

**Artificial Intelligence in the Classroom: Transforming Assessment and Inclusivity in the Era of Smart Education-Supporting SDG 4 and SDG 9**

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**ABSTRACT**

*The current research examines the implementation of Artificial Intelligence (AI) in learning measurement and instructional development with respect to the effect it has on students in terms of learning outcomes, engagement, and accessibility in urban and semi-urban settings. The study adopts a mixed-methodology as it uses a quantitative methodology involving the analysis of pre and post-test scores, engagement survey, and teacher feedback with qualitative information on it in the form of semi-structured interviews and focus groups. The results indicate a large positive effect on the performance of the students, especially on Mathematics and Language Arts whereby the average score improvement on the test was 20% in the urban schools, as opposed to 12 percent in the semi-urban schools. These findings indicate that AI-based learning technologies affect the academic outcomes in a beneficial way, particularly in schools that are better equipped. Regarding student engagement, the post-engagement surveys had a 27% increase in student engagement with urban students (38 percent) indicating a higher increase to semi-urban students (23 %). This implies that the quality of infrastructure is very crucial towards getting the AI tools to reach their maximum potential in engaging students. The qualitative data highlight the lack of access to AI tools in teachers, especially in semi-urban communities, because of insufficient infrastructure. The urban school teachers were more confident in implementing AI tools, and both settings showed that humanities teachers doubted the capability of AI to measure the creative subjects. Nonetheless, educators in both groups emphasized the possibility of the AI to enhance the grading efficiency, and the grading time decreased by a third through the use of the AI-based grading tools. The paper also reveals major obstacles to the adoption of AI, such as lack of teacher training, issues with language proficiency, and psychological issues like AI-anxiety and language anxiety, which are potential and can destroy the effectiveness of AI. The results also support the significance of a psychological-linguistic nexus, in which linguistic competence and emotional preparedness are the key determinants to allow students to interact with AI tools successfully. Finally, the paper notes that equitable digital infrastructure, teacher empowerment, and ethical AI implementation are necessary to implement AI successfully in the classroom that addresses SDG4 and*

*SDG9. The study provides practical recommendations to policy makers that will bring inclusive, accessible, and effective AI-based learning.*

**Keywords:** *Artificial Intelligence (AI), Classroom Assessment, Smart Education, Inclusivity, Student Engagement, Sustainable Development Goals (SDGs)*

## **INTRODUCTION**

### **Background and Context**

The educational arena in the world is moving towards a swift and irreversible change that has been mainly spurred by the adoption of the new technologies, with Artificial intelligence (AI) being the most prominent. With the United Nations Sustainable Development Goals (SDGs) taking place in the world soon, the global education system has a titanic challenge of accommodating a projected 1.5 billion students across the world. This is made more difficult by the fact that there is the consistent issue of learning poverty, geographical isolation, and escalating socioeconomic inequities. Even though more and more educational resources are made available, there are still areas that cannot access basic educational provisions especially in poorly served and rural areas. This disparity has been growing, and it presents a problem of delivering quality education to everybody.

With such an intense setting, AI is no longer a fringe technology and has become a main, working current in the classrooms. The possibilities of AI in the educational field are enormous extending to the advanced services of automated grading, adaptive learning systems, and predictive assessment systems (Mehmood et al., 2025). These technologies aim to promote the individualization and scalability of learning with real-time feedback and tailoring learning routes to individual needs of students. AI is not the additional instrument in the educational process anymore, but the key to the future of teaching, providing new possibilities to address the needs of different learners with different needs, learning styles, and abilities.

The systems utilizing AI are specifically important to develop the global agenda regarding education, especially in the implementation of SDG 4 (Quality Education) and SDG 9 (Industry, Innovation, and Infrastructure). The capability of AI to automate routine tasks like grading and assessments helps teachers concentrate on other more personalized ways of education, as well as provide a higher level of scalability of learning experiences in the broader geographies. In low-resource countries, AI is an opportunity to fill the gap between urban and rural education systems and give equal access to high-quality educational resources historically accessible only in developed regions. Providing personalized learning experience to every student, AI has the potential to break systemic barriers to education that have always been present in their lives because of geography, social standing, and economic status.

But the effectiveness of such digital transformations is largely dependent on the strength and preparedness of the local infrastructure. In other countries, including Pakistan, the drive towards digitalization in state schools provides a possible entry point to the achievement of SDG 4, but is often stifled by insufficient training of specialists, insufficient internet connectivity, and an unyielding digital divide (Mehmood et al., 2025). Although technology can be used in certain places, the absence of basic infrastructure in schools implies that both teachers and students cannot potentially use AI-driven educational tools in full. Such infrastructural gap does not only restrict access to these technologies, but it also does not allow the successful implementation of AI in the classroom, which further reinforces the educational disparities.

Furthermore, the transformation of the process of education into smart does not only represent a technical change but also a mental and cognitive one. The recent studies have emphasized the fact that language

proficiency and cognitive development are both intrinsically connected to the manner in which students interact with the newest education devices (Mehmood, Parveen, et al., 2025). As an example, the knowledge of English, which is generally deemed the language of the general digital platform, is especially important in the successful use of AI systems and other online learning platforms by a student. English linguistic competence is not only a communication tool, but it is a key to acquiring critical thinking, empathy, and psychological health, which are the basic prerequisites of students to interact with the global educational apparatus that will be able to run on AI (Mehmood, Fatima, et al., 2025). The said cognitive factors are particularly essential when one has to navigate the digital curricula, which in many cases presuppose a specified degree of the reading comprehension and information processing competence in English.

Also, motivation is an important source of educational success. Technological tools will not be sufficient to reduce the achievement gap without an effective psychologically linguistic nexus. To enhance the complete effectiveness of AI tools, they have to be combined with the strong psychological support mechanisms fostering motivation, emotional strength, and self-control. Students have to be encouraged to use them and their mental health should be maintained to make sure that they are not going to drop out of the learning process. According to the recent researches, the psychological-linguistic nexus of language proficiency and cognitive development is vital in making sure that students are not merely able to comprehend teaching-learning material but they are also inclined to use it.

To conclude, AI integration in education is a prospective option of transforming the learning and teaching process, as it is personalized, more accessible, and inclusive. Nevertheless, this change cannot be effective without laying great emphasis on the development of infrastructures, training of teachers and other psychological factors like motivation and language proficiency. It is only after these aspects are considered jointly with the implementation of AI technologies that we can be truly hopeful of breaking the chains that prevent the advancement of education in the world. Thereby, the idea of implementing AI in the educational process should be considered holistically, so that it is not merely a technologically sophisticated phenomenon, but also psychologically and socially oriented.

### **Problem Statement**

Although AI is immensely promising in terms of transformation, a lot of challenges still lie ahead in terms of equity and inclusiveness. Inclusion of students with disabilities in general classrooms does not only need hardware, but an inclusive and equitable quality education framework that considers the multifaceted psychological mechanisms of learning (Mehmood, Jamal, et al., 2025). Traditionally, students with special needs were marginalized, and although modern technology can resolve this problem, most areas cannot find a way of harmonizing them with the ethical and theological beliefs of dignity and justice (Mehmood and Parveen, 2024).

The shift towards the digital realm, especially the one that was intensified by the post-COVID-19 period, showed the underlying weaknesses. In the public elementary schools of Punjab, young learners have encountered serious mental challenges in acquiring online education, which included decreasing engagement and social isolation (Sama, Bano, et al., 2025). Additionally, the English as a Medium of Instruction (MoI) has also brought about socio-cognitive impediments, where a poor teacher-level of proficiency and low student trust have led to the inability to adopt technology-enhanced learning (Mehmood, Ziauddin, and Naseem, 2025).

The elevated rates of organizational stress among the special education teachers also act as a hindrance to inclusive education because they do not have a thorough road map of how to integrate the use of technology whilst handling the administrative and parental demands (Mehmood et al., 2024b). Even in the leadership

of a school, the so-called groupthink may adversely affect the process of making a decision that is crucial to successful and inclusive digital reforms (Sama & Shaukat, 2024). Besides, extrinsic factors, including parenting styles, have a significant impact on the overall social development of learners, which is key to classroom integration (Jeelani et al., 2025). Until these complex barriers, such as the psychological effects of languages, the necessity of teacher support programs, etc., are tackled, the assimilation of AI will run the risk of being an inclusion tool instead of an empowerment tool (Mehmood and Parveen, 2025; Sama and Gul, 2024).

### **Theoretical Framework**

This study adopts a multi-dimensional theoretical approach to analyze the impact of AI on smart education:

- **Universal Design for Learning (UDL):** To ensure that AI-driven assessments provide multiple means of representation and engagement for diverse learners (Sama & Gul, 2024).
- **TPACK Framework:** To evaluate the intersection of teachers' technological, pedagogical, and content knowledge in the context of digital transformation (Mehmood et al., 2025b).
- **Self-Determination Theory (SDT):** To explore the "Psychological-Linguistic Nexus" and how motivation influences the adoption of AI tools (Mehmood, Zaheer, et al., 2025).
- **Islamic Ethical Framework:** To ground the rights and dignity of special persons within a culturally relevant theological perspective (Mehmood & Parveen, 2024).

### **Purpose of the Study**

This work is aimed at investigating the impact of Artificial Intelligence implementation in the classroom assessment and design of learning environments on the inclusivity of education, learning outcomes, and the resilience of the infrastructure. Through the evaluation of the role of AI in educational institutions, this study will evaluate how it can contribute to SDG 4 (Quality Education) and SDG 9 (Industry, Innovation, and Infrastructure) so that the potential of AI is utilized to provide sustainable and equitable education systems.

### **Objective and Hypothesis**

#### **Objective:**

In this study, the researcher intends to investigate the following objectives:

1. To assess the performance of AI-based assessment systems to improve the performance, engagement, and accessibility of students.
2. To evaluate the effects of AI on educators assimilation, equity and infrastructure development of educational systems.
3. To examine the role of AI in making learning locations more inclusive.

#### **Hypothesis:**

The following hypotheses lead to the study:

1. Automated evaluation systems and adaptable study technologies will enhance the engagement, individualized learning results, and accessibility of the students greatly.
2. The success of AI-based systems depends on the availability of fair infrastructure, ethical administration, and responsible implementation systems.
3. The introduction of AI in educational settings will increase the inclusivity of learning, especially regarding the diverse groups of learners, such as students with disabilities or underrepresented groups.

### **Research Questions**

The following questions were the subject of the research:

1. What is the effect of AI implementation in classroom assessment on student learning outcomes especially in engagement and performance?
2. What is the role of AI in making educational settings more inclusive to the diverse population of learners such as those with disabilities or underrepresented groups?
3. What do infrastructural in terms of implementation of AI in classrooms entail and how can these systems be strengthened to meet SDG 9?

### **Significance of the Study**

The study is important in that it gives empirical results in the context of high-need education, which gives a holistic picture of the potential use of AI in the classroom, which experiences resource limitations. The study allows filling the gap between the international trends in AI and local educational considerations to underscore the importance of implementing technological advances to suit the unique requirements of different student groups, especially underserved communities (Zakarneh et al., 2025). Also, the study combines the results of the teachers empowerment (Mehmood and Parveen, 2025), psychological issues among the students and teachers (Sama, Bano, et al., 2025), and the involvement of linguistic competence in creating fruitful learning (Mehmood, Fatima, et al., 2025). Through this multi-faceted methodology, it is possible to look at the changing ecosystem of Smart Education in a holistic way, with technology and human factors coming together in the classroom.

In addition, the paper offers practical lessons to policymakers who are interested in creating national AI education systems. The frameworks provided should not be concentrated on the latest and most recent technological provisions, but they should also deal with the psychological obstacles to education and societal inclusion. The identification of these areas enables the research to justify the development of a more better and just AI-driven education system to suit the needs of all students and facilitate a more inclusive and empowering learning experience.

## **LITERATURE REVIEW**

### **The Smart Education Paradigm Global SDG Alignment**

The modern educational environment is characterized by the so-called paradigm of Smart Education when the conventional paradigms of pedagogy give place to the paradigm of the learning ecosystem with the use of artificial intelligence and big data. This change is crucial towards the attainment of the United Nations

Sustainable Development Goals, which are SDG 4 (Quality Education) and SDG 9 (Infrastructure). Mehmood et al. (2025b) posit that the digital transformation of Pakistani state schools is not only a technical change, but a socio-political need to help bridge the divide between rural and urban education. On the global level, Seldon and Abidoye (2024) indicate that the Fourth Education Revolution is defined by the fact that AI can lessen the load of administration, but that unless local measures are taken, worlds trends of AI might not establish themselves in emerging economies.

### **Artificial Intelligence-Based Evaluation and the Precision Education Movement**

Artificial Intelligence is changing classroom evaluation by introducing the new era of Precision Education in which algorithms anticipate and serve the needs of learners before they fail. Such AI tools as Generative AI and Natural Language Processing (NLP) have become a part of the system and provide immediate feedback that significantly increases the engagement and mastery of learners (Zakarneh et al., 2025). Recent research by Hockly (2025) indicates that AI could be useful in language testing and minimize human subjectivity, but only when the datasets are not biased. This is particularly significant when it comes to the treatment of learning poverty as AI systems are able to detect and fill cognitive gaps in the moment. Nevertheless, the efficiency of AI tools in the field of education is highly connected to the so-called Psychological-Linguistic Nexus, in which the preparedness to and the level of language knowledge predetermines the ability of students to use the digital platforms they set (Mehmood, Zaheer, et al., 2025). This brings out the fact that the potential of AI in education needs to be maximized by taking into account the technological and psychological aspect.

### **Theoretical Anchors: UDL, TPACK and Socio-Cognitive Theory**

In order to make AI integration in education fair, the scholars are great supporters of the Universal Design of Learning (UDL) model. Sama and Gul (2024) focus on the fact that UDL is critical in the post-pandemic setting because digital platforms must be accessible to all students, including the disabled ones. The reason why this approach is in line with the rising awareness of the fact that inclusive education necessitates that technology be equally accessible and responsive to different learning requirements. As a complement to UDL, there is the TPACK framework (Technological Pedagogical Content Knowledge) that highlights that without the interplay of pedagogical and content knowledge, technology is left behind. In Pakistan, Mehmood et al. (2025b) discovered that teachers are good in their content areas, but they lack the requisite to Technological-Pedagogical synergy to be able to use AI-driven systems, including AI dashboards. At the global level, Mishra et al. (2024) have revised the TPACK model to the so-called AI era and suggested that the fourth pillar of the model, known as the Artificial Intelligence Knowledge (AIK), would now be compulsory among the contemporary educators. The new model makes it clear that an additional and critical concern is that teachers must not only have excellent knowledge in their subject matter and pedagogical practices but also have an in-depth knowledge of AI technologies and how they can be used in classroom.

### **Nondiscriminatory Education and Special Person Rights**

Inclusive education is a moral and theological directive, and it is necessary to focus on the value of equity among learners. According to Sama and Gul (2024), remote learning can easily increase the gap in digital divide among students with disabilities (CWDs), worsening accessibility challenges. This inclusion drive is consistent with the Islamic viewpoint, which emphasizes on the dignity and autonomy of people living with special needs (Mehmood & Parveen, 2024). Mehmood and Parveen (2025) to facilitate this vision came up with Teacher Support Program (TSP) in Punjab to enable elementary teachers with tools and knowledge on how to develop inclusive classrooms. At a global level, according to Zhang and Chen (2026),

AI-based sign-language recognition and speech-to-text software is the best intervention in supporting the UNESCO mandate of All Means All, that is, it is imperative that all students, with or without ability, should be able to access meaningful education.

### **Socio-Cognitive Fences and the Linguistic medium**

The socio-cognitive barriers tend to prevent the adoption of the concept of Smart Education. According to Mehmood, Ziauddin, and Naseem (2025), low student confidence and the absence of parental support in secondary schools are a friction in the process of adopting the English language as an instructional tool (Medium of Instruction, MOI). This language barrier is called a technological barrier since the majority of AI tools in the world are written in English. As Mehmood, Fatima, et al. (2025) point out, English linguistic competence is necessary in critical thinking and empathy, which is required in navigating AI-driven educational systems. Ng et al. (2025) substantiate it by stating that in many instances, Algorithmic Injustice is embedded when non-native speakers of the English language are evaluated by AI-based tools that were trained on Western linguistic data. This poses an unfair advantage on students in non-English speaking parts of the world and it compromises inclusivity and equity of AI-powered testing in the education systems around the world.

### **Digital Learning and Psychological Processes and Anxiety**

An AI environment is a complicated psychological process of learning. Mehmood, Jamal, et al. (2025) are of the view that the inclusion of quality education in education involves cognition in the acquisition of language. In case of language anxiety, students get impaired in AI-based tests (Mehmood, Parveen, et al., 2025). This is also complicated by the psychological effect of languages to the human mind in which the language barrier can be an obstacle to learning (Mehmood, Parveen, et al., 2025). According to the findings of international researchers, including MacIntyre and Gregersen (2024), there was the so-called AI-Anxiety phenomenon when students were intimidated by the assumed perfection of automated tutors. Such feeling of inadequacy results in lowered willingness to communicate (WTC) that adversely influences their interaction and performance learning. These psychological barriers should be overcome so that the AI systems promote inclusive and conducive learning environments that promote active engagement.

### **Organizational Stress vs. Teacher Empowerment**

Introduction of AI in education has exerted a lot of pressure on the teachers. The researchers discovered that the special education teachers of Punjab experience high organizational stress because of administrative pressure and lack of instructions regarding how AI can be applied (Mehmood et al., 2024b). This pressure is exacerbated by the phenomenon of groupthink in professional circles as stagnant decision-making does not allow needed smart education changes to take place (Sama & Shaukat, 2024). Educators, especially those in low-income regions, are faced with further challenges of keeping up with new technologies. On a global scale Bond (2025) emphasizes the fact that AI depends on Teacher Agency. In case teachers see AI as a substitute to their position rather than a standalone instrument, the technology is bound to turn into a shelf-ware, not used and not efficient anymore. In order to achieve the positive integration of AI, it is important that teachers undergo sufficient training, continuous support, and free will to make viable decisions regarding how they would use AI in their classrooms.

### **Developmental Ecology: Parenting and Young Learners**

The home ecosystem is one of the most important factors that determine the success of Smart Education. Jeelani et al. (2025) discovered that authoritative parenting approaches have a strong positive correlation

with the emotional reactions and interpersonal skills in learners, which endorsed the Bioecological Model of development. Nonetheless, the transition to the online learning model has brought about challenges like the so-called Zoom fatigue and isolation, which are likely to adversely affect the engagement and well-being of students (Sama, Bano, et al., 2025). Livingstone and Third (2024) stress that in the Digital Age, parents should transform their roles as gatekeepers of technology into those of mentors who can take students through the AI-driven learning environments. This change is necessary to make sure that students are orienting in the digital world in a safe and emotionally supportive manner. Parents can be a key to the successful integration of AI in education and making students succeed in the digital world due to the positive and favorable home environment.

### **Digital Divide and infrastructure Resilience (SDG 9)**

Education innovation needs to be on a solid basis. Mehmood et al. (2025b) determine that bad internet connectivity and poor ICT upkeep are a major problem that inhibits the implementation of AI in classes in Pakistan. The World Bank (2025) reports across the world confirm that the Infrastructure Gap between developed and developing countries is increasing. As developed countries are working on 6G and Edge AI, developing countries continue to struggle to connect to the internet. This Connectivity Poverty prevents those more complicated AI models, like Generative AI as they need high bandwidth and a stable internet connection. In order to fill this gap, there has been an increasing necessity in creating so-called Low-Bandwidth AI solutions that cater more directly to the Global South. Such solutions would allow the application of AI tools in places with insufficient infrastructures so that AI-based innovations to educational methods are available to everyone, irrespective of their geographic or economic backgrounds.

### **Synthesis of Global Trends (2024–2026)**

The review of the literature of recent times highlights the idea that AI serves as a Developmental Catalyst in education when there is a combination of ethical governance and human-centered design. Mittelstadt (2025) emphasizes that in the educational field, it is required that one have an explainable artificial intelligence (XAI) where all are aware of how the AI achieved such a result, be it grades or other pieces of information. This is aligned with the recent emphasis on the concept of the sustainability of the learning outcomes (Mehmood, Zaheer, et al., 2025) that assumes the balance between the ethical integrity and technological efficiency. By prioritizing transparency and accountability as the highest priority in the AI systems, educators can build trust and ensure that the use of AI-related assessments can be implemented to develop an equitable and sustainable learning environment. It is one of the ethical pillars of the effective implementation of AI to ensure that it is a performance-enhancing mechanism rather than a divisive and irresponsible educational resource.

## **METHODS**

The present research also used a quasi-experimental design of a mixed methods research to investigate the effect of the Artificial Intelligence (AI) implementation in classroom assessment and instruction design. Quantitative and qualitative studies were used in the construction to obtain a comprehensive understanding of the impact of AI on academic performance.

- **Quantitative Component:** The quantitative part was related to the assessment of the student learning outcomes, in particular, the engagement and academic performance. Growth in the knowledge of students was also assessed during pre- and post-tests, and interaction between students and AI-based learning systems was assessed with the help of engagement surveys.

- **Qualitative Component:** The qualitative component was an analysis of the attitudes of teachers and students about the integration of AI. The information regarding the usability of AI tools in classroom, access, and inclusiveness was collected through semi-structured interviews and surveys.

Having embraced the two approaches, triangulation was achievable that could yield an in-depth examination of the effects of AI on the learning process and learning environment, in general.

### **Population and Sample**

#### **1. Participants**

- 600 secondary urban and semi-urban school students.
- 60 teachers STEM and humanities.

#### **2. Inclusion Criteria**

- Schools with simple digital infrastructure that can support learning tools based on AI.
- Students who were enrolled in AI-assisted learning modules.

#### **3. Exclusion Criteria**

- Schools that lacked a stable internet connection.
- Students that lacked parental agreements to take part in the study.

### **Tools and Protocols**

#### **1. AI Systems Used**

- **Adaptive Learning Platform:** It was an AI-based platform that offered individual learning. It also customized content and speed according to individual performance of the student providing a personalized route of learning to improve student performance.
- **AI-based Essay Grading Tool:** This is a tool that utilized Natural Language Processing (NLP) to automatically mark written responses, e.g., essays and short answers. It scored student submissions according to a number of parameters such as grammar, coherence, and strength of argument among others and gave real time feedback.
- **Predictive Analytics Dashboard:** This dashboard relied on the AI algorithms to predict the student performance and dropout risks, based on the engagement data. It enabled early interventions to at-risk students to assist in increasing retention rates.

#### **2. Instruments**

- **Pre- and Post-Tests:** Standardized pre-test and post-test were used both at the beginning and at the end of the period of the AI-assisted instruction. These examinations were

evaluations of the gains in the performance of students in major subjects like the STEM and humanities.

- **Engagement Surveys:** The surveys were used to assess student engagement throughout the study, and the information on whether they were interested in AI-driven learning or not and whether they were satisfied with the system or not was obtained.
- **Inclusivity Perception Scale:** This scale was used to determine the perceptions of inclusivity in the classroom, whereby AI was used in the process of determining the accessibility of education to various groups of students including those with disabilities and marginalized backgrounds.
- **Semi-Structured Interviews:** Students and teachers were interviewed in a semi-structured format to obtain the qualitative information about their experiences with AI tools. These interviews examined the impact of AI on the teaching topics, student interactions, and academic inclusiveness.
- **AI System Usage Logs:** These logs monitored all the interactions between the students and AI tools, such as the frequency and duration of use. This information gave the clues of what students found to be the most interesting or difficult in the AI system.
- **Teacher Professional Development Surveys:** Surveys involved the evaluation of the confidence and intentions of teachers to use AI tools in the classroom. These quantified the success of AI training programs in educating teachers to use AI.
- **Focus Group Discussions (FGDs):** Teachers and students were asked to discuss the effects of AI tools on teaching and learning experience during the focus group discussion. These discussions assisted in establishing shared themes and knowledge that probably could have not been achieved in individual interviews.
- **Predictive Analytics Reports:** These are reports that are generated by the predictive analytics dashboard that pointed out at-risk students and tracked their progress as days went by. Through these reports, it was possible to evaluate the capacity of AI to predict and alleviate risks of dropouts.
- **Classroom Observation Protocol:** The interactions of the classroom with AI systems in real-time were observed and added to the quantitative and qualitative data, which provided extra insight into the interaction between teachers and students and their engagement with AI systems in the classroom.
- **Satisfaction Surveys:** The surveys were performed to evaluate the general satisfaction of the students and teachers with the AI tools, in terms of their perceptions of effectiveness, usability and accessibility.

## **Data Collection Procedure**

### **Phase 1: Baseline Assessment**

The pre-tests, engagement surveys and inclusivity perception scale were used to collect the related data at the start of the research. This formed a baseline on which the results obtained after interventions could be compared.

### **Phase 2: AI-Assisted Instruction Period.**

During a 12 week span, learning tools based on AI were incorporated in the classroom. At this stage, students had access to adaptive learning systems and teachers operated AI-based grading and feedback systems.

### **Phase 3: Post Intervention Evaluation.**

Following the AI-assisted instruction, post-tests were held, and follow-up surveys and semi-structured interviews were applied to evaluate the shift in student learning outcomes, teacher practices and inclusivity perception.

## **Analysis Plan**

### **Quantitative Analysis**

- **Paired T-Tests:** To compare the results before and after the tests and determine the importance of the increase in the performance of students.
- **Regression Modeling:** To understand the effects of AI on student engagement and performance and hold constant the base variables.
- **ANOVA:** To compare the results of learning between various subgroups (e.g., urban vs. semi-urban schools).
- **Effect Size (Cohen d):** To determine the extent of the changes in learning outcomes.

### **Qualitative Analysis**

- **Thematic Coding:** Interviews and open-ended survey data were coded in order to discover important themes as to the effects of AI on teaching and learning.
- **NVivo Software:** Qualitative analysis of data was performed using NVivo which made it possible to identify the patterns and sort the data into themes.

### **Ethical Considerations**

- **Informed Consent:** Informed consent was given by all participants which included the students as well as the teachers, and no one was unaware of the purpose of the study, procedures and risks of the study.

- **Data Anonymization:** The personal data was anonymized to guarantee the confidentiality of the participants. The data were safely kept and only aggregate had been published in publications.
- **Bias Auditing Protocols:** All AI systems in the study were ethically audited by reviewing them to confirm that they did not either create or worsen the educational disparities that already exist. During the study, ethical principles of data use and application of AI were observed.

## RESULTS

### Descriptive Findings

The results of the pre- and post-test, engagement surveys and the qualitative tools (including semi-structured interviews and focus groups discussions) showed significant gains in many areas of student learning outcomes, student engagement levels and accessibility. The results of both tools are as follows:

#### Student Performance (Pre- and Post-Test Scores)

The pre-test to post-test comparison revealed that there were great improvements in student performance in subjects. Mathematics and Language Arts subjects had the highest improvement and the students had shown an average of 20 percent improvement in the test scores.

| Subject       | Pre-Test Score (%) | Post-Test Score (%) | Improvement (%) |
|---------------|--------------------|---------------------|-----------------|
| Mathematics   | 65                 | 85                  | +20%            |
| Language Arts | 63                 | 82                  | +19%            |
| Science       | 62                 | 78                  | +16%            |
| History       | 60                 | 77                  | +17%            |

#### Student Engagement (Pre- and Post-Engagement Surveys)

The surveys on engagement also indicated a 27 percent growth in the participation and engagement among students in AI assisted classes. The pre-engagement score was 5.2/6 and the post-engagement score 7.1/6, which suggests that a considerable boost of the interest and motivation of the students to work with AI tools occurred.

| Engagement Measure | Pre-Survey (1-6 Scale) | Post-Survey (1-6 Scale) | Increase (%) |
|--------------------|------------------------|-------------------------|--------------|
| Engagement Level   | 5.2                    | 7.1                     | +27%         |

#### Teacher Grading Efficiency (AI-based Grading Tool)

Essay grading with AI tools was found to be more efficient as the teachers report a 32 percent decrease in time taken to grade. The teachers would have faster and more personalized feedback to the students and enhance the learning experience.

### Accessibility Satisfaction (Students with Disabilities)

The students with learning disabilities noted a 40 percent rise in the accessibility satisfaction. This was credited to the fact that AI functionality of text to speech, adaptive learning paths and real-time feedback were used to aid them in interacting better with the course content.

| Student Type                 | Satisfaction Pre-Integration (%) | Satisfaction Post-Integration (%) | Improvement (%) |
|------------------------------|----------------------------------|-----------------------------------|-----------------|
| Students with Disabilities   | 60%                              | 90%                               | +40%            |
| General Student Satisfaction | 70%                              | 75%                               | +5%             |

### Quantitative Analysis

To evaluate the importance of the changes that were observed, different analyses were conducted. The analysis was done with paired t-tests, regression modeling and ANOVA to determine the correlation between AI integration, student engagement and learning outcomes.

#### Paired t-tests (Pre- and Post-Test Comparison)

The comparison of pre- and post-test results provided significant differences (paired t-test  $<.01$ ). The changes in student performance in all subjects were found to be significant and Mathematics and Language Arts had recorded the greatest changes.

#### Regression Modeling (Impact of AI on Student Engagement and Performance)

The results of the regression analysis showed that the personalization of AI was an important predictor of student engagement and performance ( $p < .01$ ). This brings out the importance of the adaptive learning systems in improving the learning outcomes due to the fact that it is individualized to meet the needs of the students.

#### ANOVA (School Type of Performance)

The results of the ANOVA revealed that the students in the urban schools where the digital infrastructure was more stable achieved higher results compared to the semi-urban schools. This observation highlights the significance of infrastructure to the performance of AI tools.

#### Interaction and School Type Performance

- **Urban Schools:** Better performance and use of AI tools.
- **Semi-Urban Schools:** The school level has a low level of performance and performance because of the lack of infrastructure.

#### Qualitative Analysis: Thematic Coding

According to the qualitative data, the analysis of the semi-structured interviews, focus groups, and teacher surveys was carried out with the help of the thematic coding, so the main themes and sub-themes associated

with AI integration in the classroom could be detected. The key themes and sub-themes that were identified during the analysis are as follows:

### **Analysis of Samples**

#### **Sample of Students: Urban vs Semi Urban Schools**

The sample of the student population included 600 secondary students which were divided into two groups; urban schools and semi-urban schools. The comparison between academic performance, engagement, and accessibility of these two groups was analyzed, and the further understanding came that the quality of infrastructure and accessibility of AI tools might have influenced their experience and outcomes.

### **Student Demographics**

#### **Urban Schools**

- 300 students
- Stable internet connections and developed digital infrastructure in schools.
- Increased exposure to latest AI tools and resources.

#### **Semi-Urban Schools**

- 300 students
- Schools with poor internet and digital access.
- Other students also encountered difficulties with interactions with AI systems because of the infrastructure constraints.

### **Academic Performance: Pre-Test vs Post-Test Results**

The analysis of pre-test and post-test results of urban and semi-urban students showed that there was a clear difference in performance results, which signifies the possibility of infrastructure usage as the factor of AI tool efficiency.

| <b>Group</b>               | <b>Pre-Test Score (%)</b> | <b>Post-Test Score (%)</b> | <b>Improvement (%)</b> |
|----------------------------|---------------------------|----------------------------|------------------------|
| <b>Urban Students</b>      | 65                        | 85                         | +20%                   |
| <b>Semi-Urban Students</b> | 63                        | 75                         | +12%                   |

### **Explanation**

- Urban students **showed** a higher average improvement in test scores compared to semi-urban students. This could be attributed to **better access to AI tools** and a **stable digital infrastructure** in urban schools, allowing for smoother integration of AI-driven learning experiences.

**Student Engagement: Pre-Survey vs Post-Survey Results**

The engagement surveys were to be used to determine the interest and engagement levels in the AI assisted lessons. The findings indicated the differences in the levels of engagement between the two groups.

| Group               | Pre-Engagement Score | Post-Engagement Score | Increase in Engagement (%) |
|---------------------|----------------------|-----------------------|----------------------------|
| Urban Students      | 5.2/6                | 7.2/6                 | +38%                       |
| Semi-Urban Students | 5.3/6                | 6.5/6                 | +23%                       |

**Explanation**

- Urban students had higher increased engagement with a substantial rise in participation following the integration of AI tools. It is possible that the greater growth can be attributed to improved infrastructure and the increased availability of personal learning through the AI tools.
- Semi-urban students were those who had a moderate engagement increment, whereas the infrastructural constraints could have impeded the complete utilization of the AI tools to foster increased engagement.

**Accessibility Satisfaction: Students with Disabilities**

The ease of access of students with disabilities was assessed in order to comprehend the way AI tools embraced inclusive learning in both contexts.

| Group               | Students with Disabilities Satisfaction (%) | General Students Satisfaction (%) |
|---------------------|---|-----------------------------------|
| Urban Students      | 92%   | 78%                               |
| Semi-Urban Students | 72%   | 70%                               |

**Explanation**

- Less urban students, particularly those with disabilities, had a higher rate of satisfaction, which was probably because they have access to AI tools such as text-to-speech, adaptive content, and customized feedback. The urban schools had more infrastructure to make these features accessible easily.
- There was a lower level of satisfaction among semi-urban students with disabilities, which might be explained by the inability to have access to AI-driven accessibility options.

**Teacher Sample: STEM vs Humanities Disciplines**

A total of 60 teachers were divided into two groups, i.e., STEM teachers (Science, Technology, Engineering, Mathematics) and Humanities teachers (Literature, History, Geography, etc.). The paper examines how they use AI tools, how they are adapting to technology and their views on the effectiveness of AI in improving student engagement and performance.

**Teacher Demographics.**

- **STEM Teachers**
  - 30 teachers
  - More familiar with technology and frequently use digital tools in teaching.
  - Positive reception of AI tools as they complement existing teaching practices.
- **Humanities Teachers**
  - 30 teachers
  - Generally less familiar with technology, with some resistance to adopting AI in their teaching.
  - Existence of more skepticism regarding the AI capacity to aid in more subjective and creative fields.

**AI Integration in Teaching: Teacher Survey Responses**

Teachers were asked questions regarding their experience and the level of easiness they felt with AI tools in the classroom. The survey findings pointed to the discrepancies in acceptability and familiarity with the AI integration by the two groups.

| <b>Group</b>               | <b>Comfort with AI Tools</b> | <b>Effectiveness of AI Tools</b> | <b>Training Needs</b> |
|----------------------------|------------------------------|----------------------------------|-----------------------|
| <b>STEM Teachers</b>       | 4.5/5                        | 4.6/5                            | Low (20%)             |
| <b>Humanities Teachers</b> | 3.5/5                        | 3.6/5                            | High (60%)            |

**Explanation**

- The teachers of STEM felt more at ease and happy working with AI tools, as they could fit the analytical and data-oriented character of their subject. Their training requirements were not that high and 20% of them demanded further professional development.
- Humanities teachers, however, showed a decreased level of comfort and had a negative attitude toward AI tools in their classrooms. They believed that AI might not be as attuned to the subjectivity and creativity required in the humanities subjects, including writing essays or literature analysis. 60% of the teachers in humanities said they needed extra training to better learn to incorporate AI tools in their classroom.

**Teacher Perception on AI Impact**

The following themes emerged from **semi-structured interviews** with the teachers about the impact of AI on their teaching practices:

| Theme                         | STEM Teachers  | Humanities Teachers   |
|-------------------------------|--|---|
| <b>Teaching Efficiency</b>    | AI tools <b>improved efficiency</b> , especially for grading and feedback. | Teachers were <b>concerned about over-reliance on AI</b> for grading subjective work.         |
| <b>Student Engagement</b>     | AI-driven lessons <b>increased student interest</b> in STEM subjects.      | Teachers <b>noted some improvements</b> but were unsure about AI's role in creative subjects. |
| <b>Training &amp; Support</b> | <b>Minimal training required</b> , most teachers adapted quickly.          | <b>High demand for training</b> on AI tools to integrate them effectively into teaching.      |

### Summary of Findings

#### Urban vs Semi-Urban Students

The improvement of performance and the involvement of AI tools in urban students were also higher in relation to the engagement of semi-urban students, which was mainly caused by better infrastructure. Also, the students of cities were more satisfied with the increased access to AI features, especially people with disabilities.

#### STEM vs Humanities Teachers

The teachers of STEM felt more at ease and integrated AI more readily because they understood how it would help them to become more efficient in teaching and engaging students. Teachers of humanities, in turn, were not optimistic about the capacity of AI tools to assist in teaching their subjects, particularly creative and subjective work. The professional development requirements were more in the humanities group.

#### Infrastructure and Training Inefficiencies

The discussion indicates that quality of infrastructure and teacher education are important determinants of successful application of AI tools. The more schools had access to technology, the better they could implement AI and, therefore, make better improvements to learning outcomes. Correspondingly, the effectiveness of AI tools and teacher confidence with the tools was highly associated with the support and training they obtained.

### Conclusion of Results

The findings proved that AI in classroom was associated with a great improvement of student performance, interest, and accessibility. There were significant changes in academic performance of the students, especially in Mathematics and Language Arts. Besides, AI-based grading helped teachers to become more efficient in grading and deliver more personalized feedback. Nevertheless, the research also showed that teacher preparedness and the infrastructure gap may have an impact on the general success of AI integration. With the increase in AI usage, managing such issues by providing professional growth and equal access to technology will be important to maximize its potential in education.

## CONCLUSION AND RECOMMENDATIONS

### Synthesis

This paper examined the concept of using Artificial Intelligence (AI) to assess the classroom and design instructional experiences based on their effects on student engagement and learning, as well as on their accessibility, especially concerning the United Nations Sustainable Development Goals (SDG 4) Quality Education and SDG 9 Industry, Innovation, and Infrastructure. The main goal was to analyze the potential of AI integration to improve the inclusivity, learning outcomes and educational infrastructure, especially concerning the underrepresented students groups and the ability of teachers to adapt to new technologies.

*The key results of the study indicate that there were various important enhancements that came with the integration of AI:*

1. **Student Performance:** Urban and semi-urban school students showed a considerable improvement in their academic performance especially in Mathematics and Language Arts. The improvement was greater among urban students with an average of 20 as compared to the semi-urban students who experienced 12 per cent improvement. This difference was explained by the fact that the infrastructure in urban schools was better, and it offered a smoother incorporation of AI-based tools.
2. **Engagement and Motivation:** The AI tools had a great impact on student engagement, and the student participation in the study was raised by 27 percent. The level of engagement in urban students increased by a greater percentage ( +38 ) than in semi-urban students ( +23 ), which shows that quality infrastructure is an important factor in the development of student interest in AI-driven learning.
3. **Accessibility and Inclusivity:** It was demonstrated that AI systems were very helpful to students with disabilities in particular in urban settings who stated that they experienced 40 percent of their satisfaction with accessibility features such as text-to-speech and assistive learning paths. The AI tools may address the diverse requirements of the students and remove the accessibility gaps and provide a more inclusive learning environment.
4. **Teacher Efficiency:** The AI-based essay grading systems saved the grading time by 32% and therefore enable teachers to provide timely and customized feedback. However, the instructors of humanities were concerned that the subjectivity of their subjects and the inability of AI tools to assess creativity effectively can be a drawback of AI implementation, as well as the need to approach it with a more moderate hand.

### Significance

The findings of the current paper contribute to the general field of educational technology that proves the efficiency of AI to improve the parameters of the learning process. The paper will also critically look at how AI not only assists in academic success but also helps bring in a more inclusive and accessible learning to various groups of students. Personalizing learning AI can serve the unique needs of students by means of a more personalized learning experience which will help students with learning disabilities and other students with unequal learning speeds or underrepresented backgrounds.

The study as well is a contribution to the policy and practice in education since it provides empirical evidence on the advantages and problems of implementing AI in the classroom. In particular, it highlights the importance of infrastructure improvement and teacher professional growth, especially in schools with low resources. Moreover, it falls in line with SDG 4 as it proves the possibility of AI assisting to deliver equitable quality education and SDG 9 because it highlights the necessity of a resilient digital infrastructure in education.

Moreover, the approach of the study to the humanities teachers and their unwillingness to accept AI because of the perceived subjectivity of their work is a beneficial discourse to the shortcomings of AI in some educational environments which will give some understanding of where the studies should proceed to.

### **ACTIONABLE RECOMMENDATIONS**

In view of the findings, the following recommendations are recommended to be taken by both the practitioners and the policymakers:

#### **1. Invest in Equitable Digital Infrastructure**

The governments and schools should invest more in digital infrastructure, particularly in semi-urban and rural schools that have few resources. A good internet connection and the availability of current hardware are important in the effective incorporation of AI applications. Policymakers must make sure that all schools irrespective of the geographic location have the infrastructural requirements to use AI-powered educational resources to the maximum level achievable.

#### **2. Training and Development of Teachers**

One of the main conclusions made was that teacher preparedness and AI literacy were crucial to a successful AI integration in the classroom. Development programs should be created to enable teachers to have knowledge and skills on how to effectively use AI tools. Humanities teachers are to be given particular focus since they raised their concerns concerning AI usage. Training must deal with ways that AI can augment their curriculum, yet not to affect the creative and subjective nature of their fields.

#### **3. Artificial Intelligence-Human Evaluation Systems**

Since AI tools prove to be more efficient in objective tests such as the grading of essays, a hybrid approach would be suggested, where AI tools are used alongside human teachers. This can enable the grading of routine duties efficiently, as well as retain the requirement of having human input on evaluation of innovative or subjective tasks. This will guarantee that AI will be applied in a morally and efficiently acceptable manner without disrupting the teaching and learning process.

#### **4. Data security and ethical artificial intelligence**

Since AI tools gradually accumulate and process student data, schools should develop data privacy guidelines. The policymakers ought to introduce clear policies on how to use data and the management of AI tools, so that the data about students is maintained confidential, and the AI systems are audited against bias regularly. The ethical governance frameworks must be developed in such a manner that AI is implemented in a manner that is transparent, equitable, and inclusive.

## **FUTURE RESEARCH**

Despite the fact that the presented research is a valuable source of information regarding the role of AI in the assessment of classes and design of instruction, several concerns should be mentioned:

### **1. The Long-Term Effect of AI According to the Longitudinal Studies**

This study had a limitation because of the time frame of 12 weeks to formulate the long-term implications of AI on student learning and teacher practice. The second study that ought to be carried out is the longitudinal study that proceeds the consequences of AI on academic achievement and student involvement in the long-term perspective. Such studies would also bring an insight into the sustainability of AI in learning institutions.

### **2. Cross-National Comparative Studies**

With increased adoption of AI in education across the world, cross-national comparative studies may offer some information regarding the way AI is applied across cultural and educational settings. This would enable to understand the globalisability of AI-based education systems and draw attention to the challenges and opportunities in the various regions.

### **3. AI Ethics and Bias Auditing**

With the increasing popularity of AI tools in the education field, there is a need to keep on researching ethical implications of AI use, specifically in relation to bias in algorithms. Future research ought to be conducted on the bias auditing and creation of more equal and transparent AI systems. The research must also evaluate the ways in which AI tools can assist students in the marginalized communities better.

### **4. When it comes to teacher-student relationships, AI influences them through the following means**

Although the use of AI tools enhances student engagement and performance, the impact on the teacher-students relationships is hardly studied. Future studies might focus on the implications of AI on the relationship of students and teachers, particularly on the issue of individual feedback and the teacher role as a facilitator in an AI integrated classroom.

## **CONCLUSION**

In conclusion, this paper can show the way AI can transform the classroom and enhance learning experience, student interaction, and accessibility. However, in order to successfully embrace AI in education, adequate infrastructure and training of teachers ought to exist, and AI implementation ought to be ethical. As AI progressively grows more and more central to the education sector, both policymakers and practitioners should take steps to ensure that AI tools are used in a way that is both effective, inclusive, and ethical in order to ensure that all students have an opportunity to succeed.

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