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# Increasing Student Engagement through Mobile Learning in Mathematics Subjects

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## ABSTRACT

**Background.** Learning in this century has experienced a significant transformation, especially with the emergence of mobile learning technology. In this context, learning Mathematics becomes an important focus because it is often considered a challenging subject for some students. The problem that arises is the lack of student involvement and difficulty in understanding Mathematics concepts.

**Purpose.** This research aims to explore the effectiveness of mobile learning in increasing student involvement in Mathematics learning. By using a quantitative approach through a survey model, this research aims to collect data from mathematics education teachers and students to understand the impact of mobile learning in a broader learning context.

**Method.** This research will adopt a quantitative approach using a survey model. Researchers will compile a questionnaire in the form of a questionnaire with carefully prepared answer choices, and then collect it via the Google Form platform. The research subjects consisted of 30 respondents who were mathematics education teachers and students, who were chosen randomly from the existing population.

**Results.** The results of the questionnaire analysis showed that the use of mobile applications in mathematics learning had a positive impact on student engagement, learning motivation, and sense of trust. themselves in solving mathematical problems. However, there is still room to improve interaction between students and teachers through mobile applications.

**Conclusion**. Overall, this research shows that mobile learning has great potential in improving Mathematics learning by increasing student engagement and strengthening interactions between students and teachers. However, further adjustments and developments need to be made to mobile applications to maximize their potential in a broader learning context.

## KEYWORDS

Education, Mathematica, Mobile Learning.

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## INTRODUCTION

Education plays an important role as the foundation of development because it has a broad impact on society and the economy of a country (Zhang et al., 2021). More than just the transfer of knowledge, education shapes the character, skills and attitudes that are the foundation

for social and economic progress. In this digital era, where technology has penetrated various aspects of life, the importance of integrating technology in education has become increasingly prominent (Alenezi, 2023). Technology allows the creation of learning models that are more interactive, adaptive, and accessible to all levels of society, which in turn supports the development of inclusive and sustainable learning (El-Sabagh, 2021).

The information technology revolution has brought about fundamental changes in the educational paradigm. Learning through electronic media, such as learning videos, e-books and online learning platforms, has become the new norm in the educational process (Karagöz et al., 2023). Modern society is required to keep up with technological developments, so the use of electronic media in learning becomes increasingly important to create a relevant and adequate learning environment for students (Akour & Alenezi, 2022). By utilizing technology, education can be transformed into a more interesting, dynamic and open experience for innovation.

Therefore, governments and educational institutions in various countries must continue to strive to integrate technology in their curriculum and learning strategies (Alam & Mohanty, 2022). These steps include training teachers in the use of technology, investing in digital infrastructure, and developing learning content that suits students' needs and interests. In this way, education can continue to adapt to changing times and remain a strong foundation for sustainable societal and economic development (Didham & Ofei-Manu, 2020). However, in the field, there are still obstacles that hinder the use of learning media, including Mobile Learning, in the context of Mathematics learning (Alabdulaziz, 2021). One of the main problems is the lack of effective learning media that is in accordance with the curriculum (Simamora, 2020). Many mobile applications are available, but not all of them suit specific learning needs.

In the current learning process, learning media plays a very important role in helping students understand the subject matter better (Andriyani & Suniasih, 2021). The use of learning media not only enriches students' learning experience but also allows them to understand complex concepts more easily (Gong, 2021). Learning media can be in various formats, ranging from learning videos, multimedia presentations, to interactive software. This diversity allows educators to present learning material in different ways, according to students' learning styles.

In the Mathematics learning process, teachers are often faced with significant challenges in presenting material in an interesting and relevant way for students (Lavidas et al., 2022). One of the main challenges is the lack of creativity in delivering material. Mathematics is often considered a rigid and overly theoretical subject, so teachers need to strive to present the material in a way that is interesting and easy for students to understand (Doerig et al., 2021). Lack of variety in teaching methods can cause students to become bored and lose interest in learning Mathematics.

Another challenge is the inability to arouse students' interest in Mathematics. Many students consider Mathematics to be a difficult and uninteresting subject due to a lack of understanding of its relevance and usefulness in everyday life (Aguilar, 2021). This lack of understanding can result in low learning motivation and decreased academic achievement in Mathematics. Therefore, teachers need to use innovative and relevant approaches to help students understand the importance of Mathematics in their lives (Scull et al., 2020).

Apart from that, the lack of interactivity in Mathematics learning is also an obstacle in the learning process (Azhari & Fajri, 2022). Mathematics requires more than theoretical explanations: Students also need to actively participate in solving problems and applying the concepts they have learned. Lack of interaction between teachers and students, as well as a lack of opportunities to collaborate with fellow students in solving Mathematics problems, can hinder students' understanding and mastery of Mathematics concepts (Regmi & Jones, 2020). Therefore, it is

important for teachers to create an interactive and collaborative learning environment to increase student involvement in learning Mathematics.

The need for effective learning media in teaching Mathematics is the main reason for this research (Choirudin et al., 2021). This research aims to explore new possibilities in using Mobile Learning to increase student engagement in Mathematics learning. By utilizing the potential of the latest technology, it is hoped that innovative and effective solutions can be found for current Mathematics learning problems.

With advances in technology, Mobile Learning has emerged as an attractive solution in overcoming the challenges of Mathematics learning (A. Singh et al., 2022). Mobile Learning takes advantage of the popularity of mobile devices to provide easy and flexible access to learning materials (Alghazi et al., 2020). Various types of mobile applications have been developed to help students understand Mathematics concepts in a more interactive and fun way.

Mobile Learning offers an innovative and interesting learning approach, which can motivate students to learn Mathematics better (Aznar-Díaz et al., 2020). By providing interactive learning materials, Mobile Learning can help students understand Mathematics concepts more effectively. This allows students to learn Mathematics more independently and gain a deeper understanding.

Through the use of Mobile Learning, teachers can expand the scope of Mathematics learning beyond the traditional classroom. Students can access learning materials anytime and anywhere, allowing them to learn according to their own rhythm and learning style (Nugraha & Aminur Rahman, 2021). Thus, Mobile Learning not only increases student engagement in Mathematics learning, but also increases the accessibility and flexibility of learning.

The first previous research has shown that mobile technology has changed the way students learn and how education can take place. The use of mobile technology provides the potential for educators to further strengthen student engagement in the modern educational environment, by providing learning content and interaction via mobile devices, both inside and outside the classroom. An approach that utilizes the learning science literature on student engagement is needed to identify the most effective ways to utilize mobile and online technology to engage students. Using basic theories of student engagement, this research presents an Applied Model of Student Engagement, including individual, task, and environmental factors that influence how likely a student is to engage in learning content. Based on this model, we present instructional interventions that educational practitioners can utilize to more effectively engage students, as well as best practice guidance for achieving this, with mobile and online learning technologies, in modern educational environments (Carroll et al., 2021).

Previous studies have not fully examined mobile learning technologies and social media tools in terms of student engagement and learning outcomes. In the quasi-experimental study, the authors randomly selected 101 participants who were divided into three groups. Each group received English learning assisted by mobile learning technology (Rain Classroom), social media tools (WeChat), and traditional multimedia projection systems for one semester. The authors concluded that mobile learning technology can significantly improve behavioral, social, cognitive, and emotional engagement as well as English learning outcomes compared to social media tools. Traditional teaching tools do not improve behavioral, social, cognitive, and emotional engagement and learning outcomes as well as Rain Classroom and WeChat. Future research could focus on developing serious games to improve student engagement and learning outcomes (Yu et al., 2022).

Recent previous studies highlight the importance of understanding how educational technology can increase student engagement, especially in higher education, particularly in the arts and humanities. A literature review of 42 arts and humanities articles found that most of the

research was conducted in language learning contexts, especially in East Asian countries, but with limited theoretical grounding. The results show that educational technology supports student engagement, especially behavioral engagement, while affective engagement tends to be low. Blogs, mobile learning, and assessment tools were found to be the most effective in increasing student engagement. Nonetheless, it is important to use technology carefully and supported by effective pedagogy to avoid making students feel overwhelmed and disconnected from learning. Future research needs to pay attention to online collaboration, international courses that facilitate cross-cultural language use, and greater use of qualitative methods (Bedenlier et al., 2020).

The novelty brought by Mobile Learning lies in its ability to present learning material in a more interesting and interactive way. With access that can be reached by students from various backgrounds, Mobile Learning stimulates interest and motivation to learn, which in turn increases student involvement in mathematics learning. This research focuses on new approaches to mathematics learning by combining Mobile Learning as an innovative solution. Through the use of relevant mobile applications, it is hoped that we can overcome the problem of the lack of effective media in mathematics learning. By utilizing the latest technology, this research will explore new ways to increase student engagement in mathematics learning.

The purpose of this research is to investigate the effectiveness of Mobile Learning in increasing student engagement in mathematics learning. By using a quantitative approach through a survey model, this research aims to collect data from mathematics education teachers and students to understand the impact of Mobile Learning in a broader learning context.

## RESEARCH METHODOLOGY

This research will adopt a quantitative approach using a survey model. A quantitative approach was chosen because it provides a clear framework for measuring the variables involved in the research, such as the level of student involvement in learning Mathematics through Mobile Learning (Johnson et al., 2020). The survey model was chosen because it allows systematic data collection from respondents by sending them a prepared questionnaire.

The research procedure will begin with preparing a questionnaire in the form of a questionnaire with answer choices that have been carefully prepared. This questionnaire will be uploaded to the Google Form platform to then be distributed via the WhatsApp group of teachers and students majoring in Mathematics education. Participants who are interested and meet the criteria will be asked to fill out an online questionnaire. The data obtained will be analyzed to get a clear picture of the level of student involvement in learning Mathematics through Mobile Learning.

The research subjects will consist of 30 respondents from among teachers and students who are studying in the field of Mathematics education. Respondents will be selected randomly from the existing population, taking into account the diversity of their backgrounds and experiences in using learning technology.

Research ethics will be maintained by ensuring that respondent participation is voluntary and anonymous (Ibbett & Brittain, 2020). Researchers will provide clear information about the research objectives and procedures to respondents, as well as guarantee the confidentiality of the data collected. In addition, researchers will ensure that research results are used with high ethics and do not harm any party. Data collection techniques will be carried out through filling out survey questionnaires by respondents. The questionnaire will contain questions designed to measure the level of student involvement in learning Mathematics through Mobile Learning. These questions will be arranged with answer choices that will facilitate data analysis.

Data processing will be carried out by analyzing the percentage of answers to each question in the survey questionnaire. In addition, the collected data will be organized and presented in the form of graphs or diagrams to make understanding easier. Data analysis will use the Miles Huberman method to interpret the results and find patterns that emerge from the data that has been collected (Locke et al., 2022).

## RESULT AND DISCUSSION

### Mobile Learning

Implementing the use of Mobile Learning in schools offers great opportunities to enrich students' learning processes (Criollo-C et al., 2021). First of all, the existence of mobile applications allows more flexible access to learning materials. Students are no longer tied to a specific classroom or time, but can learn whenever and wherever they are. This provides greater freedom for students in organizing their study time according to their individual learning rhythms and styles.

In addition, Mobile Learning also allows for greater personalization of learning. Various mobile applications can be tailored to each student's needs and level of understanding (Yip et al., 2021). This allows students to study at a level of difficulty appropriate to their abilities, thereby maximizing their learning potential. The use of mobile technology in learning also provides the opportunity to enrich learning material with interesting multimedia content (Alam & Mohanty, 2023). Various applications can present learning material in the form of videos, animations, images and other interactive forms, which can enrich students' learning experiences and help them understand difficult concepts better.

In addition, the implementation of Mobile Learning can also open the door to collaboration and interaction between students and teachers. Through features such as discussion forums, chat, and online collaboration, students can interact with fellow students and teachers to exchange ideas, discuss questions, and share knowledge. This creates a more inclusive and collaborative learning environment, where students feel more involved and connected to the learning process. Mobile Learning also provides an opportunity to integrate learning into students' daily lives (Szymkowiak et al., 2021). Various learning applications can be developed by linking learning material to students' real life situations and contexts, thereby making learning more relevant and meaningful for them.

Apart from benefits for students, the use of Mobile Learning can also provide benefits for teachers and educational institutions (Qashou, 2021). Teachers can utilize various applications and learning platforms to design and present learning materials more creatively and interactively (Saputra, 2022). This allows teachers to more effectively meet the needs and learning styles of diverse students. In addition, the use of Mobile Learning can also enable more accurate and comprehensive data collection about student progress and performance. Through the analytical features available in various learning applications, teachers and educational institutions can track student progress in real-time, identify areas that require special attention, and provide more targeted feedback to students.

However, the implementation of Mobile Learning also faced with several challenges (Irfan et al., 2020). One of them is the unequal accessibility and technological infrastructure in various regions. Not all students have the same access to mobile devices and the internet, which can cause gaps in accessibility and participation in Mobile Learning. Another challenge is the integration of Mobile Learning with existing curriculum and learning strategies. Efforts are needed to ensure that the use of mobile technology in learning is not only an addition, but is also well integrated into the

existing curriculum and learning methods, so that it does not disrupt the continuity and cohesiveness of learning.

However, with appropriate efforts to overcome these challenges , the implementation of Mobile Learning has great potential to improve the quality and effectiveness of learning in schools, creating a more interesting, inclusive and meaningful learning experience for students in this digital era.

**Student Engagement Before Using Mobile Learning**

Before the adoption of Mobile Learning, student engagement in Mathematics learning often faced several challenges that needed to be overcome. First of all, in conventional learning, sometimes students tend to be passive in the learning process. They may only be passive listeners without actively participating in discussions or interactive activities that encourage deeper understanding (Shi & Tan, 2020). This can result in students' lack of interest and motivation in studying the subject of Mathematics. In addition, traditional learning models often pay little attention to students' individual learning styles. Each student has different preferences and learning styles, but in large classes with limited learning time, teachers may struggle to provide an appropriate approach for each student (Neitzel et al., 2022). This can result in some students feeling neglected or not fully involved in the learning process.

Limited resources can also be a factor that influences student engagement before the adoption of Mobile Learning. Some schools may have limited access to interactive learning materials or innovative learning tools. This can lead to a lack of variety in students' learning experiences, making them less motivated to actively engage in learning.

Not only that, the lack of interactivity in conventional learning can also limit students' opportunities to collaborate and share ideas with fellow students. Group discussions and collaborative projects are often limited in traditional classroom contexts, so students may feel less engaged in learning that involves cooperation and social interaction.

Additionally, the importance of relevance and context in learning were also factors that influenced student engagement prior to Mobile adoption Learning. Without a clear connection between learning material and everyday life or practical applications in students' real lives, students' interest and motivation to learn can decrease.

Another challenge is the lack of direct and targeted feedback in conventional learning. Teachers may have limited time and resources to provide detailed and detailed feedback to each student, making it difficult for students to understand their mistakes and make improvements.

In this context, adoption of Mobile Learning can be an effective solution to increase student engagement in learning Mathematics. By utilizing mobile technology, learning can be tailored to students' individual learning styles, allowing them to learn in a more interactive, inclusive, and relevant way (H. K. Singh et al., 2021).

**Survey Analysis Design**

After conducting the survey, the researchers carried out an in-depth analysis related to research on Increasing Student Engagement through Mobile Learning in Mathematics Subjects with relevant answer options. The first question, How often do you use a mobile device (for example: smartphone, tablet) to study Mathematics outside of class time? With answer options: Every day, Several times a week, Once a week, Rarely and Never. With the following answer results:

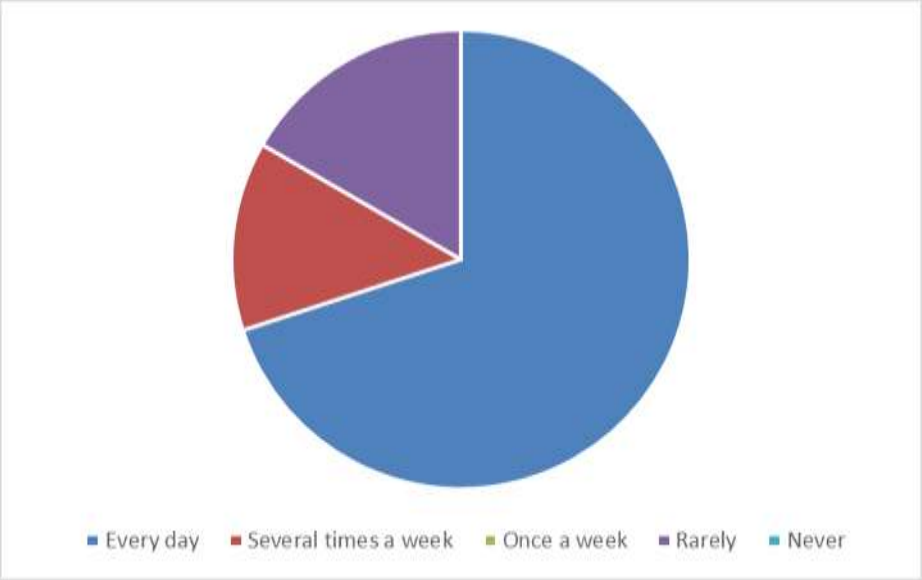


**Figure 1.** Activity of using mobile devices to study Maths outside of class hours

Based on the results of the questionnaire analysis, it appears that the majority of respondents, namely 21 out of 30 people, use mobile devices every day to study Mathematics outside of class time. This shows that the use of mobile technology in mathematics learning outside the classroom is quite common and is an important part of students' learning patterns today. However, it was also found that there were a small number of respondents who used mobile devices several times a week (4 people) or rarely (5 people). This indicates that although the use of mobile devices is common, there is still a small number of students who have not adopted the habit of learning using mobile technology regularly.

The finding that the majority of students use mobile devices every day to learn Mathematics shows the great potential for utilizing mobile technology in improving student involvement in Mathematics learning outside the classroom. Thus, learning approaches that utilize mobile applications or platforms may be effective in increasing the accessibility of learning materials and facilitating independent learning outside of class time. However, it should be remembered that there are some students who use mobile devices less frequently, and therefore teaching strategies must also take into account the diverse needs and preferences of students.

In addition, these results also show that there is still room to increase the adoption of mobile technology in Mathematics learning among students who use mobile devices with lower frequency. It may be necessary to conduct outreach or training to introduce the benefits of using mobile technology in Mathematics learning and overcome barriers or concerns that students who rarely use mobile devices may have. Thus, the analysis of this questionnaire provides valuable insight for designing more effective learning strategies in increasing student engagement through mobile learning in Mathematics learning.

Next question, How useful are mobile applications in helping you understand Mathematics concepts? With the following answer options: Very useful, Useful, Not very useful, Not useful and don't use mobile applications to learn Mathematics. With the following answer results:

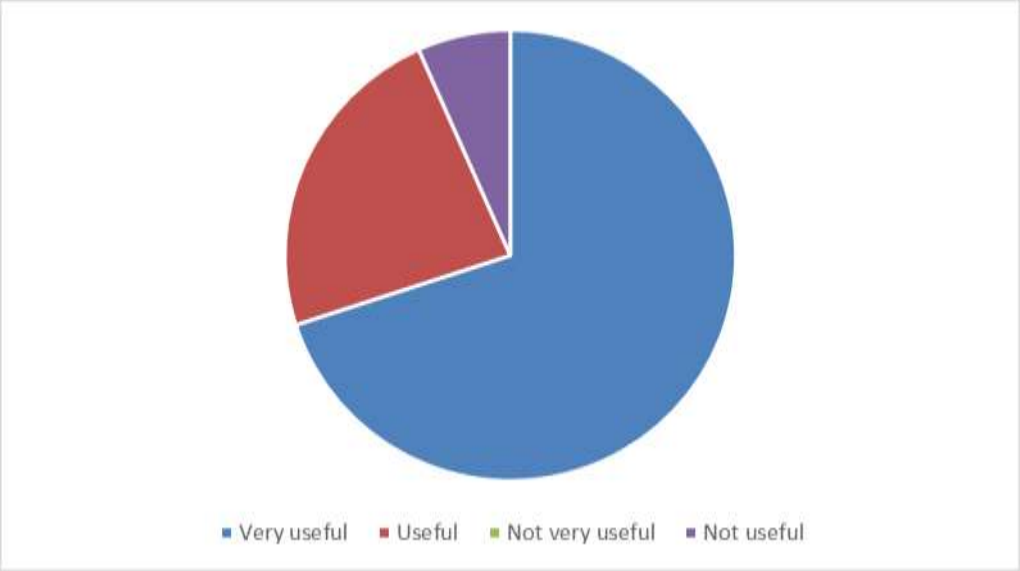


**Figure 2.** Usability of the mobile app in helping you understand Maths concepts

The results of the questionnaire analysis showed that the majority of respondents (21 out of 30 people) felt that the mobile application was very useful in helping them understand Mathematics concepts, while 7 people stated that the application was useful. Only 2 respondents thought the mobile application was less useful. Although the majority of students find mobile applications useful, there are some who have different perceptions. This emphasizes the importance of further research to understand the factors that influence students' perceptions of the benefits of mobile applications in Mathematics learning, in order to increase the effectiveness of their use.

Next question, Do you feel more motivated to study Mathematics after using the mobile application? With the following answer options: Very motivated, Motivated, Less motivated, Not motivated and I don't use mobile applications to learn Mathematics. With the following analysis results:

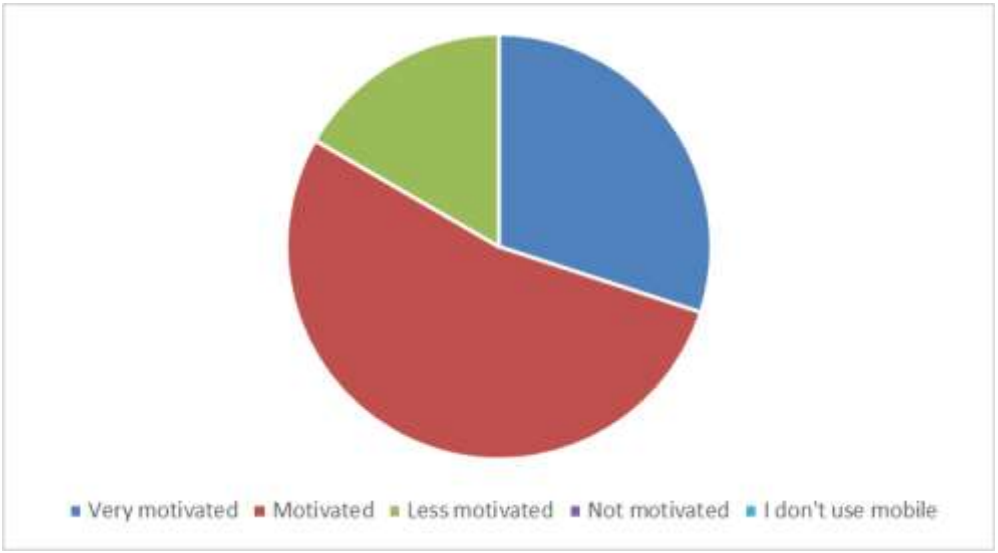


**Figure 3.** Increased motivation to learn Maths after using mobile apps

Based on the results of questionnaire analysis, the majority of respondents showed a positive level of motivation after using mobile applications in learning Mathematics. As many as 9 out of 30 respondents stated that they were very motivated, while 16 respondents felt motivated. However,

there was also a small number of respondents, namely 5 people, who indicated that they felt less motivated after using the mobile application. However, no one can say that they are not motivated.

These results show that the majority of students feel the positive impact of using mobile applications in increasing their motivation in studying Mathematics. Nevertheless, it is important to note that there are still some students who experience a lack of motivation after using mobile applications. Therefore, it is necessary to consider making adjustments or improvements to the mobile application so that it can be more effective in increasing student learning motivation in Mathematics subjects.

Next question, How often do you interact with classmates or teachers via mobile applications to discuss Mathematics material? With the following answer options: Every day, Several times a week, Once a week, Rarely and Never. With the following analysis results:

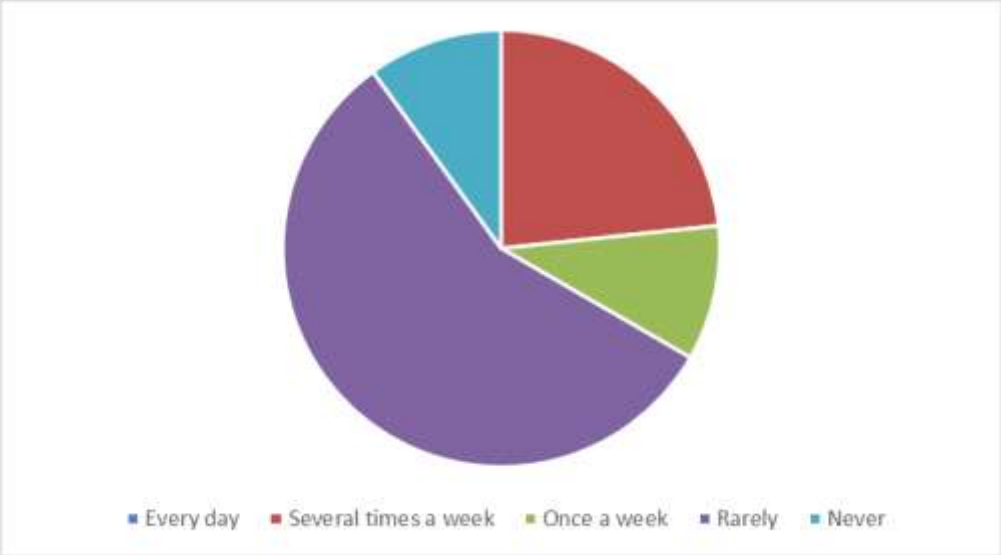


**Figure 4.** Respondents' interaction with classmates or teachers through mobile apps to discuss Maths materials

Based on the results of the questionnaire analysis, it appears that the majority of respondents rarely or never interact with classmates or teachers via mobile applications to discuss Mathematics material. As many as 17 out of 30 respondents stated that they rarely had these interactions, while 3 people never did. No one stated that they interacted every day.

These results indicate that there is little interaction between students and classmates or teachers via mobile applications to discuss Mathematics material. This could be due to various factors, such as a lack of awareness about the collaborative potential of mobile applications in learning, or perhaps due to students' preferences for using other methods of interacting with classmates or teachers. Therefore, further efforts are needed to increase student interaction using mobile applications, for example by introducing the advantages of online discussions in understanding Mathematics concepts and how this can improve their understanding.

Next question, Do you feel more confident in solving Mathematics problems after using the mobile application? With the following answer options: Very confident, Confident, Not confident, Not confident and I don't use mobile applications to study Mathematics. With the following analysis results:

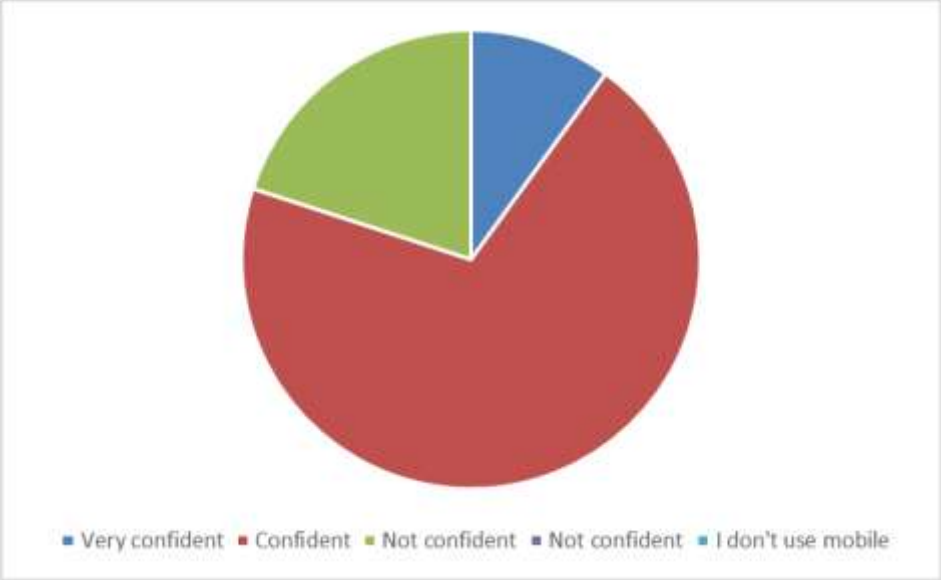


**Figure 5.** Confidence in solving Maths problems after using the mobile app

Based on the results of the questionnaire analysis, the majority of respondents showed an increase in self-confidence in solving mathematics problems after using the mobile application. As many as 3 out of 30 respondents stated that they felt very confident, while 21 respondents felt confident. However, there was also a small number of respondents, namely 6 people, who indicated that they felt less confident after using the mobile application. No one stated that they were not confident.

These results show that the majority of students felt an increase in confidence in solving Mathematics problems after using the mobile application. This shows the positive potential of using technology in improving students' skills in solving mathematics problems. However, it should be remembered that there are some students who feel less confident, and therefore, adjustments or improvements need to be made to the mobile application so that it can be more effective in increasing students' confidence in solving Mathematics problems.

## CONCLUSION

From the results of the questionnaire analysis and previous discussion, it can be concluded that the use of mobile applications in Mathematics learning has a positive impact on student engagement and their understanding of Mathematics concepts. The majority of respondents indicated that mobile applications were very useful in helping them understand Mathematics material, as well as increasing their motivation and confidence in solving Mathematics problems. However, there are also some students who are still less motivated or less confident after using mobile applications. Therefore, further adjustments and developments need to be made to the mobile application so that it can be more effective in increasing student engagement and learning achievement in Mathematics.

Apart from that, the results of the analysis also show that there is still room to improve interaction between students and classmates or teachers via mobile applications in Mathematics learning. This emphasizes the importance of continuing to strengthen collaboration and communication between students and teachers in digital learning environments. Thus, developing mobile applications that can encourage interaction and collaboration between students and teachers can be an important step in increasing the effectiveness of Mathematics learning through mobile technology.

## AUTHORS' CONTRIBUTION

Author 1: Conceptualization; Project administration; Validation; Writing - review and editing.

Author 2: Conceptualization; Data curation; In-vestigation.

Author 3: Data curation; Investigation.

Author 4: Formal analysis; Methodology; Writing - original draft.

Author 5: Supervision; Validation.

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