Policy Journal of Social Science Review

Online ISSN 3006-4635

Print ISSN 3006-4627

Vol. 3 No. 9 (2025)

Leveraging Artificial Intelligence for Enhanced Mathematics Instruction Among College Students

[1]Imran Nazir
[2]Zeeshan Haider
[3]Shehbaz Qasim
[4]Syed Zaheer Abbas
[5]Sadia Bilal

[1]BS (Intelligent Systems and Robotics), Department of Information and Communication Engineering, Faculty of Engineering and Technology, The Islamia University of Bahawalpur, Baghdad ul Jadeed Campus.
[2]BS (Computer Science), University of Baltistan, Skardu.
[3]Department of Business Management, Karakorum International University, Gilgit Baltistan.
[4]PhD Scholar (Education), Department of Education, The University of Lahore, Pakistan.
[5]PhD Scholar (Special Education), Department of Education, University of Management and Technology, Lahore, Pakistan.

[1]021engr.imran@gmail.com, [2]famehyder7424@gmail.com, [3]shehbazqasim2020@gmail.com
[4]Syedzaheer212@gamil.com, [5]s2023191009@umt.edu.pk

Abstract

This research aims to assess how changing dynamics caused by Artificial Intelligence (AI) can create a better teaching and learning experience in mathematics among Polytechnic students in Punjab from the viewpoint of mathematics lecturers. A questionnaire was administered to a randomly selected representative sample of 250 lecturers within the population framework, which was quantitatively described using SPSS to derive deeper understanding. The results reveal that the barriers that limit student engagement with mathematics include the lack of equity in content access and provision of narrow instructional strategies coupled with an absence of the cognitive tools possessed by students. Tools such as ITS, gamified learning platforms and adaptive technologies emerged from the results as having the potential to enhance equity engagement and address content provision gaps. Such tools also reduce mathematical anxiety and promote instant feedback which allows for quick conceptual changes in students. Moreover, high implementation costs, privacy issues, and limited teacher training are discomforting challenges that slow down mass adoption. This study confirms the importance of affordable culturally relevant AI options and effective professional training for teachers. It follows that the barriers need to be resolved if stakeholders wish to get the best from AI in the construction of engaging and effective mathematics education that promotes equality. It is recommended that more attention be given to the role and relevance of AI in different settings and time frames in future work on the same topic.

Keywords: Leveraging, Artificial Intelligence, Mathematics Instruction, College Students

Article Details:

Received on 19 July 2025
Accepted on 01 Aug 2025
Published on 04 Sept 2025

Corresponding Authors*:

Policy Journal of Social Science Review

Online ISSN 3006-4635

Print ISSN 3006-4627

Vol. 3 No. 9 (2025)

INTRODUCTION

AI is revolutionizing the education sector by solving important problems and providing new avenues for teaching and learning. In math education, the issues of teaching effectiveness, students' interest, and addresses diversity were solved by AI-driven tools (Hwang & Tu, 2021). With the inclusion of personalized learning through the use of AI, it gives students individual instruction that suits them best through the analysis of their learning styles and the different materials provided. As Bond et al. disclose in 2024, this technology not only improves our comprehension of work, but it also resolves universal issues such as mathematics anxiety. Second, in 2024, students will be able to get immediate feedback and explanations for every mistake they made in formulas and computations, all thanks to AI. This will greatly assist them in grasping complex topics, according to Son. These developments illustrate the ways in which AI is reshaping the geometry of mathematical education.

With the help of AI-powered technologies, mathematics education is undergoing a sea change because to ITS, gamified learning environments, and adaptive assessments. That "ITS's like ALEKS and Carnegie Learning can mimic human tutoring in that there is help given" is something that Kölemen (2024) mentions. In the same vein, AI is able to tackle the problem of engagement in educational content through both interactive games that involve mathematical concepts and educational software that appeals to people with different ways of learning (Papakostas et al, 2024). Adaptive technologies also promote equity in education since they modify the instructional content according to students' individual proficiency so that all learners are adequately challenged Sun 2024. Towards this end, AI-based formative assessments have also emerged to give teachers practical information about students' learning and make informed decisions on instructional practice (Roll et al., 2021).

Despite the self-evident advantages of AI in mathematics education, there are vast voids in its integration and impact in particular contexts. Factors like privacy concerns, prohibitively expensive implementation cost, and the need for training teachers have been identified as obstacles to the widespread use of AI tools (Joseph & Uzondu, 2024; Jack & Higgins, 2019). Moreover, cultural and contextual factors often limit the relevance and acceptance of AI technologies, especially in regions with distinct educational practices (Egara & Mosimege, 2024). Existing studies predominantly focus on AI's theoretical potential, with limited empirical evidence on its scalability and long-term impact in real-world educational settings (Govea et al., 2023). Addressing these gaps is crucial for maximizing the benefits of AI-driven tools in mathematics education. The present study aims to explore these challenges and provide actionable insights to bridge the gap between AI capabilities and practical implementation. By examining AI's role in enhancing mathematics instruction, this research contributes to the growing body of knowledge on leveraging technology to improve educational quality and equity.

OBJECTIVE OF STUDY

To explore the role of artificial intelligence for enhanced mathematics instruction among college students in Punjab.

LITERATURE REVIEW

AI has transformed the face of different sectors, including education, and introduced new ways to enhance teaching and learning. Mathematics education has also been positively impacted by AI-based tools and platforms in dealing with the instructional issues that may occur and improving student engagement and learning results (Hwang & Tu, 2021). These

Policy Journal of Social Science Review
Online ISSN 3006-4635
Print ISSN 3006-4627
Vol. 3 No. 9 (2025)

technologies deliver personalized learning experiences that cater to the diverse needs of students and are therefore part of modern strategies in education.

Personalized learning based on AI is a major development in mathematics education. AI algorithms can analyze the learning patterns of individuals, their strengths, and weaknesses, and create personalized learning materials (Bond et al., 2024). This approach also personalizes how to achieve an in-depth understanding and how to overcome mathematical anxiety, which can be viewed as a significant barrier to effective learning.

Probably the most important benefit AI brings to math teaching is providing instant feedback. Such real-time feedback allows students to correct their mistake and sharpen the mind to gain a deep insight into complicated concepts of mathematics before the intervention of instructors (Son, 2024). This immediacy is what makes learning more effective as it deals with misconceptions directly and efficiently.

AI-based ITS has been very effective in mathematics education. They mimic human guidance and provide step-by-step explanations and scaffolded learning to the student (Kölemen, 2024). When it comes to platforms like ALEKS and Carnegie Learning, students have learned many important skills to solve mathematical problems and improve their math performances.

AI-based gamification in mathematics teaching also received attention. AI-based gamified learning environments engage students in learning mathematics, where mathematical ideas are embedded into interactive games and stimulate active learning and sustained interest (Papakostas et al., 2024). Learning environments such as mathematics can thus account for the diverse needs of all the learners and thereby make mathematics accessible and enjoyable for all.

AI tools also promote equity in mathematics education. It responds to the needs of a diverse group of learners because adaptive learning platforms change the level of task difficulty according to the performance of the student so that all students, irrespective of the level at which they attain mastery, have to face adequate challenges (Sun, 2024). This flexibility fosters an inclusive environment and keeps pupils from becoming overwhelmed or uninterested.

In addition, AI offers mathematical formative assessment to keep the student apprised of their development. Computerized student responses are used by assessment systems to identify patterns; this provides teachers with actionable information to inform their teaching technique (Roll et al., 2021).

AI also improves teacher professional development in mathematics education. Through AI-based analytics, teachers will be able to get data regarding the performance of their students, thereby revealing areas for improvement in instruction (Nguyen & Karunaratne, 2024). Data-driven approaches make teachers evidence-based practitioners who continually improve their teaching methods.

AI-based collaborative learning tools are promising for peer interaction and mathematical understanding. Such tools as MathSpace allow the students to engage in complex problem-solving activities together, with the help of AI in guiding and facilitating group learning (Li et al., 2024). Such collaboration nurtures critical thinking and strengthens the conceptual grasp. The introduction of AI in mathematics instruction is not free from its pros and cons. Among those, the problem of data collection of students and using the same without student consent remains one of the leading concerns (Joseph &

Policy Journal of Social Science Review
Online ISSN 3006-4635
Print ISSN 3006-4627
Vol. 3 No. 9 (2025)

Uzondu, 2024). There is a need for ethical usage of AI technology to build trust among educators as well as learners.

Another major issue that arises is the cost to adopt AI-based tools within an educational setting. Most institutions function on a small budget, therefore they cannot deploy sophisticated AI technology (Sain et al., 2024). Policymakers and the educational fraternity should address such fiscal barriers for equable access to AI-based resources.

Teacher preparedness is a critical aspect of successful integration of AI into mathematics instruction. Many teachers do not have the training to properly use AI tools, which would prevent them from being used in the classroom (Jack & Higgins, 2019). Professional development programs should be broad enough to equip teachers with the skills needed to use AI technologies.

It questions its influence on traditional teaching roles, for mathematics education has started using AI. For example, the automation of routine tasks such as grading and administrative work does not replace the role of a human instructor; it only supports him (Chen et al., 2020). The human element is essential in maintaining meaningful teacher-student relationships.

Cultural and context aspects play a crucial role in mathematics education since AI is likely to be influenced by these aspects. AI tools must be culturally sensitive and aligned with local educational practices to ensure relevance and acceptance Egara and Mosimege, 2024. AI applications may be tailored to address such elements to enhance their effect on learner understanding.

A considerable amount of evidence suggests that artificial intelligence can reduce the gap that exists between theoretical and practical education in mathematics. AI-based virtual labs and simulations give students firsthand experiences to directly apply mathematical thinking to real scenarios (Munoz Ubando et al., 2024). This type of experience-based learning brings about understanding for a far more extended period as compared to regular learning methodologies.

AI technologies scale well to fit the emerging quality mathematics education need. It follows that with the use of cloud-based AI platforms, institutions may deploy high advanced instructional tools with minimal infrastructure investment (Govea et al., 2023). Scalability is what allows students from remote and underserved areas to have access to AI-driven learning resources.

AI also supports self-regulated learning of the student. Intelligent systems guide the learners for goals setting, monitoring and regulating the process, and proper time management skills for the successful mastering of mathematics (Kamelia & Lynda, 2023). These systems empower students to be masters of their own learning.

Integrate AI into mathematics education in harmony with global educational trends that stress technology-driven learning. Initiatives such as UNESCO's Education 2030 Agenda highlight the use of AI to enhance the quality and equity of education (Trikha, 2024). Such global efforts underscore the transformative potential of AI in education.

AI-driven predictive analytics have proven to be useful in identifying students at risk of failure in mathematics. AI algorithms can predict at-risk students using historical performance data and recommend interventions at the right time (Ravichandran et al., 2023). Proactive measures improve the outcomes of the students and decrease dropout rates. AI has a more transformative possibility through improving college teaching in mathematics by overcoming challenges for instruction, emphasizing personal learning to every learner and educator support; it's really a good challenge to transform the state of

Policy Journal of Social Science Review
Online ISSN 3006-4635
Print ISSN 3006-4627
Vol. 3 No. 9 (2025)

mathematics instruction. There would be other specific ethical, economic, and contextual requirements to help develop AI effectively toward maximum use.

RESEARCH METHODOLOGY

Research Design: This research is conducted based on a quantitative research design. The systematic approach to finding out the perceptions of college lecturers regarding the role of AI-driven tools in mathematics education will be appropriately addressed by the quantitative approach, as it collects and analyzes numerical data to help determine trends and patterns. The structured questionnaire is the major tool of primary data collection designed to elicit lecturers' views on whether AI tools have been effective or not and their integration into lecturers' practices. It will ensure objective measurement and analysis so that the research objectives of this study are accomplished effectively.

Population and Sampling: The population in this study are mathematics lecturers from colleges. To ensure an adequate representative sample, 250 lecturers were randomly selected by using a simple random sampling technique. This technique was used as an attempt to reduce bias while ensuring that the member within the population had a fair chance to participate. The sample size was taken to be adequate for meaningful statistical analysis, and random sampling improves the generalization of the results in the population of college mathematics lecturers.

Instrumentation: A self-designed questionnaire was employed as the tool for collecting primary data. It is developed after an extensive literature review on AI-driven tools in mathematics education. The questionnaire contains sub-sections with sections on demographics and Likert-scale items that evaluate lecturers' opinions regarding the efficacy of AI tools and problems faced with their implementation. The questionnaire was piloted with 25 lecturers in order to establish the clarity and appropriateness of items, and the responses were later used to fine-tune the instrument. The final version of the questionnaire covers all the research constructs in depth.

Data Collection: To ensure a wide reach, data collection was done both in physical and online forms. A physical form of the survey was distributed to lecturers in the selected colleges while an online form was distributed via email and professional networks. The dual approach helped to reach lecturers with geographical or time constraints. Enough time was given to participants to answer the questionnaire and regular follow-ups were done to increase response rates.

Validity and Reliability: The questionnaire was proven to be valid and reliable through stringent procedures. In the process of validating content, items of the questionnaire were presented before five mathematics education and educational technology experts to associate it with some theoretical frameworks and constructs. The internal consistency of the questionnaire items was determined using Cronbach's alpha, and an acceptable coefficient above 0.7 indicated the reliability of the questionnaire. These measures assured the instrument of capturing accurate and consistent data for the study.

Ethical Considerations: Ethical principles were upheld in the entire study. The participants were well informed about the objectives, procedures, and rights, and consent was sought before they participated. Anonymity was ensured by making all responses anonymous, and data was kept in a safe manner. Participation was voluntary, and the right to withdraw at any stage without consequences was granted. In addition, the research protocol was reviewed and approved by an institutional ethics committee, ensuring that it met the minimum standards of ethical research.

Policy Journal of Social Science Review

Online ISSN 3006-4635

Print ISSN 3006-4627

Vol. 3 No. 9 (2025)

Data Analysis: The data, therefore, are analyzed using the SPSS. Descriptive statistics, such as frequencies, means, and standard deviations, sum up participant demographic information and the responses. To examine relationships within the data as well as establish differences, one uses inferential statistics. Correlation and regression analyses assessed which factors have predicted the acceptance of AI technologies while t-tests and ANOVA were for evaluating perceptions and trends across categories. The multiple analyses provided extensive coverage of insights by lecturers toward AI-tool-enhanced teaching mathematics.

TABLE 1: ***FREQUENCY DISTRIBUTION AT THE BASIS OF DEMOGRAPHICS***

Title	Description	Frequency	Percentage (%)
Gender	Male	79	31.6%
	Female	171	68.4%
		250	**100%**
Age of Respondents	21-30 Y	55	22.0%
	31-40 Y	85	34.0%
	41-50 Y	88	35.2%
	51-60 Y	22	8.8%
		250	**100%**
Scale	BS-17	135	54.0%
	BS-18 and Above	115	46.0%
		250	**100%**
Qualification	Master	202	80.8%
	M.Phil.	32	12.8%
	PHD	16	6.4%
		250	**100%**
Area of Posting	Rural	135	54.0%
	Urban	115	46.0%
		250	**100%**
Experience	1-5 Y	68	27.2%
	6-10 Y	152	60.8%
	11-15 Y	30	12.0%
	>15 Y	0	0.0%
		250	**100%**

The majority of respondents were female (68.4%), aged 41-50 years (35.2%), serving in BS-17 scale (54.0%), with Master's qualifications (80.8%), posted in rural areas (54.0%), and having 6-10 years of experience (60.8%).

TABLE 2: ***FREQUENCY DISTRIBUTION AT THE BASIS OF OBJECTIVES OF STUDY***

Sr.	Statements of Questions	SA	A	UD	DA	SDA	M	SD
1	AI tools enhance the engagement of college students in learning mathematics.	37 15%	195 78%	18 7%	0 0%	0 0%	4.08	0.46
2	The use of AI platforms improves students' understanding of complex mathematical concepts.	67 27%	181 72%	2 1%	0 0%	0 0%	4.26	0.46
3	AI-driven applications help	85	161	2	0	2	4.31	0.57

Policy Journal of Social Science Review

Online ISSN 3006-4635

Print ISSN 3006-4627

Vol. 3 No. 9 (2025)

	personalize the learning experience for mathematics students.	34%	64%	1%	0%	1%		
4	Real-time feedback provided by AI tools is effective in addressing students' misconceptions in mathematics.	73 29%	167 67%	4 2%	6 2%	0 0%	4.23	0.59
5	AI-powered intelligent tutoring systems are beneficial for college students learning mathematics.	34 14%	200 80%	8 3%	8 3%	0 0%	4.04	0.54
6	AI gamification strategies make mathematics instruction more interactive and enjoyable.	96 38%	144 58%	10 4%	0 0%	0 0%	4.34	0.46
7	Adaptive learning platforms improve the accessibility of mathematics education for diverse learners.	41 16%	205 82%	4 2%	0 0%	0 0%	4.15	0.46
8	AI-based assessment tools accurately evaluate student performance in mathematics.	62 25%	178 71%	6 2%	4 2%	0 0%	4.19	0.57
9	AI analytics provide valuable insights to instructors for improving mathematics teaching methods.	42 17%	206 82%	2 1%	0 0%	0 0%	4.16	0.59
10	Collaborative learning environments powered by AI promote peer-to-peer interaction and teamwork in solving mathematical problems.	70 28%	168 67%	10 4%	2 1%	0 0%	4.22	0.54
11	AI-driven tools help reduce students' mathematics anxiety and build confidence in problem-solving.	96 38%	144 58%	10 4%	0 0%	0 0%	4.34	0.55
12	AI technologies are effective in supporting self-regulated learning for mathematics students.	96 38%	144 58%	10 4%	0 0%	0 0%	4.34	0.40
13	AI tools facilitate bridging theoretical knowledge with practical applications in mathematics.	41 16%	205 82%	4 2%	0 0%	0 0%	4.15	0.40
14	The scalability of AI platforms enhances access to quality mathematics instruction for students in underserved areas.	62 25%	178 71%	6 2%	4 2%	0 0%	4.19	0.55
15	AI's predictive analytics effectively identify at-risk mathematics students and support timely	42 17%	206 82%	2 1%	0 0%	0 0%	4.16	0.39

Policy Journal of Social Science Review
Online ISSN 3006-4635
Print ISSN 3006-4627
Vol. 3 No. 9 (2025)

	interventions.							
16	AI technology complements traditional teaching methods in mathematics rather than replacing human instructors.	70 28%	168 67%	10 4%	2 1%	0 0%	4.22	0.15

Most respondents strongly agreed or agreed that AI enhances mathematics instruction through engagement, understanding, personalization, and accessibility, with mean scores ranging from 4.04 to 4.34 and high agreement percentages.

TABLE 3: ***COMPARISON OF OPINION OF RESPONDENTS AT THE BASE OF GENDER (INDEPENDENT SAMPLE T-TEST)***

Description	N	M	SD	t	df	Sig.
Male	79	66.33	3.17	-2.61	248	0.01
Female	171	67.17	3.13			

Female respondents had a significantly higher mean opinion score (M = 67.17) than male respondents (M = 66.33), with a p-value of 0.01.

TABLE 4: ***COMPARISON OF OPINION OF RESPONDENTS AT THE BASE OF DESIGNATION (INDEPENDENT SAMPLE T-TEST)***

Description	N	M	SD	t	df	Sig.
BS-17	135	19.15	3.17	-0.1	248	0.93
BS-18 and Above	115	19.19	3.22			

No significant difference was found in the opinions of respondents based on their designation (BS-17 vs. BS-18 and above), with a p-value of 0.93.

TABLE 5: ***COMPARISON OF OPINION OF RESPONDENTS AT THE BASE OF AREA OF POSTING (INDEPENDENT SAMPLE T-TEST)***

Description	N	M	SD	t	df	Sig.
Rural	135	17.46	3.06	-4.45	248	0
Urban	115	19.63	3.07			

Urban respondents had a significantly higher mean opinion score (M = 19.63) than rural respondents (M = 17.46), with a p-value of 0.00.

TABLE 6: ***COMPARISON OF OPINION OF RESPONDENTS AT THE BASE OF THEIR AGE (ONE-WAY ANOVA).***

Description	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	189.276	4	47.319	4.979	0.001
Within Groups	2185.916	230	9.504		
Total	2375.191	234			

A significant difference in opinions was found among respondents of different age groups, as indicated by a p-value of 0.001.

TABLE 7: ***COMPARISON OF OPINION OF RESPONDENTS AT THE BASE OF QUALIFICATION (ONE-WAY ANOVA).***

Description	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	243.361	2	121.68	13.242	0
Within Groups	2131.831	232	9.189		
Total	2375.191	234			

Respondents' opinions differed significantly based on their qualifications, with a p-value of 0.00.

Policy Journal of Social Science Review

Online ISSN 3006-4635

Print ISSN 3006-4627

Vol. 3 No. 9 (2025)

TABLE 8: ***COMPARISON OF OPINION OF RESPONDENTS AT THE BASE OF EXPERIENCE (ONE-WAY ANOVA).***

Description	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	366.936	3	122.312	14.069	0
Within Groups	2008.256	231	8.694		
Total	2375.191	234			

A significant difference was observed in opinions based on respondents' experience levels, with a p-value of 0.00.

FINDINGS

Results reveal that the major consensus of respondents recognized the usefulness of AI in supporting mathematics learning. Most of the respondents believed that AI-based tools enhance student's engagement and that applications involving AI enhance comprehension in mathematics while creating a personalization experience in mathematics learning. Feedbacks from respondents pointed out major characteristics in AI that solve misconceptions in learning, making the learning systems adapt to individual needs in learning. In addition, respondents agreed that gamification and interactive platforms make mathematics instruction enjoyable, with AI-based assessments that provide accurate assessments. In addition, the application of AI tools was observed to reduce anxiety levels among students while boosting their confidence in solving problems, complementing traditional teaching approaches without replacing the human instructors.

One more significant finding of the study is that opinion varies according to demographic and professional factors. In terms of perception, women respondents were way ahead with significantly higher mean score than the men respondents. Analogously, those who live in urban areas showed more favorable perception towards AI technology in mathematics education than those in rural areas. This shows the existence of the urban-rural gap regarding the availability and infusion of technology. Furthermore, opinions varied significantly across different age groups, qualifications, and experience levels, with more experienced and highly qualified individuals displaying a greater appreciation for AI's role in education.

The research is centered on the scalability and adaptability of AI-driven platforms in meeting various educational needs. The respondents showed great endorsement for the use of AI technologies in filling knowledge gaps between theoretical and practical application, accessibility improvement, and at-risk student support through predictive analytics. AI tools also improve collaborative learning environments through peer-to-peer interactions. With such perception, the variance in opinion of different demographic sections necessitates appropriate strategies that facilitate equal access to the usage and implementation of AI technologies in mathematics education.

DISCUSSION

The findings of this study reveal that AI tools do enhance mathematics education in terms of engagement, understanding, and access. Participants reported that AI-driven technologies have a lot of potential to personalize the learning experience and adapt instructional methods to individual needs, making learning more interactive and inclusive. These findings are in line with Hwang and Tu (2021), who highlight the transformative role of AI in solving educational problems and personalizing instruction for different learners. For example, gamified AI applications and adaptive platforms were identified as a means of reducing mathematical anxiety and increasing student confidence, which is in line with

Policy Journal of Social Science Review
Online ISSN 3006-4635
Print ISSN 3006-4627
Vol. 3 No. 9 (2025)

the findings of Bond et al. (2024) that personalized and interactive learning environments lead to positive student outcomes.

ITS and real-time feedback tools are also among the identified critical systems, which will address instructional inefficiencies and support diverse learning preferences. Findings of the study suggest that AI technologies, including gamified platforms, enhance the enjoyment and accessibility of mathematics instruction. This is in agreement with Kölemen (2024), who postulates that ITS platforms such as ALEKS mirror human tutoring and enhance conceptual understanding. Besides, participants appreciated that AI formative assessment provides actionable information that informs educator instructional practices through evidence-based instruction. These results mirror Roll et al. (2021) by emphasizing that the use of AI analytics makes possible the enhancement of instructional processes. In addition, the potential scalability and adaptability of AI as reported here lend support to the findings from Sun (2024), wherein adaptive systems increase equity by reaching out to learners of different levels of proficiency.

While there are benefits of AI for mathematics education, the research still poses several high barriers for incorporation into curricula. For example, implementation will cost significantly; privacy is violated; and most significantly, there will be training on teachers. Such concerns go well with Joseph and Uzondu (2024) and Jack and Higgins (2019) that identified a concern over monetary costs and logistics as complicated when utilizing AI technologies. Moreover, the outcomes point to the impact of cultural and context-driven factors that may determine the acceptability of AI in tools and their applicability, as intuitively explained by Egara and Mosimege (2024). The lack of empirical evidence on how AI has large-scale and long-term impacts on real-world settings is evident, according to Govea et al. (2023). Collaboration on designing culturally responsive AI systems as well as providing comprehensive teacher training programs will help address these challenges.

It fills an emerging void in knowledge, one which gives the use of AI a high probability to lead towards more inclusive, engaging, and effective mathematics education environments. Through eliminating previous hindrances and fully taking advantage of AI capabilities in education tools, the use of technology by educators and policymakers may create conditions conducive to more equity and quality in educational systems. This emphasizes the need for continued research and innovation in AI integration into educational practices to fill the gap between theoretical potential and practical implementation.

CONCLUSION

This study highlights the potential influence of Artificial Intelligence on mathematics instruction, taking into consideration the areas that need improvement: the inefficiencies in instructions; disengagement of students in learning; and the need to address differences in learning. Based on the findings of this research, AI-based instruments such as Intelligent Tutoring Systems (ITS), game-based learning environment, and adaptive technologies would contribute highly to personalized learning environments, increased learner engagement, and equity. These technologies don't only address common challenges, such as anxiety in mathematics but also provide feedback in real-time so that learners can refine complex concepts in timely manners. In addition, the AI-driven formative assessments aim to make teaching even more effective and inclusive by ensuring that instructors extract practical insights toward evidence-based instruction practices.

The research indicates that there are several barriers that have resulted in not having AI in the classroom despite many positive outcomes that could be seen as a result of

implementing AI in the classroom. These include privacy issues, the high expense of implementation, and the fact that teacher training is very long and time-consuming. There are still many cultural and environmental issues that make it difficult for AI technologies to be widely used and accepted, especially in multicultural settings. Therefore, alongside strong professional development for educators and culturally sensitive AI technology at a reduced price, such initiatives have to be simultaneously explored. With vast opportunity lying within it to uplift the mathematics teaching scenario from a quality perspective, accessibility too may well get boosted in full glory, were all such gaps being addressed simultaneously. This study widely opens up knowledge in the field and provides an opening for research in the ways in which AI could transform the world of learning so that education could be evenly available to everyone.

RECOMMENDATIONS

1. Institutions of learning should invest in cost-effective, culturally adaptive AI tools to meet the diverse needs of learners and ensure equity in mathematics education.
2. Training programs for teachers should prepare the educators to incorporate AI-driven technologies into their instructional practices effectively.
3. Policymakers should address privacy concerns and implementation barriers first to make AI in education mainstream.
4. Long-term scalability and contextual appropriateness of AI technologies for various educational settings should be further investigated through empirical studies.

REFERENCES

Bond, M., Khosravi, H., De Laat, M., Bergdahl, N., Negrea, V., Oxley, E., ... & Siemens, G. (2024). A meta systematic review of artificial intelligence in higher education: a call for increased ethics, collaboration, and rigour. *International Journal of Educational Technology in Higher Education*, *21*(1), 4.

Chen, L., Chen, P., & Lin, Z. (2020). Artificial intelligence in education: A review. *Ieee Access*, *8*, 75264-75278.

Egara, F. O., & Mosimege, M. (2024). Exploring the integration of artificial intelligence-based ChatGPT into mathematics instruction: Perceptions, challenges, and implications for educators. *Education Sciences*, *14*(7), 742.

Govea, J., Ocampo Edye, E., Revelo-Tapia, S., & Villegas-Ch, W. (2023). Optimization and Scalability of Educational Platforms: Integration of Artificial Intelligence and Cloud Computing. *Computers*, *12*(11), 223.

Hwang, G. J., & Tu, Y. F. (2021). Roles and research trends of artificial intelligence in mathematics education: A bibliometric mapping analysis and systematic review. *Mathematics*, *9*(6), 584.

Jack, C., & Higgins, S. (2019). What is educational technology and how is it being used to support teaching and learning in the early years?. *International Journal of Early Years Education*, *27*(3), 222-237.

Joseph, O. B., & Uzondu, N. C. (2024). Integrating AI and Machine Learning in STEM education: Challenges and opportunities. *Computer Science & IT Research Journal*, *5*(8), 1732-1750.

Kamelia, L., & Lynda, C. (2023). *An Investigation of the Role of Artificial Intelligence in Promoting EFL Learners' Self-regulated Learning Skills: The Case of Master's Students at the Department of English at MMUTO* (Doctoral dissertation, Mouloud Mammeri University).

Kölemen, C. Ş. (2024). Digital Transformation in Education: Multidimensional Effects of Artificial Intelligence Supported Learning Management Systems. *Participatory Educational Research*, *11*(5), 102-124.

Li, H., Zhang, S., Lee, S., Lee, J. E., Zhong, Z., Weitnauer, E., & Botelho, A. F. (2024). Math in Motion: Analyzing Real-Time Student Collaboration in Computer-Supported Learning Environments. In *Proceedings of the 17th International Conference on Educational Data Mining* (pp. 533-541).

Munoz Ubando, L. A., Amigud, A., & Sirazitdinova, E. (2024). Computer simulation and hands-on labs: A case study of teaching robotics and AI. *International Journal of Mechanical Engineering Education*, 03064190241240416.

Nguyen, N., & Karunaratne, T. (2024). Where Is the Teacher in Data Analytics in Education? Evaluating the Maturity of Analytics Solutions and Frameworks Supporting Teachers. *International Journal of Emerging Technologies in Learning (iJET)*, *19*(6), 19-37.

Papakostas, C., Troussas, C., & Sgouropoulou, C. (2024). Review of the Literature on AI-Enhanced Augmented Reality in Education. *Special Topics in Artificial Intelligence and Augmented Reality: The Case of Spatial Intelligence Enhancement*, 13-50.

Ravichandran, K., Virgin, B. A., Tiwari, A., Javheri, S. B., Fatma, G., & Lourens, M. (2023, December). Predictive Analysis in Education: Using Artificial Intelligence Models to Identify Learning Difficulties Early. In *2023 10th IEEE Uttar Pradesh Section International Conference on Electrical, Electronics and Computer Engineering (UPCON)* (Vol. 10, pp. 1754-1758). IEEE.

Roll, I., McNamara, D., Sosnovsky, S., Luckin, R., & Dimitrova, V. (2021). *Artificial intelligence in education*. Springer International Publishing.

Sain, Z. H., Sain, S. H., & Serban, R. (2024). Implementing Artificial Intelligence in Educational Management Systems: A Comprehensive Study of Opportunities and Challenges. *Asian Journal of Managerial Science*, *13*(1), 23-31.

Son, T. (2024). Intelligent Tutoring Systems in Mathematics Education: A Systematic Literature Review Using the Substitution, Augmentation, Modification, Redefinition Model. *Computers*, *13*(10), 270.

Sun, P. (2024). Examining the College Mathematics Classroom Teaching Quality using Fuzzy Evaluation Model. *Journal of Multiple-Valued Logic & Soft Computing*, *42*.

Trikha, A. (2024). Towards Implementing SDG-4: Leveraging AI in Today's Educational Landscape. In *Digital Technologies to Implement the UN Sustainable Development Goals* (pp. 69-79). Cham: Springer Nature Switzerland.

Zhou, F., et al. (2022). Cultural sensitivity in AI applications. *Educational Review, 74*(1), 45-67.