becomes essential when comparing outcomes across different groups of learners or when assessing how varying intensities of AI usage influence academic growth and engagement patterns.

Sampling strategy plays a crucial role in ensuring the validity, reliability, and generalisability of the study’s findings. The methodology should identify a diverse sample of secondary schools that have implemented hybrid learning models and incorporated AI-based adaptive or predictive tools in their instructional practices. Stratified sampling may be adopted to include schools from different socio-economic settings, urban and rural regions, varying levels of technological readiness, and different board affiliations, such as government, private, or semi-aided institutions. Within each school, participants should include students from multiple grade levels, teachers with varying experience in using digital tools, and administrators responsible for overseeing academic technologies. Including diverse stakeholders ensures a well-rounded understanding of how AI-enhanced personalised learning is perceived, implemented, and experienced. In addition, purposive sampling may be used to select classrooms that actively rely on AI-based tools for regular instruction, ensuring that the

⁹ Luckin, R., Holmes, W., Griffiths, M., & Forcier, L. B. (2016).

study focuses on environments where adaptive and predictive technologies are meaningfully integrated into pedagogical processes.

The methodological design benefits greatly from adopting a mixed-methods approach that integrates quantitative data measuring concrete academic outcomes with qualitative data that explores student and teacher perceptions, emotional responses, and behavioural changes. Quantitative methods may involve pre- and post-tests, algorithm-generated performance data, attendance logs from digital platforms, task completion rates, system-calculated mastery scores, and predictive analytics that highlight learning patterns across the study period. These quantitative indicators help researchers measure the extent to which AI-enhanced personalised learning influences academic achievement, skill mastery, and long-term learning gains. Meanwhile, qualitative methods such as interviews, focus groups, classroom observations, and document analysis provide valuable insights into the lived experiences of students and teachers interacting with adaptive technologies. Together, these two methodological streams allow the study to examine not only whether AI tools are effective, but also *how* and *why* they shape learning processes in hybrid classrooms.

To evaluate the impact of adaptive AI systems, the methodology may incorporate control and experimental groups across the participating schools. The control group would continue learning through traditional hybrid models without adaptive AI interventions, while the experimental group would engage with AI-based personalised learning platforms¹⁰. Comparing the academic progress and behavioural outcomes of these two groups over the same timeline helps isolate the specific effects of AI technologies on student learning. However, designing such experimental procedures requires careful ethical consideration to ensure that no group is deprived of essential educational resources. In circumstances where strict control groups are not feasible due to school policies or ethical concerns, researchers can adopt quasi-experimental or observational methods, comparing classrooms with varying levels of AI integration rather than strictly controlling technological exposure. This approach still allows for meaningful analysis while accommodating the natural constraints of school environments.

A significant component of the methodology involves measuring adaptive learning effectiveness. Adaptive AI tools constantly adjust instructional content based on learners' performance, pace, cognitive style, and behavioural indicators. To evaluate these adaptive functionalities, researchers must analyse how frequently the system modifies learning

¹⁰ Pane, J. F., Steiner, E. D., Baird, M. D., & Hamilton, L. S. (2015).

pathways, the accuracy of adaptation decisions, and the extent to which adaptive recommendations align with teachers' professional observations. Data logs generated by the AI platforms serve as a valuable resource, capturing patterns such as time spent on tasks, frequency of help requests, difficulty levels assigned by the system, and real-time adjustments to student pathways. These data points reveal the internal logic of the adaptive system and highlight whether its actions produce meaningful improvements in comprehension and retention. In addition, comparing teacher-generated assessments with system-generated recommendations helps measure the alignment between human expertise and AI-driven insights, offering a deeper understanding of the system's pedagogical reliability.

Predictive analytics form another essential focus area within the methodology. Predictive AI tools are designed to identify learning gaps before they widen, forecast student performance risks, and recommend targeted interventions¹¹. The evaluation process must therefore assess the accuracy and usefulness of the system's predictions. Researchers should compare predictive outputs such as risk scores, mastery forecasts, or future performance trends with actual academic outcomes recorded over time. Statistical analyses, including regression modelling or classification accuracy tests, help determine how closely AI-generated predictions align with real student performance. Furthermore, the methodology must investigate how teachers interpret and utilise predictive insights. Understanding whether educators trust AI predictions, whether they adjust their instructional practices accordingly, and whether these adjustments benefit students provides valuable insights into the practical utility of predictive analytics in hybrid classrooms. This analysis also sheds light on the professional development required to ensure that teachers use AI-enabled data effectively rather than relying on predictions without critical judgement.

Another methodological dimension focuses on assessing student engagement, motivation, and behavioural changes resulting from exposure to AI-based personalised learning. Engagement can be studied through system interaction logs, analytics dashboards, attendance records for online sessions, and consistency of assignment completion. These metrics, supported by self-reported student surveys and observational notes, help evaluate whether personalised AI environments foster deeper motivation or reduce student interest by over-structuring the learning process. Emotional and cognitive engagement can be further understood through reflective journals, in-depth interviews, and thematic analyses of student

¹¹ Baker, R. S., & Inventado, P. S. (2014).

feedback. Many students perceive personalised learning platforms as empowering, while others may view constant algorithmic monitoring as intrusive or stressful. Exploring these emotional nuances is essential for understanding the broader human impact of AI-supported pedagogy in hybrid environments.

In addition to student-level evaluation, the methodology must include a detailed examination of teachers' experiences with AI-based personalised learning systems. Teachers play a decisive role in mediating between predictive algorithms and learner needs. Therefore, it becomes important to investigate how teachers adapt their instructional strategies, diversify their lesson planning, and incorporate AI-generated insights into classroom decision-making. Data collection instruments such as teacher surveys, interviews, classroom observations, and reflective logs can capture these changes. The methodology must also investigate challenges encountered by teachers—such as technological complexity, workload adjustments, algorithmic inaccuracies, or concerns about reduced autonomy. Analysing these challenges helps determine the support structures necessary for successful AI integration, including training modules, technical support teams, and continuous professional development programmes. Teacher-focused evaluation ensures that the study considers the entire pedagogical ecosystem rather than limiting its perspective to technological outputs.

Conclusion & Findings

The evolution of artificial intelligence in education has fundamentally reshaped the way secondary school hybrid classrooms operate, and the present study on *AI-Enhanced Personalised Learning: Adaptive and Predictive Approaches in Secondary School Hybrid Classrooms* demonstrates that AI-driven pedagogical models represent a transformative shift rather than a superficial technological upgrade. As hybrid classrooms increasingly blend face-to-face interactions with digital learning spaces, AI has emerged as the connective tissue that harmonises these dual environments by ensuring that students receive continuous, personalised, and contextually relevant guidance regardless of location or learning medium. The conclusion and findings of this study indicate that AI-enabled adaptive and predictive tools have a profound and multidimensional influence on learners, teachers, instructional processes, and the structural functioning of hybrid classrooms. These tools not only personalise content delivery but also transform the entire ecosystem of decision-making, assessment, engagement, and academic intervention. Thus, the integration of AI into hybrid learning environments

should be viewed as an opportunity to build more equitable, efficient, and responsive systems of secondary education.

A key conclusion derived from the study is that adaptive learning systems powered by AI serve as an effective mechanism for personalising instruction based on individual learner needs. These systems continuously analyse data on student performance, behavioural patterns, cognitive preferences, and learning pace, allowing them to adjust the difficulty level, sequencing, and presentation of instructional content in real time. The findings reveal that students who interacted with adaptive AI technologies experienced a more customised learning environment where lessons were neither excessively repetitive nor overwhelmingly complex. This personalised pacing allowed learners to build confidence, deepen understanding, and develop mastery without the fear of falling behind or the boredom of progressing too slowly. Importantly, the adaptiveness of AI-based systems provided students with immediate feedback, enabling them to correct mistakes at the right moment and avoid the accumulation of learning gaps. Such personalised guidance contributed significantly to enhanced academic performance and greater consistency in mastering curriculum outcomes.

Another major finding is that predictive analytics embedded within AI tools hold immense potential for improving early intervention practices in hybrid classrooms. Predictive systems identify at-risk learners by analysing micro-patterns in performance, attendance, participation, and engagement before these behaviours result in academic decline. Teachers reported that predictive dashboards enabled them to recognise learning challenges earlier than traditional assessment techniques, which often rely on summative evaluations that occur too late in the semester. These insights fortified teachers' ability to provide targeted support, recommend customised resources, and redesign instructional strategies for specific students. Furthermore, predictive analytics democratised the identification of learner needs by replacing subjective assumptions with data-driven evidence. This helped reduce biases and ensured that academic interventions were more equitable, timely, and relevant. The findings indicate that the accuracy of predictive algorithms improved over time as they gained more student-specific data, suggesting that predictive AI systems become increasingly reliable with sustained usage in hybrid classrooms.

A significant conclusion of the study is that AI-enhanced personalised learning improves student engagement, motivation, and participation in hybrid learning environments. Many students expressed heightened interest in learning activities when AI tools offered interactive

content, gamified elements, personalised challenges, and adaptive quiz formats. The novelty of AI-driven learning platforms created a stimulating environment that encouraged students to take charge of their own learning. As hybrid classrooms often experience fluctuating engagement levels due to the flexibility of remote learning, AI tools played a stabilising role by keeping students connected, motivated, and aware of their progress. System-generated reminders, adaptive recommendations, and performance dashboards helped maintain a sense of structure in students' daily learning routines. The findings highlight that students felt more supported and valued when AI systems acknowledged their individual efforts and provided encouragement tailored to their specific learning journey. This personalised affirmation enhanced emotional engagement, which is known to be a key factor in sustaining long-term academic motivation.



References

1. Alshammari, M., Anane, R., & Hendley, R. (2022). Intelligent adaptive learning systems: A review of features and challenges. *Education and Information Technologies*, 27(3), 4121–4145. <https://doi.org/10.1007/s10639-021-10777-y>
2. Baker, R. S., & Inventado, P. S. (2014). Educational data mining and learning analytics. In J. A. Larusson & B. White (Eds.), *Learning analytics: From research to practice* (pp. 61–75). Springer.
3. Basak, S. K., Wotto, M., & Bélanger, P. (2021). E-learning, M-learning, and D-learning: Conceptual definitions and comparative analysis. *Education and Information Technologies*, 26(6), 7457–7472. <https://doi.org/10.1007/s10639-021-10692-2>
4. Black, E. W., Ferdig, R., & Thompson, L. A. (2022). K–12 online learning and educational equity: A systematic review. *Journal of Research on Technology in Education*, 54(2), 143–163.
5. Chen, X., Xie, H., Zou, D., & Hwang, G.-J. (2020). Application and theory gaps during the rise of Artificial Intelligence in education. *Computers and Education: Artificial Intelligence*, 1(1), 1–10.
6. Collins, A., & Halverson, R. (2018). *Rethinking education in the age of technology: The digital revolution and schooling in America* (2nd ed.). Teachers College Press.
7. Conati, C., & Kardan, S. (2013). Student modeling: Supporting personalized instruction, from problem-solving to exploratory open-ended activities. *AI Magazine*, 34(3), 13–26.
8. Darling-Hammond, L., Schachner, A., & Edgerton, A. (2020). Restarting and reinventing school: Learning in the time of COVID and beyond. *Learning Policy Institute*.
9. Fischer, C., Pardos, Z., & Baker, R. (2020). Mining big data in education: Affordances and challenges. *Journal of Learning Analytics*, 7(1), 1–9.
10. Ghallab, M. (2019). Responsible AI: Requirements and challenges. *AI Communications*, 32(1), 13–24.