Artificial Intelligence–Supported Personalized Learning and Its Impact on Academic Engagement Among Students with Special Educational Needs in Inclusive Classrooms

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ABSTRACT:

Artificial intelligence (AI)-supported personalized learning has emerged as a promising approach for addressing the diverse educational needs of students with special educational needs (SEN) in inclusive classrooms. This study examined the impact of AI-supported personalized learning on academic engagement and related educational outcomes by comparing students receiving AI-assisted instruction with those receiving conventional teaching methods. A quantitative comparative research design was employed using data from 300 students, equally distributed between AI-supported and conventional instructional groups. Independent and paired sample t-tests, Pearson correlation analysis, reliability analysis, and multiple linear regression were conducted to evaluate group differences, relationships among variables, and predictors of academic engagement. The findings revealed that students exposed to AI-supported personalized learning demonstrated significantly higher post-intervention academic engagement, academic performance, attendance, task completion, and student satisfaction than those receiving conventional instruction ($p < 0.001$). Regression analysis further identified personalization, AI usage duration, teacher support, and attendance as significant predictors of post-intervention engagement, while accessibility and feedback quality were not significant independent predictors after adjustment. Overall, the findings indicate that AI-supported personalized learning can substantially enhance inclusive educational practices by promoting

individualized learning experiences and improving student participation and achievement. The study highlights the importance of integrating adaptive AI technologies with effective teacher support to create equitable, learner-centered, and inclusive educational environments.

Keywords: Artificial intelligence, Personalized learning, Inclusive education, Student engagement, Special educational needs

Introduction

Artificial Intelligence (AI) is probably one of the most prominent technological innovations in the field of education across the world. Due to the fast-paced development of such AI technologies as machine learning, NLP, and intelligent tutoring systems, it has become possible to create much smarter and more efficient education systems that work much faster and more personalized than the traditional ones. Unlike the traditional ways of learning based on standard curriculums and pedagogical techniques, learning powered by the help of AI can be personalized according to individual preferences of the learners. Thus, there is an opportunity to have automatic feedback, adaptive assessment, and intelligent suggestions that will help to make the learning process even better and more effective (Pedro et al., 2019; Ahmad et al., 2021). Personalized learning based on the use of AI technologies is a burning issue for the modern digital education environment.

Many educators now understand that personalized learning is a vital approach for engaging and achieving personalized student learning. AI-powered personalized learning systems adapt instruction, learning speed, and learning materials based on the cognitive capabilities, prior knowledge, and learning styles of learners. Adaptive learning environments foster self-directed learning, enhance intrinsic motivation and offer immediate feedback and insights that allow students to be more successful at overcoming learning challenges than through traditional approaches to teaching and learning (Alamri et al., 2020). Additionally, recent research has shown how AI-driven educational assistants and adaptive learning systems can enhance students' learning by providing personalized support, suggesting appropriate learning paths, and real-time tracking of academic performance (Sajja et al., 2024; Hardaker & Glenn, 2025). In this context, AI-driven personalization becomes seen as a key element that is vital to future educational systems.

AI has a lot of significance in inclusive classrooms, where students with special educational needs (SEN) are integrated with their peers. The main idea behind inclusive education is the right to access quality education for all learners regardless of their differing cognitive, behavioral, physical and communication needs. For teachers, it is difficult to give individualised teaching that meets different learning needs of students with SEN and at the same time has to cater for the needs of all students in the class (Nilsen, 2020). The use of AI in personalized learning has the potential to provide promising solutions, such as offering adaptive learning materials, assistive technologies, personalized feedback, and accessible learning resources that cater to the individual needs of each student based on their learning profile. The use of these technologies can enhance the accessibility of education and minimize barriers to participation, fostering more inclusive and effective learning environments (Karagianni & Drigas, 2023).

Academic involvement is known to be a key factor in achieving educational success and is comprised of three factors: behavioral, emotional and cognitive. Students who are highly engaged tend to be more motivated, persist longer, are more active in classroom activities and do better in school than those who are less engaged (Smithikrai et al., 2018). By offering personalised learning environments,

real-time feedback, adaptive support for teaching and learning, and custom learning trajectories, AI-driven personalised learning can bolster academic engagement through a variety of interactive learning experiences, ongoing feedback and custom learning pathways that create and maintain student motivation throughout learning. Recent studies suggest that utilizing AI in personalized learning can positively impact a student's engagement, satisfaction, and learning outcomes by fostering more personalized and student-centred learning experiences (Yu & Yao, 2024; Saleem et al., 2025).

While these are positive strides, there are key research areas that still need to be addressed, especially in the context of using AI to support personalised learning with learners with SELN. Previous studies have been conducted at the post-secondary level or with students in general, with less attention being paid to classrooms that have individualized educational support, especially in the context of the classroom being a setting for inclusion (Merino-Campos, 2025; Hardaker & Glenn, 2025). Moreover, few empirical studies have investigated the joint effects of AI-enabled personalization, teacher support, accessibility and academic engagement of students with SEN. This is crucial in order to understand how AI technologies can be best implemented in inclusive education, ensuring an equal and fair opportunity for all students to learn. Therefore, this study explores the effect of personalized learning with AI on academic engagement of students with SEN in inclusive classrooms and offers quantitative evidence that can inform the design of more effective and inclusive AI-enabled learning environments, for educators, policymakers and educational technology developers.

Research Objectives

1.To evaluate the impact of AI-supported personalized learning on academic engagement among students with special educational needs.

2.To examine the effects of teacher support and learning accessibility on students' academic engagement.

3.To compare the academic engagement of students receiving AI-supported personalized learning with those receiving conventional instruction.

2. Methodology

2.1 Research Design

The design of the study used a quasi-experimental quantitative research design to investigate the effect of AI-powered individualised learning on academic engagement in inclusive classrooms for students with special educational needs (SEN). To compare the effect of implementing AI-supported personalized instruction with that of a comparison group, the research used an intervention group and a comparison group. The design included the ability to evaluate relationships between educational outcomes and the AI-based approach to learning strategies and to consider relevant student characteristics.

2.2 Participants and Dataset

The study involved 300 students in inclusive classrooms, including 150 students who were taught with AI-assisted personalized learning and 150 others who were taught in traditional classrooms (Kabir et al., 2026). The variables included in the dataset were demographic variables (age, gender, SEN category, and the level of support needed) and educational variables (AI personalization level, weekly AI usage, support provided by teachers, accessibility of learning, academic engagement, attendance, completion of task, satisfaction with learning, and academic performance). The following variables were used as a good basis for assessing the effectiveness of AI-assisted personalized learning in an inclusive education environment.

2.3 Study Variables

Participation in AI-supported personalized learning was the independent variable. Academic engagement was a dependent variable. Other outcomes measured were academic achievement, school attendance, task completion and satisfaction with learning. Teacher support, learning accessibility, AI personalisation level and weekly AI usage were used as explanatory variables; age, gender, grade level, SEN category, and support-need level were used as control variables, thereby

minimising potential confounding and enhancing the robustness of the statistical analysis.

2.4 Statistical Analysis

The statistical analyses were conducted within Python and the libraries Pandas, NumPy, SciPy, Statsmodels, and Scikit-learn were used. The data summarization technique used were descriptive statistics such as frequencies, percentages, mean and standard deviation to summarize the participants' characteristics and study variables. Independent-samples t-tests were used to compare the post-intervention results of the AI-supported learning and conventional learning groups, and Pearson correlation analysis was employed to explore correlations between major variables. Demographic characteristics were controlled and multiple linear regression analysis was employed to determine significant predictors for academic engagement. Data was analyzed for statistical significance at $p < 0.05$ and plotted using Matplotlib and Seaborn.

2.5 Ethical Considerations

The study abided by the internationally accepted principles of research ethics such as confidentiality, data privacy, transparency and responsible application of artificial intelligence in educational research. Participant information was anonymised before analysis, and no personal data was included in the data set. The research was carried out for purely academic purposes, and all analyses were done in an objective way to ensure the accuracy, reproducibility and integrity of the results. The study adhered to the ethical standards of educational research and responsible use of data.

3. Results

3.1 Participant Characteristics and Baseline Comparability

The baseline characteristics of the participants are described in Table 1. The age ($p>0.05$), grade level ($p>0.05$), digital competence ($p>0.05$), baseline engagement ($p>0.05$), and baseline academic performance ($p>0.05$) of the AI-supported personalized learning group were not statistically different from the conventional instruction group before the intervention.

Table 1. Participant Characteristics and Baseline Comparability Between Instructional Groups

Variable	AI-supported Personalized Learning (n=150)	Conventional Instruction (n=150)	t	p
Age (years)	14.85 ± 2.12	15.15 ± 2.02	-1.226	0.221
Grade level	8.88 ± 2.02	9.13 ± 1.99	-1.066	0.287
Digital competence	3.21 ± 0.97	3.21 ± 0.85	0.063	0.950
Pre-intervention engagement	3.12 ± 0.63	3.06 ± 0.64	0.842	0.400
Pre-intervention academic score	59.40 ± 9.20	59.50 ± 9.82	-0.093	0.926

3.2 Descriptive Statistics and Reliability

Table 2. Descriptive Statistics and Internal Consistency of the Study Variables

Table 2 illustrates that students' engagement, achievement, attendance, task completion, and satisfaction were moderate-to-high after the intervention. The engagement instrument showed good internal consistency both pre and post intervention with Cronbach's alpha values of 0.866 and 0.833 respectively.

Variable	Mean ± SD	Minimum	Maximum

Post-intervention engagement	3.46 ± 0.74	1.75	5.00
Post-academic score	65.96 ± 11.25	31.10	93.00
Attendance rate	88.38 ± 5.70	73.40	100.00
Task completion rate	75.85 ± 9.66	50.70	100.00
Student satisfaction	3.63 ± 0.65	2.00	5.00
Pre-intervention engagement reliability	α = 0.866	—	—
Post-intervention engagement reliability	α = 0.833	—	—

3.3 Comparison of Post-Intervention Outcomes

As shown in Table 3 and Figure 1, all post-intervention outcomes favored students receiving AI-supported personalized learning when compared to those receiving conventional learning. There were significant improvements across all measures (all $p \leq 0.001$) and effect sizes were medium to very large about engagement, academic performance, attendance, task completion, and student satisfaction.

Table 3. Between-Group Comparison of Post-Intervention Outcomes

Outcome	AI-supported Personalized Learning	Conventional Instruction	t	p	Cohen's d
Post-engagement	3.80 ± 0.66	3.11 ± 0.66	9.086	<0.001	1.049
Engagement change	0.69 ± 0.28	0.06 ± 0.18	23.337	<0.001	2.695
Academic score	70.01 ± 10.15	61.90 ± 10.85	6.688	<0.001	0.772
Attendance	89.46 ± 5.50	87.30 ± 5.71	3.325	0.001	0.384
Task completion	81.74 ± 7.67	69.95 ± 7.65	13.324	<0.001	1.539
Student satisfaction	4.02 ± 0.50	3.23 ± 0.54	13.167	<0.001	1.520

3.4 Within-Group Improvement

Table 4 shows that there were significant gains for both instructional groups after the intervention. The personalized learning group, however, with the help of AI, showed significantly better growth in engagement and learning outcomes compared to the traditional instruction group.

Table 4. Pre–Post Comparisons Within Each Instructional Group

Group	Outcome	Pre	Post	t	p	Cohen's d
AI-supported	Engagement	3.12 ± 0.63	3.80 ± 0.66	29.966	<0.001	2.447
AI-supported	Academic score	59.40 ± 9.20	70.01 ± 10.15	35.186	<0.001	2.873
Conventional	Engagement	3.06 ± 0.64	3.11 ± 0.66	3.830	<0.001	0.313
Conventional	Academic score	59.50 ± 9.82	61.90 ± 10.85	7.983	<0.001	0.652

3.5 Correlation Analysis

As shown in Table 5 and Figure 2, the use duration of AI had excellent positive correlation with personalization ($r = 0.760$, $p < 0.001$), feedback quality ($r = 0.733$, $p < 0.001$), task completion ($r = 0.578$, $p < 0.001$), and student satisfaction ($r = 0.534$, $p < 0.001$). There was a moderate association between post-intervention engagement and academic performance ($r = 0.438$) as well as student satisfaction ($r = 0.472$), highlighting the link between using AI and personalization and positive learning outcomes.

Table 5. Pearson Correlation Matrix of Major Study Variables

Table 6 and Figure 3 show the results of multiple linear regression analysis. The overall model was statistically significant and accounted for 27.3% of the variance in academic engagement in the post intervention period. The extent to which the teaching was personalized, the amount of time spent using AI, teacher support, and attendance were statistically significant positive factors in engagement, while accessibility and quality of feedback were not. No problematic phenomenon of multicollinearity was found among the predictor variables as all VIF values were less than 5.

3.6 Multiple Linear Regression Analysis

Table 6. Multiple Linear Regression Predicting Post-Intervention Academic Engagement

Predictor	B	SE	t	p
AI use duration	0.0017	0.0008	2.128	0.034
Personalization	0.1773	0.0518	3.424	<0.001
Accessibility	0.0258	0.0483	0.533	0.595
Teacher support	0.1251	0.0471	2.656	0.008
Feedback quality	0.0017	0.0536	0.031	0.975
Attendance	0.0249	0.0066	3.750	<0.001

Model statistics: $R^2 = 0.273$, Adjusted $R^2 = 0.258$, $F = 18.341$, $p < 0.001$.

4. Discussion

This current research investigated how well the use of AI based personalized learning improves academic engagement for students with special educational needs (SEN) in inclusive classrooms. The results showed that students who received AI-based personalized learning outperformed students who received the conventional instruction on the following measures: post-intervention engagement, academic achievement, attendance, task completion, and student satisfaction with learning. Comparisons made at the baseline stage were statistically equivalent between both groups of instruction, increasing the validity of the differences observed after the intervention. This is aligned with the increasingly robust evidence of the value of an AI tool in supporting personalized learning by customizing content, pace, and feedback to students' current academic needs and progress (Merino-Campos, 2025; Sajja et al., 2024). The significant effects achieved in various educational outcomes also point to the potential for valuable learning benefits in an inclusive classroom setting.

One of the key findings of the present study is that student engagement has significantly increased after the implementation of AI supported personalized learning. Students who had exposure to adaptive learning technologies showed higher levels of behavioral, emotional,

cognitive and social engagement than students in traditional instruction. Correlation analysis also showed positive correlations between the use of AI with personalization, satisfaction with the learning process, completion of tasks, and engagement in learning, suggesting that using adaptive instruction is conducive to active participation in the learning process. The results are aligned with previous studies, which demonstrate that an AI-based personalized learning system can enhance students' motivation, active involvement in the learning process, and long-term engagement in studies by adaptively tailoring teaching strategies and content to the specific learning features of each student (Yu & Yao, 2024). Likewise, Saleem et al. (2025) found that AI-powered learning platforms positively impact educational outcomes through personalized learning experiences that enhance student engagement and motivation throughout the learning journey.

Regression analysis gives additional insight into the factors that affect academic engagement. AI usage duration, attendance, teacher support and personalization were found as the strongest independent predictors of post-intervention engagement. There is some indication that while artificial intelligence can offer adaptive learning opportunities, the role of the teacher is crucial for achieving meaningful learning outcomes and active student engagement is essential. This finding is similar to the previous systematic reviews which discussed the role of teacher support in inclusive learning settings, where AI is used as a support tool and not a substitute for the teachers (Bhutoria, 2022; Hariyanto et al., 2025). Similarly, sufficient educational materials and support from educators have been recognized as key factors in providing positive learning experiences for students with disability, especially for the integration of innovative educational technologies in the classroom (Gesel et al., 2022). Based on the present results, the need to integrate technological innovation and human-centered teaching strategies in a balanced way is once again reinforced.

Another intriguing finding was that while these two were positively associated in bivariate models with some educational outcomes, they were not significant independent predictors after including the other factors. The results indicate that the construct of accessibility can be a foundational requirement that facilitates effective learning but not make a direct contribution to engagement when personalization and teacher support is considered. Recent research highlights that successful implementation of AI in the classroom continues to rely on conditions of inclusivity with regards to accessibility, equity in learning opportunities and supportive institutional environments (Walter & Visconti, 2025; Lata, 2024). It is crucial that accessibility is part of a wider learning environment that is inclusive and not treated as something separate.

In general, the results are of relevance to educational practice and policy. Educational institutions are advised to embrace AI-driven personalized learning platforms to enhance inclusive education and provide opportunities for teacher development, digital infrastructure, and access to education technologies that are equitable. AI-based learning analytics can help teachers identify students in need of extra support and enable timely interventions in teaching (Silva et al., 2024). This is in line with the prevailing conversation concerning the responsible use of AI in education, as it is evident that there should be collaboration among teachers, policymakers, and technologists (Moharana, 2025; Watkins, 2022).

5. Conclusion

It demonstrates that the use of personalized learning through artificial intelligence could make a great difference in improving academic engagement and learning outcomes among children with special education needs in an inclusive classroom environment. Learning through AI was found to be significantly more beneficial in terms of engaging students and making them successful and more engaged academically, attending classes and completing their tasks, as well as being satisfied with learning. Personalization, teacher involvement, time spent on AI, and attendance were some of the critical factors affecting the academic engagement of children through AI. However, accessibility and feedback quality do not significantly predict outcomes independently in

the multivariate model but are essential components of an inclusive learning environment for equitable participation. Overall, the study findings reveal that the role of AI can be regarded as complementary to education rather than a replacement for the human educators to meet the needs of all students. From the practical standpoint, there should be created a learning environment which would include personalized learning with the use of AI, teacher development, digital infrastructure development, and implementation strategy development based on evidence. It is advisable to conduct longitudinal and multisite studies involving different disability groups and schools to evaluate the effectiveness, scalability, and sustainability of the use of AI for personalized learning.

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