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Chapter

# The Impact of Tablet Device Applications on Mathematics Teaching and Learning at Secondary School Level in Saudi Arabia

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## Abstract

There has recently been a rapid rise in the use of educational applications (apps) in teaching and learning, and they are increasingly being viewed as a necessary part of instruction. However, they are still relatively new in secondary schools in Saudi Arabia. The purpose of this study was to investigate the impact of apps on mathematics teaching and learning in the 10th grade of secondary school. Also, this study will help higher education institutions to know about the supportive educational apps to continue using the beneficial apps and to support the needs of future teachers to be trained and improve the curriculum to keep pace with technology development in education. The interviews' findings show the need to consider the integration of new technology carefully prior to launching projects involving a change in the educational system to avoid failure. The integration of educational apps helped the students develop their mathematics learning skills, and the teachers viewed it positively in terms of the impact on teaching mathematics concepts at the secondary school level. The study also investigated the obstacles encountered by teachers and students when using various apps and sought solutions. It highlights the implications of app use and makes recommendations.

**Keywords:** tablet devices, education apps, mathematics apps, students' performance, teachers' perceptions

## 1. Introduction

Educational settings have changed significantly over the past decade due to the integration of technology. Technology can have potential benefits, enhancing teaching and learning opportunities, and it can aid teachers and students improve academic performance. Therefore, technology is considered an important tool to be used in classrooms. According to Lamb and Johnson [1], technology allows students to monitor their learning and progress in the classroom and provides communication

channels between teachers and their students. Many studies have shown that using technology for learning raises levels of student engagement, fosters positive attitudes and improves motivation [2]. Studies have shown that students and teachers derive many advantages from using technological applications (apps) in the classroom. These include higher levels of motivation among students, improved knowledge and skills among both teachers and students and greater familiarity with different kinds of resources [3].

In secondary schools in Saudi Arabia, students face difficulties in learning mathematics, which negatively affects their performance and can discourage them from studying the subject. Incorporating technology, especially the use of apps, in mathematics classrooms is a powerful means of promoting engagement between students and teachers and enhancing teaching and learning [4]. A study that investigated the effect of using iPad apps on the development of mathematical skills and attitudes in an elementary school in the United States (US) found that students preferred using apps, such as the Splash Math app, rather than doing mathematics activities from the textbook [5]. The apps engaged and motivated the students in their mathematics classes, and they spent more time on their tasks, thus receiving a different learning experience [5]. There are many educational apps that can be used in the teaching and learning process, and the number of apps available to support students and teachers is continuously increasing. The Apple App Store contains more than 80,000 educational apps, the most common of which are mathematics apps [6].

Tablet apps offer excellent opportunities for mathematics teaching and learning. Research examining the effect of using mobile technology in mathematics has found that it increases academic learning levels [7]. Moreover, apps may be more helpful than other educational tools, especially for keeping students on-task, which could positively affect their attitudes, engagement and achievement [7]. Students may benefit from the use of apps to enhance their academic performance, as evidenced by improvements in their grades [8]. Apps can also reduce the achievement gap between successful students and struggling students, giving the latter opportunities to engage in mathematics activities and receive immediate feedback from the app and enabling them to undertake complex operations, for example, by separating the solving of equations into clear steps [9]. However, it is essential that teachers engage in adequate planning and choose an appropriate app before integrating it in the mathematics classroom. Moreover, they should train their students on how to use it to ensure they gain the benefits in the learning process.

Tablet apps can foster collaboration and communication among students as well as between students and their teachers [3]. Students can communicate and share their knowledge more readily using technology. They can benefit from different communication apps that support them in sharing their experiences with others, engaging in collaborative and constructive learning in a way that enables them to become more creative and connected with other students [10]. Mathematics is often a subject students struggle with, but the use of new methods and tools can have a great impact on their levels of understanding. Employing different apps in the mathematics classroom could also improve students' attention and focus, for example, through the collaborative approach offered by communication apps, which make learning easier. Conversely, other research showed that students found it challenging and experienced difficulties communicating and collaborating with other students via tablet devices' apps [11]. For instance, evidence from other studies identified that social isolation could have a negative impact on iPad and smartphone usage in educational settings

[12, 13]. Thus, the use of tablet device apps makes learners feel depressed and lonely, as well as increases social isolation [12].

However, mathematics apps provide an excellent opportunity to practise activities that aid creative and critical thinking among students. They can also support individual differences in learning among students by offering different levels of activities. It has been found that students in the classroom became more creative by learning in different ways, particularly using apps that support academic performance [14]. An exploratory study conducted in an inclusive fourth-grade classroom in the US that used three apps (Splash Math, Motion Math Zoom and Long Multiplication), each employing different scaffolding strategies to support students' learning of decimals and multiplication, found that using the apps improved learning and reduced the achievement gap between struggling and capable students [9]. Using apps has a range of benefits, such as making complex operations, for example, multiplication and solving equations, easier to understand by undertaking different activities. Also, students can gain a better understanding of mathematics content through the complex critical thinking activities that some mathematics apps provide to reach a new level of knowledge [15]. For instance, Motion Math features different levels, from the easiest activities to the hardest ones, designed to help students understand fractions [16]. In another study, the students expressed the belief that using mathematics apps improved their computation strategies and multiplication skills [17]. Finally, many apps introduce creative and critical thinking skills through games or specific mathematics activities which allow students to learn new skills in an enjoyable way whether studying or playing in their free time at school or home.

Furthermore, when students use different educational apps for individual learning, they become more motivated to learn new knowledge [18]. Research has found that technology has a positive effect on pupils by enabling them to comprehend lessons in greater depth and increasing their motivation to learn mathematics [19]. This in turn can help students understand how to perform complex mathematics, such as solving equations. Playing games in educational apps during class time can also enhance motivation and encourage students to engage in more activities in class [20]. Finally, mathematics apps support students with disabilities and allow students to submit their homework online, which makes learning easier and is inclusive for disabled students, encouraging them to learn at school and at home [21]. To motivate students, teachers should integrate technology in their teaching and encourage students to use it for learning at home.

However, some studies have found negative effects of using tablet education apps in the classroom. A study conducted among teachers and students to identify the benefits and challenges related to using iPad apps in teaching and learning found that apps had a negative effect because the students could become distracted in class, using social networking apps such as Facebook and iMessage rather than listening to their teachers [3]. Also, the students faced difficulties writing extended texts in solving complex equations requiring several steps and explanation. Moreover, some apps did not enable access to the Internet to research new information through an eBook [3]. The Internet is an essential tool for incorporating technology in education as it provides the necessary support for the teaching and learning environment to connect with the external educational context. Teachers may wish students to connect to the Internet to undertake searches, download information or watch an educational video on YouTube, but they can face technical problems. For instance, a weak internet connection can disrupt students' learning by disconnecting their devices [22].

In conclusion, using mathematics apps on tablet devices can increase teachers' and students' performance. Such apps can increase students' mathematics skills and help them achieve their goals, as well as provide encouragement and motivation. Using educational apps in the classroom may improve students' attention as simultaneous information can be displayed directly to the student. Also, students can engage with mathematics content easily using apps both inside and outside the classroom. However, teachers need professional development to help them use technology and integrate it in the classroom, specifically to develop Technological Pedagogical Content Knowledge [4]. Crucially, they need to know how to use an app and apply it with their students before introducing it in class. However, the use of mathematics apps in secondary schools in Saudi Arabia is comparatively new, leading to the need for investigation. Hence, the major focus of this research study was 'To assess the impact of using educational apps on mathematics teaching and learning at secondary school level in Saudi Arabia'.

## **2. Methodology**

To achieve the research objective, this study investigated teachers' and students' perceptions of the use of apps and sought to identify some of the obstacles they encountered when using various apps and to propose solutions, as well as make recommendations to develop the use of educational apps in class. The research took place in two 10th grade classrooms at the Al-Rowad Secondary School in Saudi Arabia. The classes employed a range of mathematics and social media apps and the Marefah teaching and learning platform. The study adopted a qualitative approach, conducting semi-structured interviews with 8 focus groups of students and 4 teachers. The interviews took around 15 to 20 minutes. Thematic analysis was applied to code the qualitative data, seek patterns and identify themes. Six final themes emerged: enhancing students' performance in mathematics, promoting communication and collaboration among students and teachers, increasing students' motivation, providing immediate feedback to students, the need for training on how to use apps in teaching and learning and barriers to the use of apps in teaching and learning mathematics.

## **3. Results and discussion**

This section presents the findings concerning the teachers' and students' perceptions, presented according to the six themes identified in turn.

### **3.1 Enhancing students' performance in mathematics**

One of the main objectives of using educational apps for teaching and learning mathematics is to enhance students' mathematics performance. Both the teachers and students conveyed that the apps helped students improve their performances and skills in mathematics and that their achievement increased. Also, they mentioned that some mathematics apps were a beneficial tool for raising grades because they offered a variety of applications that supported their studies. For instance, the findings showed a definite increase in students' performance after the use of applications such as GeoGebra and Marefah, with iPad apps found to have a more beneficial impact on



the students' performance than traditional (paper and pencil) methods. They could understand the aims of the lesson, practise different activities, understand graphs and solve challenging questions via the GeoGebra app, which could create competition among students when engaging in mathematics activities.

This result is in line with other research studies showing that apps can enhance students' academic performance and positively affect their overall attainment by increasing their independent study time [8, 23]. The use of various apps in mathematics learning helped students to understand the visualisation of mathematical concepts such as Desmos and GeoGebra apps [24]. Also, introducing different apps has the benefit that students can find the easiest one for them personally to use and enable them to develop an understanding of concepts in a way that is under the teacher's control. The results of this research are also consistent with other research studies in Saudi Arabia that present a positive view of the effects of iPad use on student achievement [25, 26].

However, some students in the study, who mentioned that they were struggling in mathematics and found it difficult to understand the concepts, reported that their performance worsened after using some educational apps because they were not trained in or familiar with them. Several other studies have found no difference in the performance of students whether using apps or traditional methods to improve their learning [2, 27, 28]. This suggests the need to teach students how to use educational apps to gain the benefits in supporting their learning identified in the study.

### **3.2 Promoting communication and collaboration among students and teachers**

The teachers and students in this study mentioned collaborating when undertaking mathematics activities via various communication apps, such as WhatsApp, AirDrop, Telegram, Snapchat and the Marefah platform, as well as other social media apps. This they did until they found the correct solution, prior to sharing it with their other classmates, and it gave them a better understanding of the mathematical problems they were solving. Thus, collaborative learning enabled them to achieve the lesson goals and improve their communication [18, 29]. Both the teachers and students agreed that the apps promoted collaboration among the students and offered a means of facilitating collaborative learning. Furthermore, the teachers pointed out that having the students present use a projector or screen via their tablet devices was a better way of sharing knowledge and collaborating than using conventional approaches. Also, the iPad supported the students' collaborative learning outside school, for example, through social media apps. Apps such as these allowed the students to communicate, share their knowledge and recognise their errors through feedback from one another in the form of text message chats, voice recordings and audio or video calls.

This finding is broadly consistent with results reported in the literature, which have shown that the iPad and apps encourage communication and collaboration among students and instructors in the classroom and outside of school time; therefore, communication apps promote the development of relationships among the students as well as with the teacher, helping them construct their knowledge in more creative ways by sharing the ideas and presenting outcomes within task limits [3, 10, 30, 31]. The communication apps encouraged students to put more effort into their mathematics activities and allowed them to communicate with other students, discussing the tasks and sharing their knowledge through the apps or the Marefah platform.

### **3.3 Increasing students' motivation**

Both teachers and students reported that the various educational apps were a factor that motivated them to achieve the lesson plan. The teachers stated that these apps aided them in conveying complex lessons in an easy way and also improved their teaching methods, helping their teaching have a positive impact on their students' learning. Using apps, it is a simple process for teachers to merge different goals simultaneously to increase students' understanding; consequently, students' motivation is increased. Furthermore, the students believed that using the apps enhanced their achievement of objectives in diverse ways, such as summarising the lesson with clearly organised information and motivating and encouraging them to study outside of the school environment. These findings align with prior research showing that teachers can incorporate education apps in delivering lessons in an effective way that influences students' learning, motivating them to learn and study more than conventional methods [32]. Clearly, students become more motivated to study hard in mathematics lessons, and the iPad allows them to spend more time engaged in mathematics activities, both in and out of class [10, 19, 20].

Conversely, some students believed that using tablet apps made them less motivated than traditional methods for learning mathematics or doing homework. They did not think using the iPad and apps made a significant difference and preferred the traditional handwritten approach as they considered using tablet apps in school and at home to be a waste of time. They were of the view that the iPad and apps made them less focused in their studies or homework, and this affected them negatively. Similarly, some other research has reported negative effects from app use in class and at home in terms of students' motivation. In particular, studies have reported that various apps can be distracting for students, and they may be tempted to check social networking sites, such as iMessage or Facebook, rather than pay attention to the teacher [3, 5]. Overall, this study argues that it is important to train students and teachers how to use tablet apps, especially in terms of solving equations and writing up the solutions. It might be that students' motivation in the classroom could be negatively affected if they are not trained in how to use an app.

### **3.4 Providing immediate feedback to students**

Feedback encourages students to review their answers and learn from their mistakes. The findings recounted that receiving immediate feedback fostered better performance in mathematics tasks. For instance, the students said that after submitting their homework or a test via the Marefah platform, they received comments and information from the teacher related to their answers, which helped them to improve their performance. Thus, the students said that they preferred completing their homework and solving problems through an app because they received feedback at once, consistent with other studies that have found prompt feedback was an advantage in allowing students to check their answers against the solutions [2, 4, 10, 33].

However, the findings showed that some students were not keen on using certain apps for their homework, such as the Marefah platform, because they did not think there was a significant difference from using the book and preferred the traditional approach of doing their homework on paper and giving it to their teachers to get handwritten feedback. They believed that some apps made them less focused when studying or doing homework. Thus, as previously noted, students might need

training in the use of an app before it is integrated in their education system. This point is taken up in the next theme.

### **3.5 The need for training on how to use apps in teaching and learning**

The findings suggest that teachers and students need training or personal experience to integrate tablet apps successfully in the study of mathematics. The teachers commented that prior to integrating technology in the classroom, they needed training courses on how to use it, especially new educational apps. Nevertheless, even with training (whether independently or through a private training course), it would still be challenging for first-time users in the classroom. Thus, the teachers reported that to gain the benefits of mathematics apps such as GeoGebra, they would likely have to train the students in its use before they could use it in the classroom. This result is in line with other studies showing that teachers need professional development on the use of any apps that are to be integrated in teaching and learning as a lack of preparation is a significant barrier to their application for most teachers and students and has a negative impact [2, 4].

It is suggested that school management and/or educational departments should organise training courses for teachers to equip them to use various educational apps, rather than relying on teachers learning how to use them independently. Once the teachers are trained, they will be able to pass their knowledge on to their students prior to using the apps in their lessons. This will ease their integration, maximise the benefits and avoid wasting valuable lesson time.

### **3.6 Barriers to the use of apps in mathematics teaching and learning**

The integration of tablet apps at secondary school level in Saudi Arabia faces several obstacles with the potential to diminish the beneficial effects on teaching and learning as reported by teachers and students. They highlighted several challenges: interrupted or weak internet connection, tablet battery issues, technical problems with some educational apps and the use of non-educational apps. They also suggested some potential solutions to resolve these issues.

The first obstacle described by the teachers and students was the potential for interrupted internet service or a weak connection. This could be detrimental to the educational process as the students could not use some iPad apps without an internet connection and faced difficulty in downloading a new app, including the Marefah platform and GeoGebra, the main apps used in the school.

These findings are in line with other research showing that teachers face technical problems related to the internet connection when they give students a task, such as searching for information online or watching educational videos on YouTube, negatively impacting students' learning [22, 34]. The teachers and students reported that they overcame this obstacle by asking the Information Technology department to resolve the issue immediately by bringing an alternate router or fixing the modem. This suggests that school management should work on ensuring full internet coverage in all areas of the school through a reliable server and providing maintenance cover throughout the academic year. Thus, teachers and students will have the benefit of the availability of various technologies in the classroom.

The second obstacle reported by the teachers and students was issues with tablet battery life. The teachers noted that some students forgot to recharge their tablet devices at home, which affected their devices' power levels. Also, the students



sometimes forgot to bring their charger cables from home, which made it difficult for them to use their devices throughout their time in school. While some students brought their own power banks and chargers to school, they pointed out that sockets were not always readily available to recharge their devices, or they were situated far from their desks. This suggests the need for school management to ensure classes are equipped for the use of technology, providing electrical outlets and charger cables throughout the classroom and power banks for those too far from an electrical outlet.

The third obstacle several students mentioned concerned technical problems with some education apps, for example, becoming unresponsive while they were doing mathematics activities in class. This had a negative effect on their work as they had to delete what they had done and start again. To address this, the students proposed using an alternative app or website as a temporary solution in place of a suspended app. They also pointed out that apps should be updated before use in class to avoid suspension.

The final obstacle highlighted by the teachers was that some students used non-educational apps when they were explaining the lesson. They reported that students chatted with each other on one of the social media apps or played games during class time, which distracted them from listening to the explanation of the lesson or doing mathematics activities. Prior research has also found a negative correlation between using social media and students' academic performance due to the students being distracted [35]. This suggests that teachers should focus their students' attention by ensuring they are only accessing educational apps, not social media apps.

#### **4. Recommendations for future research**

Based on the findings, the following recommendations for future studies are made:

- It would be beneficial to conduct studies on the impact of educational apps on attainment by applying an experimental pre-test/post-test design and over a longer period to compare academic results for two different groups (experiment and control).
- Future research on tablet apps might focus on a particular app for mathematics, such as GeoGebra, to investigate its effectiveness in enhancing teaching and learning performance.
- Researchers could provide training courses on using educational apps for teachers and students before their integration in class to derive the greatest benefits.

#### **5. Conclusion**

This research aimed to investigate the potential impact of using educational apps for mathematics teaching and learning in a secondary school in Saudi Arabia. The students' focus groups and teachers' interviews in this research showed that the students believed there were advantages to using educational apps to learn mathematics and that they were beneficial for teaching and learning. The apps supported students'

performance in mathematics, providing immediate feedback on tasks and assisting them in searching for information. The students found using the apps motivating, and they made it easier to understand the content, as well as promote communication and collaboration among students and teachers. The students could communicate with their colleagues at any time and from any location, without needing to meet to discuss their school assignments. Thus, they could share their knowledge both in and out of school easily and fast. Moreover, they reported that several apps helped them improve their grades in mathematics, and some, such as the Marefah platform, allowed students to review and resubmit their work.

However, a few students also mentioned some disadvantages of using apps, such as being less focused and feeling that they were a waste of time. These students tended to prefer submitting handwritten work. Others preferred handwritten exercises as they faced difficulty writing out equations in some apps, giving rise to negative perceptions concerning their use. Furthermore, some students contended that using apps had a detrimental effect on their performance in mathematics due to a lack of training in their use. This could be resolved by organising courses to familiarise students with the apps chosen for use in the classroom.

Furthermore, both the teachers and students reported encountering several obstacles that impacted teaching and learning, such as an interrupted or weak internet connection, tablet battery issues and technical problems with some apps. They overcame these issues in various ways, for instance, by bringing their own modems, chargers and power banks to school and finding an alternative app or website to access as a temporary solution if the one they were using became unresponsive. The teachers also mentioned issues with students accessing social media in class rather than educational apps and losing focus, indicating the need to monitor the students and ensure they were on-task and accessing an appropriate app.

This study demonstrated that using various educational apps promoted students' motivation, communication and collaboration; provided immediate feedback and enhanced their attainment in mathematics. The teachers also had positive perceptions of teaching mathematics concepts through apps. In addition, the study highlighted challenges to using these apps in class and potential solutions that could ensure their successful integration in the classroom. It is hoped that this study will be valuable in highlighting a path to progress in mathematics teaching and learning within secondary schools in Saudi Arabia and other similar contexts.

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## **Conflict of interest**

The authors declare no conflict of interest.

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