



AI-enabled adaptive learning and its impact on learner engagement and academic performance

Dr. Meenakshi Joshi^{1*} and Deepansh Joshi²

¹ Mahatma Jyotiba Phule Rohilkhand University, Bareilly, Uttar Pradesh, India

² O. P. Jindal Global University, Sonapat, Haryana, India

*Corresponding author: Dr. Meenakshi Joshi

Received 11 Sep 2025; Accepted 27 Oct 2025; Published 3 Nov 2025

DOI: <https://doi.org/10.64171/JAES.5.4.80-85>

Abstract

The incorporation of Artificial Intelligence (AI) into digital learning environments has revolutionized the framework and dissemination of higher education. Adaptive learning systems that use AI are made to make educational content more personal, change the way lessons are taught based on how well students do, and make school more interesting. In populous and demographically varied states like Uttar Pradesh, where higher education institutions cater to substantial student bodies, the deployment of adaptive digital platforms presents considerable opportunities for enhancing educational outcomes. This study examines the influence of AI-driven adaptive learning systems on student engagement, academic achievement, and satisfaction among 175 higher education students from universities and colleges in Uttar Pradesh. The study used a mixed-methods approach, which combined structured analytical procedures with quantitative survey methods. The data were gathered through a standardized questionnaire organized around four main constructs: the efficacy of AI-enabled adaptive learning, learner engagement, academic performance, and satisfaction with the e-learning environment. We used a five-point Likert scale to measure the answers. The reliability analysis showed that all of the constructs were very consistent with each other. Confirmatory factor analysis validated the measurement model, and regression analysis indicated a statistically significant positive correlation between AI-enabled adaptive learning and learner engagement. Also, learner engagement had a strong predictive effect on academic performance, which means it had a mediating effect. Analysis of variance revealed disparities in satisfaction levels contingent upon institutional type and prior experience with e-learning platforms. The findings indicate that AI-based adaptive learning systems make the learning process more individual, active, and the students can improve their performance in school. This is because students who had prior experience with digital learning settings reported being more engaged and performing well at school. Besides, specific differences in satisfaction were observed between the demographic groups, which shows that contextual and institutional factors play a crucial role in the process of adopting digital learning. The given research contributes to the research on AI in higher education by offering some real-world data on a big Indian state. The findings display the extent to which adaptive learning technologies have the potential to transform the learning process of students, their grades, and general quality of education. The research provides significant insights for educational policymakers, institutional administrators, and technology developers aiming to enhance digital learning strategies in higher education systems.

Keywords: Artificial Intelligence (AI), Higher Education, Learning Systems, College/University Students

1. Introduction

Online technologies are increasing tremendously and this has transformed the manner in which tertiary education functions. Increasingly schools and colleges in India are employing technology-based solutions in the management of issues of access, quality and diversity of learners. One of these new technologies is called Artificial Intelligence (AI) and it can transform the way education is provided. The most developed application of this technological shift is in adaptive learning platforms powered by AI. Traditional schools have long been using standardized teaching practices. These models can be effective in formal classroom settings, but they do not usually consider the difference in the learning pace of various individuals, their level of prior learning, their thinking styles, and motivation. Instead, adaptive learning systems apply intelligent algorithms to track student behaviour, gauge their performance during real time and adjust the manner of content delivery according to this. Such personalization is supposed to

seal the information gaps, clarify concepts and ensure that students perform better at school.

Colleges and universities in the state of Uttar Pradesh, which is one of the largest and most populated states of India, have their own structural and teaching issues. There are numerous colleges and universities in the state that accommodate students of every type in terms of their backgrounds, financially, and academically. The variations in the infrastructure in the schools, resources the teachers have, and the digital literacy levels all influence the effectiveness of the students in their learning. These systemic issues require learning solutions which can develop and evolve. Adaptive learning systems that are run by AI are a solution to these issues. Data analytics, automated feedback systems, and predictive modeling help these platforms create ever-changing learning environments that can meet the needs of individual learners. Not only do such systems tailor learning paths to the individual student, but they also provide an educator with details regarding the

performance of his or her students, which allows teachers to intervene when necessary.

1.1 Evolution of adaptive learning technologies

The adaptive learning technologies have gone through a number of stages. Most early digital learning systems were simply concerned with the digitization of content and the provision of courses online. Improvements followed later to include interactive capabilities, automated testing tools, and easy tracking of the students. However, these initial models did not really allow the people to make their own choice. With the progressive improvement in machine learning and data analytics, modern adaptive learning platforms have the ability to continuously monitor the performance of students due to the use of superior algorithms. Such systems determine what you are good at, what you need to improve, adjust the difficulty, recommend particular resources, and provide you with feedback in real time. The incorporation of real-time analytics will enable continuous enhancement in learning paths that will yield superior interaction and academic outcomes. The emergence of mass-sized digital learning platforms, particularly following international systems disruptions to traditional education, accelerated the implementation of adaptive platforms. More and more, universities are realizing how important learner-centered digital ecosystems are that put a premium on flexibility, accessibility, and personalization.

1.2 The higher education situation in Uttar Pradesh

Uttar Pradesh is a special education environment due to its high population and a variety of diverse schools. The state has central universities, state universities, private schools and technical colleges. Colleges in the urban areas might have an excellent digital infrastructure, whereas rural and semi-urban colleges usually face technological problems. The largest of the issues include:

- A lot of students compared to teachers
- Few ways to teach that involve students
- Differences in levels of digital literacy
- Not everyone has the same access to technology
- Standardized curricula that don't take into account different speeds of learning

These issues demonstrate the significance and the importance of possessing smart systems that are capable of delivering individualized learning experience. The quality of instruction could be filled in due to AI-based adaptive learning platforms that provide learners with the personalized, data-driven, and consistent assistance with their studies.

1.3 Theoretical framework of the research

The present research rests on the conceptual framework that examines four major constructs interrelations:

- Adaptive Learning with AI
- Engagement of Learners
- School Performance
- Satisfaction with the E-Learning Environment

The independent variable that influences the engagement of students and the academic performance is adaptive learning

with AI. Learner engagement is a multidimensional construct that incorporates behavioral, cognitive and emotional participation in the learning activities. Academic performance can be used to gauge the performance of an individual in school such as grades, ability to comprehend concepts and development of skills. Satisfaction demonstrates the emotion by the learners regarding the effectiveness of the digital environment and its ease of use. According to the framework, adaptive learning that provides personalized, interactive, and timely feedback will make people more interested. With greater involvement, there is improved performance in school. It is anticipated that satisfaction will mediate and strengthen these relationships.

1.4 Reason for the research

Even though digital learning has grown quickly, there isn't much research on AI-enabled adaptive learning in large Indian states. Majority of the current studies focus on small institutional samples or hypothetical studies of technological benefits. To assess the real effect of adaptive systems on student performance there is the need of systematic empirical studies using statistical validation strategies to examine the impact of adaptive systems.

In this work, the researcher observes 175 respondents of the higher education institutions in Uttar Pradesh, providing a specific research context on the effectiveness of AI-based adaptive learning. The study investigates both direct relationships among constructs and demographic disparities in engagement and satisfaction levels.

1.5 Importance of the study

This study is important for:

- **Educational institutions:** To assess the efficacy of AI integration strategies.
- **Policymakers:** To back digital education changes that are based on facts.
- **Technology developers:** To improve adaptive learning systems based on what students need.
- **Researchers:** To add to the theoretical and empirical discussion about AI in education.

The research can help to continue with the current tendency to modernize higher education systems as it represents the detailed statistical overview of the engagement and performance of the learners working in the digitally adaptive setting.

2. Objectives of research

Application of Artificial Intelligence (AI) in higher education has resulted in the adoption of adaptive learning systems which alter the lesson content depending on the performance of students and the level of their interest. Although an increased number of institutions are adopting these systems, empirical evidence on the effectiveness of these systems has not been available in large Indian states such as Uttar Pradesh. Therefore, this paper aims to examine the measurability of the impact of adaptive learning systems based on AI on student engagement and learning outcomes in higher education. The primary research questions of this are:

- To investigate the effects of adaptive learning systems based on AI and its effect on student engagement.

The specific goals are-

- To determine the impact of learner engagement on academic performance.
- How AI-driven adaptive learning systems impact academic performance directly.
- To validate a theoretical model between adaptive learning, engagement and performance.
- To examine that there is a demographic difference in engagement and performance indicators.

3. Review of literature

3.1 AI in schools and other educational systems

Over the past 20 years, the use of artificial intelligence in education has changed a lot. The first smart systems were mostly about rule-based tutoring and ways to represent knowledge. In a paper by Afanasyev, Voit, and Kanev (2016) titled Development of Intelligent Learning System Based on the Ontological Approach, the authors discussed how the modeling of the learner knowledge would facilitate more flexibility in the system. Their study revealed the opportunity of AI to demonstrate conceptual hierarchies and alter the material of lessons to adapt.

In the article Intelligent Tutoring System Authoring Tools: The Design Characteristics, Adenowo and Adenowo (2016) examined how the intelligent tutoring systems are designed and stated that adaptive instruction requires system flexibility and modeling of learners to be effective. They reported that individualizing the lessons simplifies the learning process and the ability of students to retain what they learn.

Almohammadi, Hagra, Alghazzawi, and Aldabbagh (2017) conducted a survey in their paper, A Survey of Artificial Intelligence Techniques Employed in Adaptive Educational Systems in E-Learning Platforms to investigate AI techniques used in adaptive learning systems, such as fuzzy logic, neural networks, and machine learning. Their study found that AI-based personalization makes learning much more efficient than static digital platforms.

These basic studies all show that AI-powered systems can change content on the fly. This is the theoretical basis for adaptive learning platforms.

3.2 Personalization and adaptive learning

Adaptive learning systems are made to change based on how well a student is doing in real time. Brusilovsky (2001), in his seminal work "Adaptive Hypermedia," presented the idea of personalized content navigation predicated on user modeling. He said that adaptive systems make learning more efficient by changing the way lessons are taught based on what the student wants to learn and what they already know.

In User Models of Adaptive Hypermedia and Adaptive Educational Systems, Brusilovsky and Millan (2007) said more about adaptive algorithms and how learners can be modeled. They discovered that adaptive personalization helps the learners be more independent and engage themselves in whatever they are learning.

Chen and Duh (2019) demonstrated that deep learning algorithms can determine what a learner requires by identifying what the learner needs and adjusting the lesson intensity in the article Personalized E-Learning System Design Based on Deep Learning. Their findings reflected greater interest and learning in customized virtual environments.

The study Chen, Zou, and Xie (2022) are engaged in is a personalized adaptive learning, which after conducting a systematic review they discovered that adaptive systems enhance knowledge retention and cognitive engagement significantly.

These articles demonstrate that adaptive personalization directly influences the level of engagement and school performance of students.

3.3 How students get involved in digital environments

Most people agree that learner engagement is a complex idea that includes behavioral, emotional, and cognitive aspects. Fredricks, Blumenfeld, and Paris (2004) wrote in their article, School Engagement: Potential of the Concept, State of the Evidence that engagement is one of the critical aspects of academic achievement. In their framework, behavioral participation, emotional involvement, and cognitive investment are the primary components listed.

Bimba, Idris, and Al-Hunaiyyan (2017) discussed the significance of personalized feedback in sustaining interest among people in the learning environment in the article titled Adaptive Feedback in Computer-Based Learning Environments: A Review. Their research indicated that adaptive feedback mechanisms augment learner motivation and task perseverance.

In their article, The Impact of AI-Driven Personalization on Learners, Das, Malaviya, and Singh (2023) provided empirical evidence of the fact that AI-driven systems contribute substantially to the level of engagement, which, in turn, influences academic performance.

Taken together, these studies back up the idea that adaptive learning environments improve engagement, which in turn leads to academic success.

3.4 Academic performance in AI-driven settings

Academic performance encompasses such aspects as grades, degrees of mastery and student comprehension of concepts. In their article, Chen and Yang (2020) stated that adaptive learning models can enhance student academic performance due to their ability to discover knowledge gaps and present study participants with relevant content.

Govindarajan, Kumar, and Kinshuk (2017) demonstrated in the article Dynamic Learning Path Prediction A Learning Analytics Solution that predictive analytics can enhance performance significantly by making the instructional sequences effective.

In their study, Modeling a Learner Affective state in Real Time to Increase Intelligent Tutoring Effectiveness, Brawner and Gonzalez (2016) stated that AI systems capable of detecting emotions of a learner enhance the performance, adjusting themselves to those emotions.

These practical researchers indicate that adaptive learning systems supported by AI can have a direct influence on the performance of students in school by creating lessons that are personalized to their needs and offer predictive analytics.

3.5 Research gap

There has been a lot of research on adaptive learning systems around the world, but not much has been done on large and demographically diverse Indian states like Uttar Pradesh. Moreover, much of the research examines each of the two aspects of engagement and performance independently rather than the way in which they influence one another in a systematic statistical framework. The current study fills this gap by empirically examining the relationships between AI-enabled adaptive learning, learner engagement, and academic performance through a structured hypothesis-driven framework.

4. Research hypotheses

Based on the literature review and conceptual framework, the study proposes the following three hypotheses:

H1: AI-enabled adaptive learning systems significantly enhance learner engagement.

H2: Being engaged in learning has a big positive effect on how well students do in school.

H3: Adaptive learning systems that use AI have a big positive effect on academic performance.

5. Research methodology

5.1 Research design

The research employs a quantitative design underpinned by descriptive and inferential statistical methodologies. The design is explanatory and seeks to evaluate causal relationships among the variables.

5.2 Population and the sample

- The target population consists of undergraduate, postgraduate, and doctoral students enrolled in higher education institutions throughout Uttar Pradesh.
- We used stratified sampling to make sure that all 175 valid responses were collected from different groups.

5.3 Ways to analyze data

Following statistical methods will be used:

- Statistics that describe
- Reliability Analysis (Cronbach's Alpha)
- Analysis of Correlation
- Analysis of Multiple Regression
- Testing for mediation (engagement as a mediator)
- ANOVA (for comparing demographics)

5.4 Limitations of research

The study has some flaws, even though it made some important contributions:

- The sample size of 175 respondents, although statistically adequate, constrains broader national generalization.
- The cross-sectional design limits long-term causal inferences.
- Self-reported data may lead to perceptual bias.
- The research is solely concentrated on higher education students in Uttar Pradesh.

6. Discussion

We present the statistical analysis of data obtained from 175 higher education students in Uttar Pradesh. The analysis aims to evaluate the three proposed hypotheses and confirm the conceptual model that connects AI-enabled adaptive learning, learner engagement, and academic performance.

6.1 Demographic information about the respondents

We find total of 175 valid responses.

Table 1: Shows the demographic distribution (N = 175)

Variable	Category	Frequency	Percentage (%)
Gender	Male	86	49.1%
	Female	89	50.9%
Academic Level	Undergraduate	92	52.6%
	Postgraduate	63	36.0%
	Doctoral	20	11.4%
E-Learning Experience	< 1 Year	32	18.3%
	1–2 Years	58	33.1%
	2–5 Years	60	34.3%
	> 5 Years	25	14.3%

The sample shows a good mix of genders and moderate exposure to digital learning, which makes the results more generalizable.

6.2 Descriptive statistics

Table 2: Descriptive statistics of constructs

Construct	Mean	Standard Deviation
AI-Enabled Adaptive Learning	3.94	0.61
Learner Engagement	4.01	0.58
Academic Performance	3.88	0.64

The average values show that people generally have positive views of adaptive learning systems, engagement, and performance outcomes.

6.3 Analysis of reliability

Cronbach's Alpha was used to measure internal consistency.

Table 3: Reliability results

Construct	No. of Items	Cronbach's Alpha
AI-Enabled Adaptive Learning	6	0.86
Learner Engagement	6	0.88
Academic Performance	6	0.84

All constructs surpass the acceptable threshold of 0.70, thereby affirming robust internal consistency and measurement reliability.

6.4 Analysis of correlation

We used Pearson correlation analysis to look at how variables were related to each other.

Table 4: Correlation matrix

Variables	AI Adaptive	Engagement	Performance
AI Adaptive	1		
Engagement	0.72**	1	
Performance	0.68**	0.75**	1

** $p < 0.01$

There are strong positive correlations between all of the variables, which supports further regression analysis.

6.5 Testing hypotheses with regression analysis

6.5.1 Testing hypothesis 1

H1: AI-enabled adaptive learning systems significantly enhance learner engagement.

Table 5: Results of the regression (AI → Engagement)

Model	R	R ²	Beta (β)	t-value	p-value
Model 1	0.72	0.52	0.72	13.94	< 0.001

< 0.001

AI-enabled adaptive learning accounts for 52% of the variance in learner engagement. The beta coefficient ($\beta = 0.72$) is statistically significant ($p < 0.001$), which supports H1.

6.5.2 Testing hypothesis 2

H2: Being engaged in learning has a big positive effect on how well students do in school.

Table 6: Results of the Regression (Engagement → Performance)

Model	R	R ²	Beta (β)	t-value	p-value
Model 2	0.75	0.56	0.75	15.26	< 0.001

< 0.001

Learner engagement accounts for 56% of the variance in academic performance, thereby supporting H2.

6.5.3 Testing hypothesis 3

H3: Adaptive learning systems that use AI have a big positive effect on academic performance.

Table 7: Results of the Regression (AI → Performance)

Model	R	R ²	Beta (β)	t-value	p-value
Model 3	0.68	0.46	0.68	12.02	< 0.001

< 0.001

AI-enabled adaptive learning accounts for 46% of the variance in academic performance, thereby supporting H3.

6.6 Mediation analysis

A mediation regression model was tested to see if learner engagement affects the link between adaptive learning and performance.

Step 1: AI → Performance (Direct Effect)

$\beta = 0.68$ (Significant)

Step 2: AI → Engagement

$\beta = 0.72$ (Significant)

Step 3: AI + Engagement → Performance

Table 8: Shows the mediation model

Predictor	Beta	t-value	p-value
AI Adaptive	0.32	5.21	< 0.001
Engagement	0.61	9.74	< 0.001

After adding engagement, the beta value of AI goes down from 0.68 to 0.32, which shows that it is partially mediated.

This substantiates that learner engagement partially mediates the correlation between AI-enabled adaptive learning and academic performance.

6.7 ANOVA analysis

ANOVA was utilized to analyze disparities among e-learning experience groups.

Table 9: ANOVA results

Variable	F-value	p-value
Engagement	4.82	0.003
Performance	5.11	0.002

There are big differences between groups with different levels of e-learning experience. Students with 2 to 5 years of experience said they were more engaged and did better work.

6.8 Results

- The findings indicate that AI-based adaptive learning system would make students significantly more interested in learning. The large value of the beta coefficient (0.72) indicates that personalization, feedback systems and adaptive content delivery contribute significantly to the extent to which the students take part.
- The most important predictor of academic performance was the one of learner engagement. This observation supports the engagement theory which postulates that thinking and acting affect learning outcomes.
- Direct impact of adaptive learning on performance The direct impact of adaptive learning on performance indicates the presence of AI-driven personalization to assist students in learning more and advancing at school.
- The mediation analysis also explains how adaptive systems have an impact on performance- through the increase of the levels of engagement.
- The outcomes of the ANOVA show that the efficacy of adaptive learning can be improved with the help of digital familiarity. Those students who have consumed e-learning minimally or largely can employ AI-driven features better.

6.9 Future implications

According to the outcomes, several things can occur in future:

- University/Higher education institutions should include adaptive systems based on AI in the standard curricula.
- Similar to other faculty training programs, AI literacy must be included.
- Money should be invested in the development of digital infrastructure by policymakers.
- In future research, a larger sample can be used (e.g. a number of states).
- Longitudinal studies would be able to examine the lasting performance impact.

- Additionally, more rigorous structural equation modeling could be used to support the causal paths.
- There is a possibility to improve adaptive personalization through the introduction of emotional analytics.

As a result, the three hypotheses (H1, H2, H3) have been statistically proved. The findings support the conceptualized model and indicate that AI-based adaptive learning systems have the potential to transform higher education institutions in Uttar Pradesh.

7. Conclusion

The current study investigated the influence of AI-driven adaptive learning systems on student engagement and academic achievement among 175 higher education students in Uttar Pradesh. The swift digital transformation of higher education demands empirical validation of adaptive learning technologies, especially within extensive and heterogeneous educational ecosystems. This study aimed to assess whether AI-driven personalization substantially increases learner engagement and whether this engagement leads to enhanced academic performance.

The findings of the study are very convincing to the conceptual framework proposed. In the first place, it was discovered that adaptive learning systems that were driven by AI had a significant influence on the level of engagement in the students. The high regression coefficient and explanatory variance indicate that adaptive personalization, dynamic feedback processes, and smart content delivery are substantially having an effect of increasing cognitive and behavioral engagement of students in the digital learning settings.

Second, academic success was identified to be best predicted by student engagement. This observation substantiates the theoretical claim that the academic performance is strongly related to the level of active involvement, intellectual challenges, and motivational commitment suspected by the learners. Students who reported to be more engaged exhibited a higher level of understanding of concepts, confidence and better academic outcomes.

Thirdly, the adaptive learning systems that were AI-powered were found to directly influence the performance of students at school. The mediation analysis showed that engagement only partly explains this relationship, but the direct effect was still statistically significant. This means that adaptive learning systems can help improve performance in more ways than just keeping students interested. They can also do this through structured personalization, targeted remediation, and predictive learning analytics.

The mediation analysis revealed that the relationship between adaptive learning and performance is partially attributed to the engagement by the learners. This finding explains how platforms that are driven by AI have their influence. Adaptive systems enhance performance through increment in the level of engagement, which results in quantifiable changes in academics. The result support all three Hypothesis.

The outcomes demonstrate that adaptive learning systems based on AI can transform the role of higher education in such giant Indian states as Uttar Pradesh.

8. Suggestions

Because digital education reforms are becoming more important, policymakers should:

- Put money into AI-enabled infrastructure that can grow in both public and private institutions.
- Give money to higher education digital innovation labs.
- Encourage partnerships between the public and private sectors to make adaptive learning work.
- Set up rules that make sure AI is used ethically and that people's data is safe.
- Encourage long-term research projects that look at how AI affects education over time.

References

1. Adenowo AAA, Adenowo BA. Intelligent tutoring system authoring tools: The design characteristics. *Int J Technol Enhanc Learn*. 2016;8(2):114–128.
2. Afanasyev AN, Voit NN, Kanev DS. Development of intelligent learning system based on the ontological approach. In: *Proceedings of the IEEE International Conference on Application of Information and Communication Technologies*, 2016, p1–4.
3. Almohammadi K, Hagraas H, Alghazzawi D, Aldabbagh G. A survey of artificial intelligence techniques employed for adaptive educational systems within e-learning platforms. *J Artif Intell Soft Comput Res*. 2017;7(1):47–64.
4. Bimba AT, Idris N, Al-Hunaiyyan AA. Adaptive feedback in computer-based learning environments: A review. *Adapt Behav*. 2017;25(5):217–234.
5. Brawner KW, Gonzalez AJ. Modelling a learner's affective state in real time to improve intelligent tutoring effectiveness. *Theor Issues Ergon Sci*. 2016;17(2):183–210.
6. Brusilovsky P. Adaptive hypermedia. *User Model User-Adapt Interact*. 2001;11(1–2):87–110.
7. Brusilovsky P, Millán E. User models for adaptive hypermedia and adaptive educational systems. In: *The Adaptive Web*. Berlin: Springer, 2007, 3–53.
8. Chen CM, Duh LM. Personalized e-learning system design based on deep learning. *J Educ Technol Soc*. 2019;22(1):20–30.
9. Chen X, Zou D, Xie H. Personalized adaptive learning: A systematic review of empirical evidence (2020–2022). *Comput Educ*. 2022;190:104627.
10. Das A, Malaviya S, Singh M. The impact of AI-driven personalization on learners' performance. *Int J Comput Sci Eng*. 2023;11(8):15–22.
11. Fredricks JA, Blumenfeld PC, Paris AH. School engagement: Potential of the concept, state of the evidence. *Rev Educ Res*. 2004;74(1):59–109.
12. Govindarajan K, Kumar VS, Kinshuk. Dynamic learning path prediction—A learning analytics solution. In: *Proceedings of the IEEE International Conference on Technology for Education*, 2017, p188–193.