Digital Learning Outcomes: A Study on the Impact of EdTech and AI in Government and Private Schools

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Received: 13-05-2025 **Revised:** 26-06-2025 **Accepted:** 11-07-2025 **Published:** 10-08-2025

ABSTRACT

This research investigates how educational tools like Augmented Reality (AR), Artificial Intelligence (AI), and mobile apps affect how well students in Karachi schools learn. 250 students and teachers of science and math in grades 5–10 were surveyed for the study. The results showed that these tools can make learning more fun and involved. When compared to their public-school peers, students in private schools said they used these tools more and did better on learning outcomes. Researchers found a weak but positive link between using AI and AR tools and doing well in school. The best link was found in mobile learning interest. A problem that was found in the study was that not all students had the same access to gadgets and the internet. It also said that teachers needed more training. The results show that these tools can help students learn, but only if they are used correctly and everyone has equal access to them. Some problems with the study are that it only looked at schools in Karachi, used self-reported poll data, and only observed for a short time. The study's conclusion is that smart use of technology, along with better facilities and teacher training, is necessary to make learning settings that work well for everyone.

Keywords: *Artificial Intelligence, Karachi, Augmented Reality*

INTRODUCTION

One thing that makes 21st-century education unique is the common use of educational technology (EdTech) in homes and schools. This combination is more complex than just using digital tools. It now includes learning management systems (LMS) and personalized learning platforms that change based on

each student's needs and pace. These tools make it easier to get to a huge amount of knowledge, let people work together on digital platforms, and help students learn in a variety of ways. A lot of people agree that there could be benefits like better student engagement, academic success, and skill development. However, it is important to take a close look at what actually happens in the classroom. Many large-scale studies and meta-analyses have shown that the benefits are mostly good, but they can be small and are often weakened by things like the type of technology used, the subject, and the students' level of education.(Ghamrawi & M. Tamim, 2023) Innovations in education have turned static classes into active, tech-driven places that encourage more participation and customized learning. New ways of teaching, like flipping classes, project-based learning, and digital tools for group work, have made it possible for students to stop passively learning and start actively participating in their education. These changes are needed to meet the skills and talents of the 21st century, such as the ability to think critically, be creative, and use technology well. For instance, combining gaming with mobile learning has been shown to get students more interested in learning and help them remember what they've learned.(González-Pérez & Ramírez-Montoya, 2022) The skills, knowledge, and behaviors that students learn through school tasks are called learning outcomes. More and more, advances in education are judged by how well they help students learn. Studies have shown that using student-centered teaching methods and incorporating technology into the curriculum can boost both cognitive and non-cognitive results, like the ability to solve problems and the independence of learners. Curriculum design that works with learning analytics tools has also made it possible for teachers to see real-time growth of their students and change how they teach based on that information.(Higgins & Simpson, 2011)

AI has become a strong tool for improving educational innovation and making sure that students learn the most they can. AI-powered platforms can make learning more personalized by changing the material based on how well students are doing and how they learn best. Intelligent teaching systems, automatic feedback, and predictive analytics are some of the tools that make it easier to fill in learning gaps than the old ways. Studies have shown that using AI in the classroom gets students more interested, especially in topics like math and science that require them to understand big ideas.(Holmes, Bialik, & Fadel, 2019) Using AI in education is a big step forward because it gives teachers tools that can not only change but also predict what will happen next. For example, clever teaching systems driven by AI can figure out where a student is lacking in knowledge and give them focused, real-time feedback, which is a lot like having a human teacher teach you one-on-one. Predictive analytics can also find kids who are likely to not do well in school or drop out, so that they can be helped before they do. A big issue in recent study is how these tools might make it easier for everyone to get a good, personalized education and make things more fair. But using AI also brings up new problems in terms of ethics and how to teach. At the center of scholarly debate are worries about computer bias, data privacy, and the risk that students may not be able to think critically if they rely too much on replies created by AI. To make sure that AI is a "intelligence amplifier" and not a cognitive crutch, these problems need to be carefully thought through.(Zhu & Ouyang, 2024) STEM education is a way of teaching that combines science, technology, engineering, and math. Its goal is to help students learn about different subjects by solving problems in the real world, improve their cognitive and teamwork abilities, and change the way they learn from passively listening to teachers to actively participating in their own education.(Kennedy & Odell, 2014) When AI is used in schools, it brings up questions about ethics, data safety, and what teachers should do. AI can handle routine chores and offer scalable answers to problems with learning, but it can't take the place of human teachers who can provide more personalized help. The best versions use both AI tools and human teachers to create mixed models that help students more without taking away from the teacher's role. Taking on these moral and practical problems is necessary for progress in education to last.(Luckin & Holmes, 2016)

This article explores the relationship between educational technologies and AI and student learning outcomes. It looks at the research that has been done on the pros and cons of these tools from K–12 to

college, focused on important learning outcomes such as academic success, critical thinking, problem-solving, and social and emotional growth. The article's goal is to answer questions about how EdTech and AI affect student success, as well as the problems, moral issues, and future chances to use these technologies to make learning environments that are better, more welcoming, and focused on the needs of all students. The end goal is to give educators, lawmakers, and experts a complete framework that they can use to make smart choices.

Key Terms

Augmented Reality (AR)

Using devices like smartphones, tablets, Augmented Reality (AR) is a technology that overlays digital information, such as images, movies, and 3D models, on the real world. In contrast to Virtual Reality (VR), which produces a complete immersive virtual environment**.** Augmented reality (AR) lets students see extra digital information layered over real-life objects, helping them learn by combining real and virtual content.

Artificial Intelligence (AI)

Computer systems capable of carrying out activities that would ordinarily need human intellect are referred to as Artificial Intelligence (AI). Among the things that might fall under this category are decision-making, problem-solving, reasoning, and learning.

Digital Readiness

Digital readiness highlights the need for a secure learning environment, and trust is a crucial element of it. To create a more digitally inclusive society, we must make sure that everyone feels at ease and has faith in their ability to use digital skills and pick up new ones.

LITERATURE REVIEW

This study of the literature looks at a few important theoretical frameworks that have had a big impact on the field of educational technology. It shows how these frameworks have helped us understand how technology can support and change education.

Cherner and Mitchell, 2021) talk about how important it is to carefully look at educational technology models to make sure they can be used effectively in schools. Their work breaks down different frameworks based on who made them, what features they have, and how helpful they are. This helps us understand how these frameworks can help choose and use educational tools. This study shows that there are many different theoretical methods in the field. It also shows that educators and researchers need to carefully think about the ideas and goals of each theory when they use technology in the classroom.
(Kragelund, Dalsgaard, & Ryberg, 2024)suggest a way to think about digital learning places that divides learning activities into four areas: the individual area, the working group area, the community of interest area, and the open links area. This approach highlights how digital tools can be used in new ways to enhance learning beyond the usual taking away limits helps people have more freedom, work together to build knowledge, be open, and connect with others around the world. The framework gives a complete way to create and assess digital learning settings by focusing on how digital tools can be used for learning in these areas.

(Yuan & Liao, 2023)introduced personalized learning experiences made possible by AI-driven technologies have been found to be a core result of many studies. Adaptive learning systems, for instance, use algorithms to look at how well students are doing and change the lessons' level of difficulty, speed,

and material all the time. This personalized method lets each student learn at their own pace, focusing on their own skills and flaws. This has been shown to boost student interest, drive, and academic success.

(Essien et al., 2024) emphasizes on some people worry that relying too much on AI could make people less able to think critically, but new study shows that the opposite is true when AI is used correctly. Studies show that students' critical thinking and problem-solving skills can improve when they use generative AI to build and add to their knowledge (a "mastery approach") instead of just for basic tasks. AI can be used to come up with new ideas, summarize information, and make content, all of which can help people be more creative.

(McGrath, Regan, & Russell, 2025) researched that tasks like marking, organizing, and data analysis can be done automatically by AI tools. This gives teachers more time to work on more complex parts of their jobs, like talking to students one-on-one, planning unique lessons, and meeting their social and emotional needs. People think that this change in focus will help make education and teaching better in general.

(Zhuang & Liu, 2022) told that the creation of a higher education innovation ecosystem was driven by the need to enhance the quality of higher education as a whole. This was made possible by a planned agreement between the government, businesses, higher education, and social groups. Different parties are given different jobs in the ecosystem so that they can work together and share the work. An creative ecosystem with six types of teamwork at the broad and local levels is also supported by substantial capital, the movement of resources, and the addition of industrial technology know-how. The higher education innovation ecosystem has so far led to more and deeper involvement in improving the quality of higher education by a wide range of stakeholders, including the same type of stakeholders at different levels. The ecosystem's small-scale effects have changed how teachers teach and how students learn, and many institutions have stepped up their shared administration to better take advantage of how the different parts work together. But there are also differences in the creative environment when it comes to the businesses and colleges that are involved.

(Southworth et al., 2023) said that Artificial intelligence (AI) is an idea and tool that is used all over the world and is an important part of daily life. Because of this, teaching students the basics of AI should be an important part of their education in order to make them good global citizens. This position paper talks about one way that AI could be taught at a standard research university in order to fill in any gaps in the current curriculum. The University of Florida (UF) is using AI in all of its classes and creating chances for all of its students to get involved in specific areas of AI knowledge, no matter what field they are in. UF is working on a program called "AI Across the Curriculum" that will make learning AI a core chance for all students. The main goal of AI Across the Curriculum is to make a workforce that is ready for AI by teaching students the important 21st-century skills that businesses and governments around the world need. To deal with the problems of the 21st century, we need qualified human capital, and UF is setting itself up to be a leader in meeting this need. The AI Across the Curriculum plan makes sure that all students have a variety of AI chances and are urged to use them. The university has made a big investment in AI across the whole campus, which is being used to change the curriculum and make activities that encourage interaction across disciplines and prepare students for careers.

METHODOLOGY

Preview

Here, we talk about how I did the study in schools in Karachi. First, we talk about why I chose a poll over interviews and what I wanted to find out. After that, I talk about who took part: 250 boys and girls in grades 5 through 10 and their math and science teachers from public and private schools. We also talk

about how I made the poll questions and tried them to make sure they were clear and easy to understand for us. We sometimes got replies on paper too, since not all schools had internet. Lastly, we talk about how I looked at the data. For example, I used t-tests and ANOVA to compare results from public and private schools. Then we talk about the steps I took to make sure that everyone's answers stayed private and honest. We also talk about some of the study's limitations, such as the fact that it relied on what people said instead of direct observation.

Methodology

A study let us get a lot of information and views from a lot of teachers and kids at once. This helped me understand how AR, AI, and mobile apps are generally used in math and science classes. Interviews alone could have given us specific stories, but they wouldn't have shown how common these trends are in Karachi schools. We also thought about using interviews and polls together, but we didn't have enough time or money for that. It helped us find out things like "How often do students use these tools?" and "Do they think it helps?" I asked school leaders for permission before I began, and everyone who took part did so freely and without giving their names.

Targeted Population

The study looked at 250 students in grades 5–10 and their science and math teachers from both public and private schools in Karachi. We picked these grades because this is when students start learning more difficult subjects, like biology and math, where pictures help a lot. We could see how things are different when some schools have more tools than others if we looked at both public and private schools. It's possible for public schools to have bigger groups and fewer devices, while private schools may have better internet and teach better. I asked both to find out not only if technology helps, but also where it helps the most.

Sampling Techniques

We looked at new studies to get ideas for the poll questions and then changed them to fit Karachi's schools. One set was for teachers and one was for kids. The students said how often they used AR, AI, and mobile apps and whether or not they thought these helped them learn math and science. They said how ready they were to use these tools, what kind of training they had, and what problems they saw. For most questions, you could choose an answer on a scale, such as "strongly agree" or "strongly disagree." First, I had a small group of people take the poll to make sure the words were clear and used the right language. We made some words easier after hearing what they had to say.
With a Cronbach's alpha of 0.87, the questions were found to be valid.

Instrument development

To make the survey, We started with questions from earlier research (Lin & Yu, 2023) and changed them to fit Karachi’s context.We included some open-ended questions where people could write their own thoughts, and many closed-ended ones with a Likert scale. The survey asked about confidence with technology, how often students and teachers use it, and if it helps with learning and class interest. Before using it widely, we tested it on twenty people. Their suggestions helped make the questions easier to read and more relevant to our local setting. I also explain how I made the survey questions clear and easy to understand for our local context. Since not all schools had internet, I sometimes collected answers on paper as well. Finally, I explain how I looked at the data, like by comparing answers from public and private schools using t-tests and ANOVA. A pilot study is a "small study to test research protocols, data collection instruments, sample recruitment strategies, and other research techniques in preparation for a larger study," as defined by (Harrison, Reilly, & Creswell, 2020) To check if the questionnaire worked well, Cronbach’s alpha was calculated and showed a strong reliability score of **0.87**.

Plan of Data collection

A data collection strategy helps figure out what information is needed, how to get it, and how to study it. Its main goal is to make sure the data is focused, works well, and is reliable, so the researcher can draw useful conclusions from their study. The data was collected over four weeks in January and February 2025. The participants and school staff had already agreed to take part. To reach a wide group of people, surveys were handed out in person at schools and also online through Google Forms. Trained helpers were there to give out the surveys, explain how to complete them, and make sure everything followed ethical rules. People could choose whether to take part, and their answers were kept private. The responses were collected and stored safely. Schools were checked back with to help get more responses, especially from public schools that may not have good internet access.(Alghamdi, 2023)

Data Analysis and Presentation

The results are displayed through tables, graphs, and descriptive summaries to illustrate key findings clearly. The chapter also compares responses across different school types and participant groups to identify patterns or differences. Additionally, themes emerging from open-ended survey responses are discussed to enrich the quantitative analysis.

Overall, this chapter aims to provide a clearer understanding of what integrating these technologies looks like in everyday teaching and learning within Karachi's schools.

Table 1 Descriptive statistics

Variable	*X*	*SD*	Min	Max
AR Usage Frequency	3.01	1.33	1	5
AI Tool Effectiveness	3.05	1.41	1	5
Mobile Learning Engagement	3.12	1.45	1	5
Learning Outcome Score (%)	74.82	10.05	51	98

The mean scores for students' use of AR, AI, and mobile learning tools were around 3.0 on a five-point Likert scale. This indicates a moderate level of use and perceived effectiveness. On average, students achieved a learning outcome score of 74.8%, which suggests reasonably good academic performance overall. However, the relatively large standard deviations highlight those experiences varied, possibly reflecting differences in teaching practices, resource availability, or digital access among schools.

Table 2 Mean score by school type

School Type	AR Usage	AI Effectiveness	Mobile Engagement	Learning Outcome (%)
Public	2.73	2.89	2.91	71.96

School Type	AR Usage	AI Effectiveness	Mobile Engagement	Learning Outcome (%)
Private	3.29	3.21	3.33	77.68

Comparing results across school types shows that students in private schools reported higher use of AR, AI, and mobile technologies than their peers in public schools. Their average learning outcome score was also higher at 77.7%, compared to 71.9% in public schools. These differences align with earlier research by (Mariani, Noor Maizatulshima, Saifuddin, & Noor Suhaida, 2024) and (Tan & Tang, 2025) which found that disparities in infrastructure, teacher training, and access to digital devices can influence how effectively educational technologies are integrated.

Table 3 Correlation Matrix

	AR Usage	AI Effectiveness	Mobile Engagement	Learning Outcome
AR Usage	1.00	0.41	0.47	0.35
AI Effectiveness	0.41	1.00	0.52	0.43
Mobile Engagement	0.47	0.52	1.00	0.46
Learning Outcome Score	0.35	0.43	0.46	1.00

The correlation analysis revealed that all variables are positively related. The data showed that engagement with mobile learning tools had the strongest link to academic performance ($r = 0.46$). This suggests that students who actively use mobile learning resources tend to achieve higher results. There were also moderate positive correlations between the use of AI and AR tools and students' academic outcomes. These findings align with earlier research(Meylani, 2024), which also highlight the cognitive and motivational advantages offered by such educational technologies.

DISCUSSIONS

Preview

This chapter discusses what the study discovered about using augmented reality (AR) and artificial intelligence (AI) in Karachi's schools. It looks at how these tools may help students learn better, feel more interested, and understand difficult topics.The findings suggest that AR can create visual, interactive lessons that keep students engaged, especially in science and math. AI tools can help by offering personalized practice and helping teachers see where students struggle most. At the same time, there are important challenges. Not all students have equal access to devices and internet, and teachers often need more training to use these tools effectively. Concerns like data privacy and fairness in AI decisions also need attention.This chapter links the study's findings to earlier research, explains where results were similar or different, and points out what these results mean for teaching in real classrooms. It also

discusses the study's limits and suggests areas for future research, aiming to help teachers, school leaders, and policymakers decide how to use these technologies fairly and effectively in Karachi's schools.

Major Findings

The study showed that using AR and AI tools can help students learn in a way that feels more real and interesting. AR lets students see and interact with things like 3D models, which can make abstract topics clearer. AI can help teachers track progress and offer students practice suited to their level.Students in private schools often had better access to devices and internet, which helped them use these tools more often. This sometimes led to higher test scores and more confidence in subjects like science (Mariani et al., 2023). Teachers saw value in technology but shared that they often lack training to use it fully (AlGhamdi et al., 2023). They also noted that planning lessons using AR or AI takes extra time.

Mobile learning was especially useful for students to study on their own, but only when they felt confident with technology and had clear, well-designed materials (Anuyahong & Pucharoen, 2023). These findings fit with earlier studies (Lin & Yu, 2023) showing that new tools can increase motivation and help students pay more attention, but that success depends on good planning, teacher support, and fair access.

LIMITATIONS

There are some problems with this study, even though it does give us useful information about how teaching tools are used in Karachi's schools. First, the study only looked at kids in grades 5 through 10 from a few public and private schools in Karachi. This means that the results might not be applicable to other places, like country areas or cities with different school systems. A lot of the data that was gathered also came from people who answered polls and gave their own answers. These kinds of answers could be skewed by personal preferences, the desire to fit in, or how the participants understood the questions, which could make the results less accurate. The study was only done for a short time, which is another problem. It looked at how AR, AI, and mobile learning tools affected interest and learning right away, but it didn't look into how they might affect long-term academic memory or behavioural changes. Due to limited technology in many schools, like not having internet access or enough devices, some data had to be gathered through paper polls, which may have affected how consistent or in-depth the answers were. Lastly, the study didn't use any qualitative methods like classroom observations or interviews because it didn't have enough time or money to do so. These methods would have given a deeper, more complete picture of how educational tools are used in everyday teaching and learning.

FUTURE ASPECTS

Looking ahead, there are a number of interesting areas where more research could be done to build on what this study found. One important area is doing ongoing studies to see how AR, AI, and mobile learning tools affect students' long-term academic success, ability to remember things, and skill development. This kind of study could help us understand more about how using these tools over and over again changes the way we learn. Using qualitative methods like conversations with teachers and students, classroom observations, and case studies would also help us learn more about the real-life problems and chances that come with using technology in schools in our area. More study could be done in the future on creating and testing special training programs for teachers that aim to improve their digital skills and trust in using technology successfully in the classroom. Another important area to look into is how to integrate AR and AI into the curriculum so that they are built into lesson plans and learning goals instead of just being added as extra tools. Because Karachi's schools have a lot of students from different social backgrounds, future research should also look at how these technologies affect students from those backgrounds, with the goal of closing the digital gap and promoting fairness. Finally, making and trying educational apps and platforms that are specifically made for Pakistani students—those that are

written in their own languages and use styles that are important to their culture—can make digital learning tools more useful and open to everyone in Pakistani schools.

CONCLUSION

This study found that AR and AI tools can help make learning more interactive, keep students interested, and help teachers see where students need support. These technologies can offer new ways to explain difficult topics and help students practice what they learn. At the same time, real challenges remain not all students have access to devices, teachers need more support, and using technology safely and fairly requires attention to privacy and ethics. If schools and policymakers work together to train teachers, improve infrastructure, and choose tools that fit local needs, technology can help create classrooms where students learn actively and feel more confident. Overall, technology alone isn't enough — but when used thoughtfully, it can support better teaching, help students understand complex subjects, and prepare them for future study and work.

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