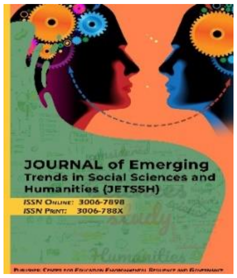


Journal of Emerging Trends in Social Sciences and Humanities

A Double-Blind, Peer-Reviewed, HEC recognized Y-category Research Journal

E-ISSN: 3006-7898 **P-ISSN:** 3006-788X

Volume 3 Issue 3, 2026, 209-222

The Impact of Digital Tools on Students' Engagement and Academic Performance in Grade VII Mathematics Classroom: An Action Research

Rutab Asim Khan[1] Dr. Victoria Joseph[2]

[1] B.Ed. Student, Department of Education, SZABIST University, Karachi, Sindh, Pakistan.

[2] Assistant Professor, Department of Education, SZABIST University, Karachi, Sindh, Pakistan.

Corresponding Author: Rutab Asim Khan, **Email:** rutab74@gmail.com

Article Information

Received:

2026-06-21

Revised:

2026-07-26

Accepted:

2026-08-14

Keywords

Grade VII Mathematics Classroom; Digital Tools; Student Engagement; Adapt Mind; Geogebra Learning; Academic Achievement.

ABSTRACT

This paper explored the effectiveness of using digital applications Adapt Mind and GeoGebra on students' engagement and achievement in Grade VII the mathematics classroom. This is an action research study working on single cycle. Adapt Mind and GeoGebra were the main instructional tools used in the process of intervention to facilitate the interactive learning environment. The study is done with in natural classroom environment among Grade VII students. Quantitative data is used to analyse both engagement and academic achievement of Grade VII students in mathematics classroom. The findings of the research demonstrated that the academic performance and engagement had significantly improved statistically after the integration of digital tools. The academic scores of students have increased in post-test after using digital applications Adapt Mind and GeoGebra. Moreover, students have shown increased participation while using the apps. The research paper concludes that Adapt mind and GeoGebra can contribute to the increased involvement and academic achievement of students in mathematics classrooms significantly.

Introduction

In twenty first century the classrooms have transformed as various teaching technology has been introduced, unlike traditional classroom where chalkboard and textbooks are formerly the main instruments of teaching. Platform such as Moodle, Canvas, collaborative tools, and adaptive

Publisher: **Institute for Educating Environmental Resilience and Governance**

learning software have drastically transformed learning (Khoso, et al., 2024; Sultana & Imran, 2024; Ahmad, Bibi & Imran, 2023). This is a technological enhancement that has bring change in learning and teaching as students are more actively participating in student teacher interaction has increased forming a collaborative learning environment (Hardiyanti et al., 2023). There are other efficiencies that such technologies offer, which are just simply unmatched by the old methods of learning. Since the development of smartphones and other wireless technology gadgets has become common among the masses, it is only logical to expect that schools and other educational institutions utilize them effectively by implementing various digital technology in the classroom. In reality, the flexibility of the current technology and its assessable nature makes learning more attractive to the upcoming generation (Wardat et al., 2023).

It is during the corona virus pandemic that the technology uses in education gained more momentum, and its potential benefits, as well as limitations, were revealed. Since schools were forced to shut and everything was shifted to online, therefore many digital tools introduced to facilitate remote learning. However, difficulty in the access of students to the devices, internet, and supportive learning conditions at home also been a huge concern (Alismaiel et al., 2022). Since then, the world has changed and made teachers to reconsider their way of teaching, and equip students with digital skills that they will need in the lifelong learning process. Therefore, schools seek new approaches to teaching, which has led many educationalists to transition from traditional methods to online platforms that facilitate learning and teaching in diverse ways (Haleem et al., 2022).

Mathematics is an important subject that improves students' analytical, problem-solving, and logical thinking, in addition to helping them make sense of the world by recognising patterns and connections (Imran, Akhtar, & Khan, 2026; Haider, et al., 2025). In general, mathematics classrooms are organised to encourage collaboration, promote inquisitive thinking, and apply methods in the practical world (Drijvers & Sinclair, 2024). The general mathematics classroom arrangement is group seating that promotes collaboration and communication, a transparent board or digital display for demonstrations and visual aids. Digital resources in mathematics classrooms can help students grasp complex concepts more easily and increase engagement (Al abdulaziz, 2021). Moreover, it helps instructors assess and encourage student progress. Interactive apps, visual models, and simulations help students visualise complex concepts. Moreover, online platforms enable professors to track progress and give tailored feedback. Incorporating technology into lesson plan can ensure learning in an exciting process among all students (Wardat et al., 2023).

Digital tools are frequently marketed on the basis of their capacity to broaden accessibility, and individualize learning (Uzorka & ODEBIYI, 2025). The accessibility is a result of the widespread presence of internet-enabled devices and cloud-hosted materials that enable students to access material at all times and in all places. Adaptive systems support personalization learning and also scaffold the task depending on student and are designed to simulate one-on-one tutoring through engaging material (Drijvers & Sinclair, 2023). Active students are more focused and they are willing to work hard in challenging activities. However, conventional methods of teaching are still useful, but they are difficult as they challenge teacher to maintain the interest of the students in the world where digital media is now an inseparable part of everyday life. Digital tools, applied wisely, provide opportunities to connect and collaborate more, which traditional methods do not always allow (Wardat et al., 2023). Interactive whiteboards, learning management systems, virtual manipulatives, educational apps and others provide a possibility to have an active and engaging learning process (Imran, Akhtar, & Khan, 2026; Zaidi, et al., 2024). These tools can arouse curiosity, foster conceptual knowledge and assist in differentiated instruction, which may result in higher academic performance (Hossein-Mohand et al., 2021). Nevertheless, the connection between digital tools and student academic results is not simple all the time. There are significant improvements in academic achievements of the students in case of successful usage of technology, however, distraction, computer fatigue and disproportionate use of technological services have been raised (Alt, 2023).

Digital competence of teachers in mathematics classroom has been found to be important due to the increased use of technology in the modern society. The relevance of technology integration in creating a digital competence beyond mere technical competencies, but also critical thinking and effective teaching (Hardiyanti et al., 2023). Students in mathematics classroom become highly competent when they learn in digital environment and make use of technology in a productive manner to improve their learning experiences. The virtual classrooms, the interactive tools and the introduction of the online classrooms have altered the way students can consume and interact with information (Alt, 2023). Moreover, it is more holistically oriented, e.g. social-emotional learning, critical thoughts, and cultural competency. But other than the memorization of facts, education must also enable a student to possess the right skills that will enable him/her to cope with an ever-changing society (Uzorka & ODEBIYI, 2025).

This research was conducted action research to systematically explore the application of Adapt Mind and GeoGebra as technological applications to enhance the achievement and engagement of pupils in the mathematics classroom. Through employing repeated stages of planning, action, observation, and reflection, the researcher tests these digital applications in the actual classroom atmosphere to solve the learning challenges. Personalized learning can be made possible with the help of Adapt Mind, which also facilitates interactive practice and GeoGebra will ensure the visual and dynamic exploration of the mathematical concepts.

Currently, there has been a greater focus on developing critical thinking skills, engagement, collaboration, adaptability, and academic proficiency in the classroom, where learning is taking place through online platforms However, teachers are seeking to provide every individual with the relevant skills to survive in a rapidly evolving environment (Viberg et al., 2023). The use of new technologies and teaching styles can present more customised learning.

Some research indicates that these digital tools help increase motivation and foster a better understanding; however, others suggest that digital technology provides little change. Whereas other suggests that in many schools, teachers in mathematics classrooms have adopted technology without clear instructional design, and some focus on short-term improvements in students' engagement, particularly with specific digital tools in mathematics classrooms (Cirneanu& Moldoveanu, 2024). This leaves the problem regarding the potential long-term use of digital applications to enhance academic achievement and engagement in the mathematics classroom. This research utilized different digital tools to demonstrate how they affect students' engagement and academic achievement.

Research Objectives

1. To evaluate the impact of digital apps on students' engagement in the grade VII mathematics classroom.
2. To assess the impact of digital apps on students' academic performance in the grade VII mathematics classroom.

Research Questions

1. How are digital apps impact students' engagement in the grade VII mathematics classroom?
2. How do digital apps impact students' academic performance in the grade VII mathematics classroom?

Literature Review

This model is an inclusive model of successful incorporation of technology in learning and teaching. The model undertakes that successful implementation of technology in instruction has to involve a profound comprehension of the way to interaction technology with pedagogical and content-related knowledge (Merono et al., 2021). Moreover, it assists educators to comprehend the knowledge they should have to successfully integrate technology into their instructions by bringing together three main domains. These domains are Pedagogical Knowledge (PK), Content Knowledge (CK) and Technological Knowledge (TK). The model also highlights the fact that a combination of the three areas is complex and should all be combined to result in successful technology integration to promote learning experiences in students (Shuaib & Adnan, 2025).

The effectiveness of the TPACK model with respect to enhance student engagement, learning outcomes, and teacher efficacy relays on effective use of digital apps and start with the awareness of the teacher on how technology can assist the exact content being taught (Bakar et al., 2020). Technology application is not a goal but a tool that educators should choose depending on the subject they are teaching. For example, in mathematics, the GeoGebra would be used to enable the student to visualize functions, as simulation would enhance the learning of the concepts. This correspondence between content and technological knowledge means that digital tools can add value to teaching and learning (Merono et al., 2021).

Constructivist Learning Theory

Constructivism is the theory that emphasises that individuals build knowledge through their own experiences, rather than simply memorising facts. Personal experiences and thoughts allow people to form new ideas and include new information (Zajda, 2021). Constructivist learning theory emphasizes that digital learning involves students because they actively learn through hands-on experiences and dealings with outside influences. It inspires students to connect what they learn with something they already know, making things more straightforward. At the same time, digital platforms are designed to support active learning, cooperation, and access to diverse content (Tamur & Juandi, 2020).

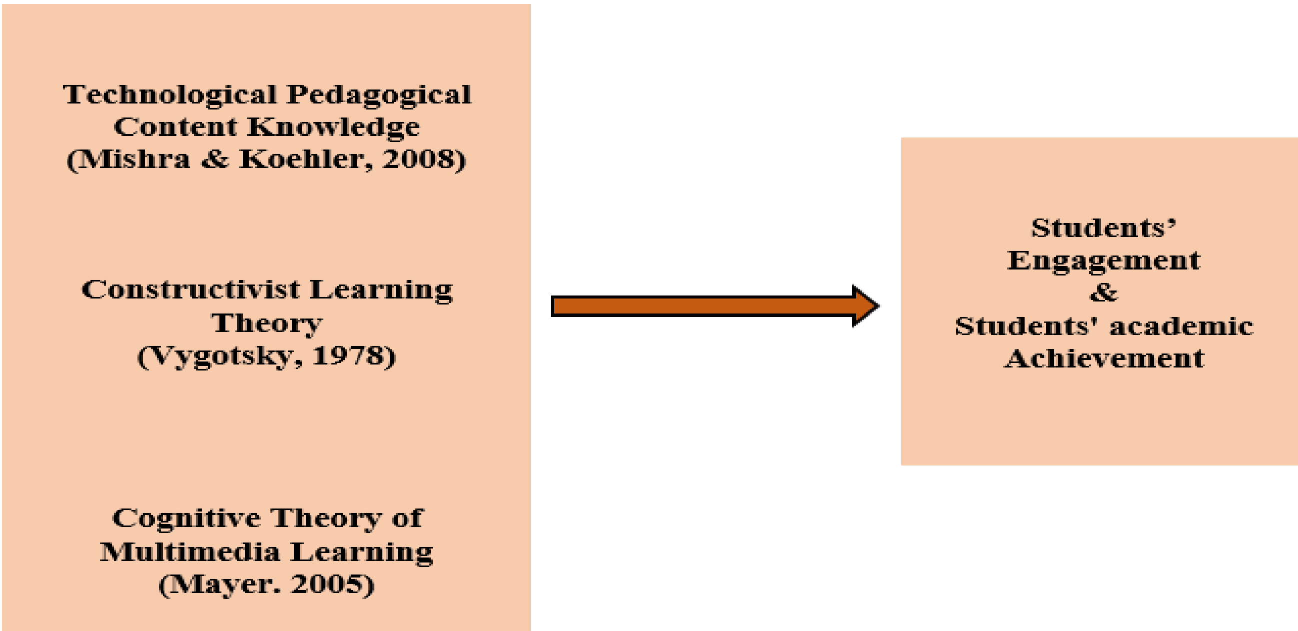
Constructivism is premised on the belief that mathematics is not the set of rules and processes to memorize but is an inquiry and discovery process that is directly connected with the real-world experiences (Bermejo et al., 2021). The fundamental belief of constructivism in mathematics classroom is that students ought to be introduced to real-life problem-solving tasks. Inside a standard math classroom, the students may be challenged to complete repetitive tasks or memorize algorithms without having a clue of the concepts. Conversely, constructivist math classroom emphasizes the why of mathematical operations and enables the students to establish a relationship between different mathematical concepts and the real world (Kusuma, 2021). Indicatively, students can study geometry by building forms and designs, or they can gain algebraic reasoning skills by answering questions based on real-life situations. Such practical exercises will allow the students to perceive the applicability of mathematics in their everyday life and enhance their perception of the abstract mathematical concepts (Zajda, 2021).

Cognitive Theory of Multimedia Learning

The theoretical model is CTML which is based on how individuals process and understand information using multimedia. The knowledge transfer process may be effective in the case of information incorporated in the existing knowledge (Cavanagh & Kiersch, 2023). Therefore, when the students are engaged in active processing of incoming information, they also rely on the available knowledge to facilitate the process (Danish, Akhtar & Imran, 2025; Mankash, et al., 2025; Hafeez, Yaseen & Imran, 2019). According to the theory, meaningful learning is possible when students actively choose, assemble and combine information in these two channels. Cognitive processing is more effective when mathematics content- graphs, geometric figures, algebraic processes or visual models are accompanied by the corresponding verbal explanations. Students can be overloaded with long text, complicated diagrams or unnecessary multimedia which can be counterproductive to learning (Pourahmadali et al., 2025). Since concepts of mathematics are sometimes symbolic, and multi-step, to avoid cognitive overload, multimedia content must be carefully designed. The active processing assumption points to the fact that learners do not receive the information passively but instead, they should be active participants in building the knowledge. This interaction takes place when students select meaningful information as they think about it, arrange it in meaningful structures, and relate it with the knowledge they already have (Mayer, 2024).

CTML is a multimedia-based mathematics teaching that aims at increasing student engagement and comprehension. The teaching strategy will include the use of multimedia tools that are in line with the principles of CTML to help learners have a conceptual understanding and remember the complicated mathematical concepts, as well as engage in active learning (Cavanagh & Kiersch, 2023). Consequently, CTML provides the theoretical framework and groundwork of the teaching on the exploratory nature of the effects that multimedia-based teaching has on learning of students in the mathematics classroom (Pourahmadali et al., 2025).

Figure 1: Theoretical Framework



Research Gap

Although a digital tool has increased in majority of the schools but most of the teachers do not use it out of the class. They do not take formative assessment and feedback from students. Moreover, most of the digital tools used in classroom are not applied for the long-term this leads to low engagement classroom. Moreover, the digital tool used to increase students' learning are not specified. This suggests a major gap in the current literature on the full approach to the digital resources in the whole teaching-learning process. Moreover, this research will apply GeoGebra and Adapt Mind two specific digital apps in mathematics classroom of grade VII in different cycle. Each research cycle will be done in 4 weeks that is the longest time to judge the impact of Adapt Mind and GeoGebra on students' engagement and academic grades.

Research Methodology

Type of Action Research

This research is classroom-based practitioner led action research. In this research, practitioners used contextual inquiry to improve both their own profession and their students' learning. As in this research, the issue that needs improvement is students' engagement and achievement in mathematics Grade VII. Such technique is active relative to passive observational research, which requires the involvement of intervention in the learning process.

The plan of action suggested the incorporation of digital technologies (GeoGebra and Adapt Mind) into the math classroom. The design would fit best in a practitioner-led investigation since it directly targets an area perceived to be in need of improvement using a systematic inquiry-based investigation. It gives the practitioner the authority as knowledge-producer in their own classroom.

It used a quantitative method to collect objective, measurable, and context-specific. Numerical was collected over the use of pre and post-tests, for academic achievement and structured checklists for engagement. This data was statistically analysed to reveal patterns, and present convincing evidence of the effectiveness of the interventions.

Setting of the Action Research

This research was conducted in EFG Secondary School. It focused on the grade VII mathematics classroom, which has basic digital infrastructure, like all the other schools in the city. The setting was selected carefully as it is a standard Pakistani urban school with simple digital infrastructure. This was equipped with a computer lab, and a constant internet connection. Such setting enhances the validity of the research and improves the results as it was more easily applicable to other teaching situations within the city, instead of being confined to excellently well-equipped schools. The study was narrowed down to the Grade VII mathematics classroom, allowing in-depth study in a specific subject and age group.

Participants

In this research, the 30 participants were selected from grade VII students from EFG secondary school, Karachi. Moreover, the researcher was actively involved in designing the digital interventions, administering them in their classrooms, and offering reflective feedback. This method reduces the level of disruption and is demonstrate the way an intervention would take place in a school. The participants were in the age of development (early adolescence) in which the attitude towards subjects such as mathematics can be established and therefore this is a crucial moment to intervene positively. More importantly, the classroom mathematics teacher is also involved in the research process. Their cooperation was a key to genuine implementation and provide worthy opinion about the viability and effectiveness of the intervention. Moreover, since the researcher was an insider their practice and reflection are part of the study.

Action Research cycle

Cycle 1

The study followed the iterative action research cycle of planning, acting, data collection, and reflection. This is not a linear cycle but a spiral cycle wherein the insight from each cycle, is informed and refined from the previous cycle.

Planning

The planning stage is diagnostic stage. The core problem has been identified as students' low academic achievement and engagement in the mathematics classroom, which in turn can be improved by digital tools. As literature review indicates that digital tools may improve conceptual knowledge, offer instant feedback, and motivate. Thus, the proposed intervention combines two different digital tools Adapt Mind and GeoGebra which were introduced in the classroom.

GeoGebra: It is a powerful mathematic learning app chosen to teach “Sets”. The app has power to visualise abstract sets concepts through interactive Venn diagrams making impalpable ideas of unions, complements concrete.

Adapt Mind: This app was chosen to teach the percentage topic. It has the ability to personalize learning through games and challenge the students depending on the performance, and to provide game-like elements for engagement.

Action

Mathematics teachers went to incorporate Adapt Mind to teach percentage and GeoGebra to teach sets for 4 weeks. During the action phase of 4 weeks the researcher incorporated digital apps systematically in the classroom. For teaching the topic of percentage the teaching instructions is held in computer lab where each individual solved different sums on percentage topic according to their level of understand by using app Adapt Mind individually or with a pair. For teaching the topic of sets researcher incorporated the app GeoGebrain lesson as a demonstration tool to visualize the problems and where feasible, the students had practical opportunity to make and manipulate their own dynamic diagrams. The lesson plan was design to incorporate apps effectively in the classroom timing and serves to meet to meet the learning outcomes.

Data Collection

The pre-test on the topic of sets and percentage was taken to assess student’s prior knowledge. After that, the teacher used Adapt mind and Geogebra to enhance their concepts. A similar post-test was done at the end of the 4-week intervention. The pre and post-tests contain standardized mathematical problems to ensure be reliable in this measurement. An observation checklist observation was created and used during the lessons to evaluate students’ engagement while using the apps.

Reflection

It is a very important stage as it analyses the collected data to answer the main reflective questions: What went well? Did engagement improve while using Adapt Mind and GeoGebra? What feature of Adapt Mind and GeoGebra is most useful? What did not go well? Did the tools not prove useful in some areas? Have there been any students having any problem with the technology?

This reflection was directly influenced the need to change anything in the second cycle of action research and, the way the intervention needs to change. The reflection revealed that GeoGebra helped students to improve in mathematics because of good visuals but they need more structured worksheets to connect the visuals, leading to a revised plan.

Digital Interventions

The interventions will be digital tools (GeoGebra and Mathelectics) in the grade VII mathematics classroom. These tools will explain sets and percentage maths problems and provide students with different mathematics exercises for practice. The major leader of implementation will be the research. Cycle 1 will last about 4 weeks, and then there will be a period of reflection and planning (1 week).

The digital interventions are not applications but they help in making informed decision making to foster learning of students. GeoGebra will change the way Set is taught. Instead of textbook students will be presented with movable Venn diagrams where items may be dragged and shaded areas of unions, intersects to be updated in real-time.

Adapt Mind will deal with the practice and skill building of Percentages. It offers a tailored approach, with practice to those students who struggle with doing easy task such as fractions and decimals, and more difficult problems on the change of percentages to those who need it. It is intended to foster determination and motivation to a subject that is often tedious through feedback and reward system.It is necessary to mention that these tools are used as a supplement and improvement, not as a substitute of good teaching. The pedagogical techniques explanation for topics and relation building with students by the teacher is of the utmost importance.

Data Analysis Tool

"Statistical Package of the Social Sciences (SPSS)" software was used to analyse the quantitative figures. The primary test of statistics is a t- test of paired samples. The test is most appropriate to compare the means of the two related groups in this case, the score of the same students on the pre-test and the post-test. The t-test was employed to determine whether the difference in scores recorded between the pre and post-test. This p-value was so large (the p-value was typically lower than 0.05) that it would provide solid quantitative evidence on the efficacy of the digital interventions in terms of academic performance.

The first part of the analysis includes the creation of descriptive statistics to have an idea of the level of baseline engagement and its variability. The evaluation focused on whether the multiple points of observation in 4-week period of the intervention cycle showed a significant statistical change in the scores of engagements in the use of Repeated Measures ANOVA. Such a method of analysis supplies an empirical, quantitative data on the effect the digital interventions have on classroom engagement dynamics, which was directly reflected in the reflective part of the action research cycle.

Researcher's Role

The researcher was an insider and participant. The researcher co-designs part of the research as it was action research. The research was applying Adapt Mind and GeoGebra in grade VII mathematics classroom where she teachers to foster engagement and academic achievement. Through the insider position, it is possible to access a rich context and establish trust with participants.

At the same time, the researcher has the responsibility to be a facilitator of the research process and also be a critical reflector of the practice. This involves being vigilant at all times about the and monitor students while using the apps. In order to counter this, a number of approaches was used such as to keep a reflective journal to clearly challenge self-assumptions, emotional reactions, and impact on the classroom relationship during the study. Moreover, the use of common statistical tests (t-test) to give objective results regarding achievement. This is a characteristic of rigorous practitioner research, which utilizes close access and scholarly objectivity.

Data Analysis and Interpretation

Presentation of Data

H_1: There is a significant difference between students' pre-test and post-test academic achievement.

Descriptives

	N	Mean	SD	SE	Coefficient of variation
Pre-test	30	9.867	3.674	0.671	0.372
Post-test	30	18.267	1.874	0.342	0.103

The descriptive statistics show that improvement in students' academic achievement is significant from pre-test to post test. The pre-test scores of the 30 students mean= 9.867 (SD = 3.674) while the post test scores mean= 18.267 (SD = 1.874) as presented in Table 4.1. This was a significant improvement in the post-test with regard to students' after intervention performance. A decrease in the standard deviation between the pre-test and post-test (3.674 to 1.874) highlighted that after the activity students' scores were closer to the mean. In the same way, the standard error has been reduced from 0.671 to 0.342 which means that the measurement of the post-test mean is now more precise. Schools' students' post-test performance also showed significantly less relative variability when compared with the pre-test as the coefficient of variation changed from 0.372 (37.2%) to 0.103 (10.3%) in the post-test. Generally, the results from the descriptive data indicated enhancement and uniformity of school performance after the intervention.

Paired Samples T-Test

Measure 1		Measure 2	t	DF	P	Mean Difference	SE Difference
Pre-test	-	Post-test	-10.47	28	< .001	-8.483	0.810

Note: *In all the tests, the alternative hypothesis is that Pre-test is worse than Post-test.*

Note: Student's t-test.

The paired-samples t test was carried out to check if there was significant difference between the mean of students' academic achievements before and after treatment. As indicated in Table 4.2, the results indicated a statistically significant difference between pretest and the post test scores, $t(28) = -10.47$, $p < .001$. The mean difference resulted to be −8.483 (SE = 0.810), which means that the difference in score is statistically significant within the margin of error and there is a substantial difference between the pre and post test scores. The p-value result is less than .05, which means that the difference between the two groups is statistically significant. So, null hypothesis is rejected and the alternative hypothesis is accepted. This conclusion suggests that there has been a significant improvement in students' academic achievement between the pre-test and post-test.

H_2: There is a significant difference in students' engagement while using the apps across the different levels/conditions.

Descriptives

Engagement while using the apps	N	Mean	SD	SE	Coefficient of variation
Level 1	11	3.273	0.786	0.237	0.240
Level 2	11	4.000	0.894	0.270	0.224

Table 4.3 displays the descriptive data on the level students were engaged in using the apps, at two level classifications. At Level 1, the 11 students had a mean engagement score of 3.273 (SD = 0.786), whereas at Level 2, the mean engagement score increased to 4.000 (SD = 0.894). This means that the students' engagement was higher at Level 2 than at Level 1. The standard deviation of the students' engagement score within each cluster varied noticeably between Level 1 (0.786) and Level 2 (0.894), indicating that there is not a huge variation across the schools within each level. This led to only a minor increase in the standard error from 0.237 to 0.270, and a minor decrease in coefficient of variation from 0.240 (24.0%) at Level 1 to 0.224 (22.4%) at Level 2. The students generally did better at Level 2 than they did at Level 1, as further inferential testing is needed to determine whether this is statistically significant.

Repeated Measures ANOVA for Engagement

Within Subjects Effects

Cases	Sum of Squares	df	Mean Square	F	p
Engagement while using the apps	2.909	1	2.909	13.91	.004
Residuals	2.091	10	0.209		

Note: *Type III Sum of Squares*

The Within-Subjects effects of the repeated-measures ANOVA shown in Table 4.4 show that this difference is significant statistically by the level of engagement of the students' use of the apps. The results indicated that engagement did have a significant effect, F (1, 10) = 13.91, p = .004. If the p-value is < .05 then the null hypothesis is rejected and the alternative hypothesis accepted. That means that students had quite a bit of difference in participation between Level 1 and Level 2. The higher level of scores from all students in the descriptive data analysis at Level 2 (M = 4.000) than at Level 1 (M = 3.273) shows that the usage of the Apps has significantly made learning more engaging among students at Level 2.

Between Subjects Effects

Cases	Sum of Squares	Df	Mean Square	F	p
Residuals	12.09	10	1.209		

Note: *Type III Sum of Squares*

The effects that were tested between subjects in the foregoing table, Table 4.5, have a residual sum of squares of 12.09 on 10 degrees of freedom, and a mean square of 1.209. There is not however a F-value or a p-value provided so this table is insufficient evidence to test an effect between subjects. The hypothesis of engagement is thus tested based on the within subject's results that revealed a significant difference $F(1, 10) = 13.91$, $p = .004$. So, the null hypothesis is rejected and the alternate is accepted.

Findings, Discussion and Recommendations

Discussion of Findings

The purpose of the present study was to look into the effectiveness of educational apps for enhancing academic achievement and engagement of the students. The study specifically examined whether students' achievement was enhanced after implementing use of the educational apps in school and whether the change in engagement in each condition of app-based learning was different. The results that emerged from both the hypotheses will be discussed below, in relation to past empirical literature.

The first hypothesis was tested to find out whether there is a significant difference between the academic achievement of the students' pre-test and that of post-test. Results of the preliminary stages proved that the students' achievement improved significantly after the intervention and thus the null hypothesis was rejected. It is inferred that the application of the educational app was positively influencing students' learning performance. An improvement can relate to the interactive approach of the app-based learning methods, which gives learners opportunities for repeated practice, gives them instant feedback, allows for the texts to be accessed flexibly and allows them to interact with the teaching. This finding is in line with all previous empirical evidence related to technology-enhanced learning. Addressing the deficiency in existing learning research, Dong et al. (2024) conducted a meta-analysis of 44 studies involving 4,145 students in school aged groups to determine the impact of mobile learning on students' achievement in science. This finding strengthens the current study as both studies suggest that the use of learning through the mobile enhances students' academic achievement. Again, Akpen et al., (2024) conducted a systematic review of 18 studies and found that online learning positively impacts students' academic learning products if the learning environment is equipped with the necessary digital resources, conditions and opportunities for learning interactions. The present finding might also be explained by the analysis of the characteristics of the technology-supported learning. Learning applications that can enhance learning to be more interactive and give students chance to interact with materials other than the traditional classroom can help their education. These learning opportunities can provide ample practice of the concepts being learned, while allowing learners to get feedback as they go. It is also suggested in the literature, though, that technology does not necessarily lead to better learning or achievements. According to Akpen et al. (2024), digital learning has a strong need of digital tools, learners' motivation, interaction as well as teaching approach used while working with technology. Therefore, any improvement in academic performance observed in the present study is probably not solely due to the usage of the apps, but to a conscious application of the apps in the learning process.

The second hypothesis addressed the question of whether there was a significant difference between students' engagement in the two categories of app use. The results indicated a significant difference between the two with the null hypothesis being rejected. In addition, the descriptive findings revealed that there was more engagement at Level 2 compared to Level 1. This indicates that as students continued to interact with the educational apps or interacted more at a higher level there was more student engagement in the learning activities. This is aligned with the recent research that has focused on the importance of technology-supported learning to foster students' engagement. In their systematic review, Bredahl et al., (2024) show that mixed learning interventions in general had moderate to high impact for engagement and learning. The engagement is multi-dimensional and can involve academic, behavioural, cognitive and affective, was highlighted in the review. Likewise, Bergdahl et al. (2024) pointed out that the concept of student engagement is complex and multidimensional with respect to learning in an TEL environment, suggesting that students' interaction with digital learning environments can yield valuable data for e.g. informing evidence of their engagement in learning. The findings from the present research can be attributed to the interactive and learner centred nature of educational Apps. Digital learning activities can enable active engagement, offer instant feedback, facilitate a multi modal approach, and allow for the pacing of learning to be controlled by the student. The features can help to make learning activities more engaging and motivate students to keep up with their learning. But it shouldn't be taken as a given that engagement will rise with the use of all technology. Earlier studies have suggested that the design and incorporation of digital tools into learning activity is important for effective engagement. The importance of keeping the engagement in technology-supported learning through interactive elements and proper instructor–student interaction was also found by (Akpen et al., 2024).

Conclusion

The purpose of the study was to find out how successful educational apps were to enhance students' learning performance and interaction. The results showed that the use of educational apps positively influenced students' learning in both aspects of learning. There were notable gains in the students' academic achievement following the intervention with their post- test performance significantly improving compared to their pre-test performance. Meaning that app-based learning was useful for the students to enhance their learning and performances. It also revealed the same stats are only marginally different based on the level of app use by students. Students demonstrated more involvement at level 2 as compared to level 1, suggesting that the educational app have prompted higher levels of engagement and participation in learning activities. The interactive and learner-cantered aspects of the apps could have played a role in such engagement, too. In general, the study finds that apps for education may offer themselves as a fruitful supplementary learning method that can enhance students' academic performance and engagement. If used well and creatively in teaching and learning, educational Apps can create a learning experience that is interactive, encourage students to participate, and contribute to students' success in learning.

Recommendation for Next Cycle

1. The digital learning should include tasks that ask students to solve problems collaboratively within pairs or groups, for example by collaborating with peers and tools like GeoGebra, encouraging the students to reason mathematically and learn from each other.
2. Students should be orientated, guided and shown through an orientation and guidance session to help them become more familiar with digital tools and ease cognitive load especially for students who need extra technical support.
3. Digital application needs to be utilized in a broader variety of mathematical problems, in challenging and complex mathematical concepts, to gain insight into the consistency of their impact on students' learning outcomes.
4. Students should be informed to conduct brief learning journals or feedback forms reflecting themselves for the encouragement of further participation. Cognitive and emotional factors like perseverance, interest, confidence, and participation should be part of the assessment in an engagement.
5. Teachers should incorporate continuous pedagogical scaffolding - questioning, exploration and feedback - instead of use of technology in procedural activities.
6. Future cycles should also include data triangulation, using observation checklists, academic outcomes assessments, and student feedback to get a full picture of the intervention.

Conflict of Interest

The authors showed no conflict of interest.

Funding

The authors did not mention any funding for this research.

References

Ahmad, D. N., Bibi, N., & Imran, M. (2023). Effects of Teacher's Motivation On Students' academic Performance at Public Secondary Schools in Karachi Pakistan. *Available at SSRN 5165741*.

Akpen, C. N., Asaolu, S., Atobatele, S., Okagbue, H., et al. (2024). *Impact of online learning on student's performance and engagement: A systematic review*. Discover Education, 3, 205.

Alabdulaziz, M. S. (2021). COVID-19 and the use of digital technology in mathematics education. *Education and Information Technologies*, *26*(6), 7609-7633. https://doi.org/10.1007/s10639-021-10602-3

Ali, M. S. B., Yasmeen, R., & Munawar, Z. (2023). The impact of technology integration on student engagement and achievement in mathematics education: A systematic review. *International journal of computer integrated manufacturing*, *6*(3), 222-232.https://journals.researchparks.org

Alismaiel, O. A., Cifuentes-Faura, J., & Al-Rahmi, W. M. (2022). Online learning, mobile learning, and social media technologies: An empirical study on constructivism theory during the COVID-19 pandemic. *Sustainability*, *14*(18), 11134.https://doi.org/10.3390/su141811134

Alt, D. (2023). Assessing the benefits of gamification in mathematics for student gameful experience and gaming motivation. *Computers & Education*, *200*, 104806. https://doi.org/10.1016/j.compedu.2023.104806

Attard, C., & Holmes, K. (2022). An exploration of teacher and student perceptions of blended learning in four secondary mathematics classrooms. *Mathematics Education Research Journal*, 34(4), 719-740. https://doi.org/10.1007/s13394-020-00359-2

Bakar, N.S., Maat, S.M. &Rosli, R. (2020). 'Mathematics teacher's self-efficacy of technology integration and Technological Pedagogical Content Knowledge', *Journal on Mathematics Education, 11(2),* pp. 259–276. doi:10.22342/jme.11.2.10818.259-276.

Bergdahl, N., Bond, M., Sjöberg, J., Dougherty, M., & Oxley, E. (2024). Unpacking student engagement in higher education learning analytics: A systematic review. *International Journal of Educational Technology in Higher Education, 21*, 63. https://doi.org/10.1186/s41239-024-00493-y

Bermejo, V., Ester, P., & Morales, I. (2021). A constructivist intervention program for the improvement of mathematical performance based on empiric developmental results (PEIM). *Frontiers in psychology*, *11*, 582805.https://doi.org/10.3389/fpsyg.2020.582805

Cavanagh, T. M., &Kiersch, C. (2023). Using commonly-available technologies to create online multimedia lessons through the application of the Cognitive Theory of Multimedia Learning. *Educational technology research and development*, *71*(3), 1033-1053. https://doi.org/10.1007/s11423-022-10181-1

Cirneanu, A. L., & Moldoveanu, C. E. (2024). Use of digital technology in integrated mathematics education. *Applied System Innovation*, *7*(4), 66. https://doi.org/10.3390/asi7040066

Clark-Wilson, A., Robutti, O., & Thomas, M. (2020). Teaching with digital technology. *Zdm*, 1-20. https://doi.org/10.1007/s11858-020-01196-0

Danish, F., Akhtar, N., & Imran, M. (2025). AI-Driven Personalization in Educational Marketing: A Framework for Enhancing Student Recruitment and Retention. *Journal of Political Stability Archive*, *3*(2), 559-590.

Dong, Z., Chiu, M. M., Zhou, S., & Zhang, Z. (2024). The effect of mobile learning on school-aged students' science achievement: A meta-analysis. *Education and Information Technologies, 29*, 517–544.

Drijvers, P., & Sinclair, N. (2023). The role of digital technologies in mathematics education: purposes and perspectives. *ZDM*, *56*(2), 239–248. https://doi.org/10.1007/s11858-023-01535-x

Effective student engagement with blended learning: A systematic review. (2024). *Heliyon*. https://doi.org/10.1016/j.heliyon.2024.e39439

Hafeez, A., Yaseen, G., & Imran, M. (2019). Management Paradigm Change in Pak¬-Turk (International Schools & Colleges) After a Failed Military Coup in Turkey: A Case Study.

Haider, S., Mirwani, R., Imran, M., & Haider, H. (2025). The Emotional Landscape of Organizational Change: A Qualitative Study of Teachers in Lasbela, Balochistan. *Journal of Political Stability Archive*, *3*(3), 1482-1502. https://doi.org/10.63468/jpsa.3.3.98

Haleem, A., Javaid, M., Qadri, M. A., & Suman, R. (2022). Understanding the role of digital technologies in education: A review. *Sustainable operations and computers*, *3*, 275-285. https://doi.org/10.1016/j.susoc.2022.05.004

Hardiyanti, E., Fitriani, V., & Ashari, W. (2023). The Influence of Digital Tools on Student Engagement and Academic Outcomes Across Educational Levels. *Educia Journal*, *1*(2), 57-66. https://doi.org/10.71435/610408

Hossein-Mohand, H., Trujillo-Torres, J. M., Gómez-García, M., Hossein-Mohand, H., & Campos-Soto, A. (2021). Analysis of the use and integration of the flipped learning model, project-based learning, and gamification methodologies by secondary school mathematics teachers. *Sustainability*, *13*(5), 2606. https://doi.org/10.3390/su13052606

Imran, M., Akhtar, N., & Khan, N. (2026). Ethical Leadership in Early Years Education: Implications for Teacher Professional Ethics and the Learning Environment–A Qualitative Study. *Journal of Political Stability Archive*, *4*(1), 260-281. https://doi.org/10.63468/jpsa.4.1.15

Karamert, Ö., & Vardar, A. K. (2021). The effect of gamification on young mathematics learners' achievements and attitudes. *Journal of Educational Technology and Online Learning*, *4*(2), 96-114.https://doi.org/10.31681/jetol.904704

Khoso, F. J., Shaikh, N., Dahri, K. H., & Imran, M. (2024). Educational Nurturing in Underdeveloped Contexts Unraveling the Dynamics of Student Teachers' Holistic Development. *Spry Contemporary Educational Practices*, *3*(1).

Kusuma, J. W. (2021). Constructivism from philosophy to mathematics learning. *International Journal of Economy, Education, and Entrepreneurship*, *1*(2).https://doi.org/10.53067/ije3.v1i2.16

Malvasi, V., Gil-Quintana, J., & Bocciolesi, E. (2022). The projection of gamification and serious games in the learning of mathematics: a multi-case study of secondary schools in Italy. *Mathematics*, *10*(3), 336.https://doi.org/10.3390/math10030336

Mankash, M. A., Ahmed, S. T., Shabbir, N., & Imran, M. (2025). Second Language Learning in the Digital Age: How Technology Shapes Language Acquisition at Universities in Karachi, Pakistan. *Liberal Journal of Language & Literature Review*, *3*(1), 182-199.

Mayer, R. E. (2024). The past, present, and future of the cognitive theory of multimedia learning. *Educational Psychology Review*, *36*(1), 8.https://doi.org/10.1007/s10648-023-09842-1

Merono, L., Calderón, A., & Arias-Estero, J. L. (2021). Digital pedagogy and cooperative learning: Effect on the technological pedagogical content knowledge and academic achievement of pre-service teachers. *Revista de Psicodidáctica (English Ed.)*, *26*(1), 53-61. https://doi.org/10.1016/j.psicoe.2020.10.002

Pourahmadali, A., Farahani, M., & Sheikhi Fini, A. (2025). Effectiveness of Multimedia Instruction Based on Cognitive Theory on Academic Motivation and Mathematics Achievement for Students in Distance Education Centers. *Iranian Journal of Educational Research*, *4*(2), 0-0.http://ijer.hormozgan.ac.ir/article-1-291-en.html

Ridha, M., Rahman, F., & Islamy, M. I. (2024). Students learning engagement in the flipped classroom: Systematic literature review. *Jurnal Inovasi Teknologi Pendidikan, 11*(3).

Shi, Y., Zhang, J., Yang, H., & Yang, H. H. (2021). Effects of interactive whiteboard-based instruction on students' cognitive learning outcomes: a meta-analysis. *Interactive Learning Environments*, *29*(2), 283-300.https://doi.org/10.1080/10494820.2020.1769683

Shuaib, M., & Adnan, M. (2025). Integrating Technology in Mathematics Education: An Evaluation of the TPACK Model for Secondary School Teachers. *Dialogue Social Science Review (DSSR)*, *3*(2), 1221–1232. Retrieved from https://dialoguessr.com/index.php/2/article/view/417

Sultana, Z., & Imran, M. (2024). Challenges Faced by English Teachers in Pakistan. *Spry Journal of Literature and Linguistics*, *2*(1).

Tamur, M., &Juandi, D. (2020). Effectiveness of constructivism based learning models against students mathematical creative thinking abilities in Indonesia: A meta-analysis study. *Pervasive Health: Pervasive Computing Technologies for Healthcare*, *1*, 107-114.http://journal.uny.ac.id/index.php/jpe

Uzorka, A., & ODEBIYI, O. A. (2025). Impact of Digital Learning Tools on Student Engagement and Achievement. *Journal of Digital Learning and Distance Education*, *4*(1), 1436-1445.https://doi.org/10.56778/jdlde.v4i1.511

Viberg, O., Grönlund, Å., & Andersson, A. (2020). Integrating digital technology in mathematics education: a Swedish case study. *Interactive Learning Environments*, *31*(1), 232–243. https://doi.org/10.1080/10494820.2020.1770801

Wardat, Y., Tashtoush, M. A., AlAli, R., & Jarrah, A. M. (2023). ChatGPT: A revolutionary tool for teaching and learning mathematics. *Eurasia Journal of Mathematics, Science and Technology Education, 19*(7), em2286. https://doi.org/10.29333/ejmste/13272

Wei, Z. (2024). Navigating digital learning landscapes: unveiling the interplay between learning behaviours, digital literacy, and educational outcomes. *Journal of the Knowledge Economy*, *15*(3), 10516-10546. https://doi.org/10.1007/s13132-023-01522-3

Zaidi, S. S., Imran, M., Khoso, F. J., & Sultana, Z. (2024). Impact of Technologies and Co-Curricular Activities on Students' Academic Achievement at the Undergraduate Level. *Journal of Social & Organizational Matters*, *3*(3), 75-90. https://doi.org/10.56976/jsom.v3i3.99

Zajda, J. (2021). Constructivist learning theory and creating effective learning environments. In Globalisation, comparative education and policy research (pp. 35–50). https://doi.org/10.1007/978-3-030-71575-5_3.