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The Mathematics Learning Aided by Android Applications and Its Impact: A Mixed Methods Study

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Abstract. The rapid development of technology in various fields requires us to adapt and incorporate it into our daily lives and the world of education. However, it is necessary to conduct research and identify appropriate applications to ensure technology is used effectively in learning. This study aims to uncover junior high school students' experiences using an Android-based application, namely Algebra Tiles, and determine the impact of using such applications on the students' learning outcomes in mathematics. The students reflected on their experiences while participating in mathematics classes in eleventh-grade at one of the junior high schools in Kerinci, Jambi, Indonesia. An embedded design of a mixed methods approach, combining qualitative and quantitative methods, was employed to understand students' experiences and learning effectiveness. Interviews and observations were conducted to reveal how the students interacted with the application during the learning process. In addition, a concept comprehension test was administered to students who learned with the assistance of the Android application and to a comparison group who learned without it. The data obtained through observations and interviews were subjected to thematic analysis. On the other hand, the data from the student's comprehension test results were analyzed using statistical methods. The research findings indicate that students who learned with the assistance of the Android application achieved higher concept comprehension scores than those who learned without it. Multi-directional communication between students and teachers, as well as between students themselves, was observed to be very active. There was a transition in the focus of discussions from technical issues with the application during the initial meetings to issues related to learning materials in subsequent meetings. However, signs of boredom were observed in the final two meetings. Overall, the students expressed enthusiasm and felt challenged to explore what could be learned using the Android-based application. The active interactions among students through verbal communication during the learning process indicate that the application can potentially enhance students' engagement in mathematics learning.

Keywords: Android-based Application; Mathematics Learning; Students' Experiences

Abstrak. Perkembangan teknologi yang cepat di berbagai bidang menuntut kita untuk beradaptasi dan mengaplikasikannya dalam kehidupan sehari-hari dan dunia pendidikan. Namun, untuk memastikan bahwa teknologi digunakan secara efektif dalam pembelajaran, diperlukan penelitian dan identifikasi aplikasi yang tepat. Studi ini bertujuan untuk mengungkap pengalaman siswa SMP dalam menggunakan aplikasi berbasis Android, yaitu Algebra Tiles seklaigus menentukan dampak penggunaan aplikasi tersebut terhadap hasil belajar siswa dalam matematika. Siswa merefleksikan pengalaman mereka saat berpartisipasi dalam kelas matematika di kelas sebelas di salah satu SMP di Kerinci, Jambi, Indonesia. Pendekatan metode campuran, yaitu kombinasi metode kualitatif dan kuantitatif, digunakan untuk memahami pengalaman siswa. Wawancara dan observasi dilakukan untuk mengungkap bagaimana siswa berinteraksi dengan aplikasi selama proses pembelajaran. Selain itu, tes pemahaman konsep diberikan kepada siswa yang belajar dengan bantuan aplikasi Android dan kelompok pembanding yang belajar tanpa aplikasi tersebut. Data yang diperoleh melalui observasi dan wawancara dianalisis menggunakan analisis tematik, sedangkan data dari hasil tes pemahaman konsep siswa dianalisis menggunakan metode statistik. Hasil penelitian menunjukkan bahwa siswa yang belajar dengan bantuan aplikasi Android mencapai skor pemahaman konsep yang lebih tinggi dibandingkan dengan siswa yang belajar tanpa aplikasi tersebut. Komunikasi multiarah antara siswa dan guru, serta antara siswa sendiri, terbukti sangat aktif. Terjadi transisi fokus diskusi dari masalah teknis aplikasi selama pertemuan awal menjadi masalah yang berkaitan dengan materi pembelajaran pada pertemuan selanjutnya. Namun, tanda-tanda kebosanan teramati pada dua pertemuan terakhir. Secara keseluruhan, siswa mengekspresikan antusiasme dan merasa tertantang untuk menjelajahi apa yang bisa dipelajari menggunakan aplikasi berbasis Android. Interaksi yang aktif antara siswa melalui komunikasi verbal selama proses pembelajaran menunjukkan bahwa aplikasi tersebut memiliki potensi untuk meningkatkan keterlibatan siswa dalam pembelajaran matematika.

Kata kunci: Aplikasi berbasis Android; Pembelajaran Matematika; Pengalaman Belajar Siswa

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INTRODUCTION

In the current digital era, smartphones have become integral to daily life. Within the context of education, smartphones can potentially bring about positive changes in learning (Galloway et al., 2015). The implementation of Android-based applications in learning has shown promising results. Using Android-based applications within the Learning Together method has significantly improved students' performance across diverse domains, encompassing creativity and cognitive attainment (Ulfa et al., 2017).

Despite ranking fourth in the world in terms of smartphone usage (Pusparisa, 2021), Indonesia still needs to completely realize the potential of smartphones as a tool for education. According to the Central Statistics Agency of Indonesia, 88.99% of Indonesian children use their smartphones primarily for social media, while only 33.04% use them for school-related activities (Mutia Annur, 2021). This fact implies that the use of smartphones for learning in Indonesia still needs to be increased and expanded. To meet the issues of education in the contemporary digital era, more efforts must be made to improve the use of smartphones as a teaching tool.

However, smartphone technology in education must be prepared and planned properly. Allowing children to use smartphones without guidance for their learning can hurt their academic performance. For instance, Zhou et al.(2022) discovered that unregulated or unsupervised use of smartphones as a learning tool by students can negatively affect their achievement in mathematics.

Slow adoption of new instructional technologies is among the most frequent errors made by educators. Many teachers hesitate to implement new technology in their classrooms because they believe it will be too challenging for students to learn or take up too much time (Bastudin, 2020). To fully profit from utilizing technological tools in the classroom, educators must be able to get beyond acceptance barriers. Technology in education can revolutionize teaching and learning when applied properly. Improper software and programs are another error that educators frequently make. It could be due to a lack of knowledge about what is available or a failure to invest the necessary time in finding the programmes and applications that will benefit their pupils the most. Before using them in their classrooms, educators must be familiar with the programs and applications that are currently available and how to use them (Lestari, 2015).

Educators should be provided with comprehensive socialization and sufficient information technology information to enhance their motivation and capacity to select relevant applications for the teaching and learning process (Lestari, 2015). Furthermore, additional research is needed to investigate the appropriate types of applications that teachers can implement. Understanding how students view class participation can help educators design more inclusive and engaging learning environments that cater to diverse student needs (Wonder, 2021). Having diverse study results

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would provide essential information for instructors to improve their motivation and capacity in choosing relevant applications in the teaching and learning process.

In mathematics learning, incorporating information technology is crucial in addressing the persistent low student motivation towards the subject. A study by Wu & Tai (2016) revealed a significant correlation between the use of multimedia learning technology and students' motivation and mathematics learning outcomes. Through interactive mathematics applications students' interest and motivation in learning mathematics can be significantly enhanced (Azzahrah et al., 2022). Information technology enables independent learning and provides diverse teaching methods that create engaging and interactive learning experiences, which include online resources and technologies that encourage the exploration of new concepts and facilitate sharing with a group of motivated and "like-minded" peers (Widiyono & Millati, 2021). As a result, the integration of information technology in mathematics education has the potential to greatly improve the quality of instruction and enhance students' learning outcomes in the subject, making it a valuable approach in modern mathematics education.

The utilization of Android applications may serve as a solution to the problem of low understanding of concepts. At the research site of one of the junior high schools in Kerinci, the understanding of concepts was low based on the results of the second semester exam in 2020/2021. The mathematics teacher further explained that algebra is the most difficult for students because it is abstract. On the other hand, there is an available Android application for algebra learning called Algebra Tiles. Algebra Tiles can connect the concept of the area of a rectangle, which students have previously learned, with the abstract concept of algebra. According to a prior study, students' understanding of abstract mathematical ideas or concepts can be more concrete using mathematics learning media (Farida, 2015). Using Android-based algebra tile applications as a virtual teaching aid has proven more efficient and effective in mathematics learning than concrete media (Khairunnisa & Ilmi, 2020).

According to previous research, Android-based apps can improve students' learning across various academic areas. Jihad & Lasmanah (2019) discovered that Android-based learning increased communication abilities. Other studies have also shown that Android-based applications can effectively improve students' learning outcomes in math and spatial geometry (Artanti et al., 2022; Dewi & Sintaro, 2019; Mulyani, 2018). Despite these encouraging results, prior research must adequately analyze how students interact with these programs, particularly in mathematics instruction. By assessing the efficiency of an Android-based application for mathematics instruction and examining students' experiences with the program, this study aims to fill these research gaps. This study intends to help create educational applications that better serve students' learning needs by concentrating on the effectiveness of Android-based applications in math

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instruction and examining the user experience. This study investigates the effectiveness of using an Android-based application, namely Algebra Tiles, in mathematics education and to uncover students' experiences interacting with the application during the learning process.

METHOD

The research utilizes a mixed methods approach, combining quantitative and qualitative methods. The data collection in this research is not simultaneous; qualitative data is collected during the experiment, and quantitative data is collected after the experiment. Both forms of data are analyzed and interpreted to achieve the research objectives. This approach can be classified as an Embedded Design, which involves collecting qualitative and quantitative data, where one form of data supports the other (Creswell, 2012). In this case, qualitative data is used to gain insights into the participants' experiences during the experiment. In contrast, quantitative data is used to measure the effectiveness of the Algebra Tiles application in mathematics education. The two data sets are combined and analyzed to understand the research problem comprehensively.

The quantitative aspect of the research employs a quasi-experimental design with two groups, consisting of 18 students in the experimental group and 20 students in the control group. The instruction was conducted over 7 sessions for each respective group, held twice a week, with the first session commencing in the third week of August 2022 and the final session taking place in the second week of September 2022. The topic of focus was Quadratic Equations. After completing the 7 instructional sessions, assessments were administered for each group to measure the level of mathematical concept understanding on September 15, 2022. The comprehension concept test instrument was designed for the specific subject matter taught during the research: quadratic equations. The indicators used to develop this test were adopted from Laswadi et al. (2016) and included measures to assess students' conceptual understanding, specifically their ability to establish connections between different mathematical concepts, their ability to represent mathematical situations through multiple methods, and their knowledge of the most appropriate representation for specific mathematical scenarios. The test was designed to consist of six essay items that effectively measure these indicators.

Quantitative data was analyzed using descriptive and inferential statistical methods to test the effectiveness of the Algebra Tiles android application. The data was further evaluated using the Norm-Referenced Evaluation (NRE) technique (Miller, 2020). This technique is utilized to compare the performance of an individual test-taker with that of other individuals. The results of the assessment criteria calculations can be observed in Table 1. This table is a crucial tool for further exploring the individual's achievements and providing more precise guidance in evaluating the Mathematics Concept Understanding test results.

EDUMATIKA: Jurnal Riset Pendidikan Matematika *e-ISSN 2620-8911*
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Tabel 1. Criteria for Assessing Mathematical Concept Understanding Test Results

Category	Criteria
Excellent	> 8.2
Good	8.0 - 8.2
Adequate	7.5 - 7.9

Meanwhile, the qualitative aspect of the research adopts a case study design (Creswell, 2012) involving 18 students from the experimental group who learn using Algebra Tiles application for observations and interviews to capture their experiences in learning. Qualitative data will be analyzed using thematic data analysis, where emerging themes will be identified and analyzed to understand the phenomena.

RESULTS AND DISCUSSION

Quantitative Data From The Mathematical Concept Comprehension Test

The results of the exams for each group can be summarized as presented in Table 2.

Tabel 2. Descriptive Table: Exam Results with and without Android Algebra Tiles Application

Group	N	Min	Max	Mean	SD	Variance
With the assistance of the Android Algebra Tiles application	18	7.6	8.7	8.26	0.41	0.17
Without the assistance of the Android Algebra Tiles application	20	7.5	8.1	7.78	0.23	0.05

Table 2 presents the results of an examination from two different groups, namely the group that learned with the assistance of an Algebra Tiles application and the group that learned without the aid of the application. The table provides a descriptive overview of the data characteristics of both groups.

Based on the data provided, it can be observed that the group that utilized the Algebra Tiles application as an aid achieved a higher mean score (8.26) compared to the group that did not use the application (7.78). However, it is also evident that the data variability within the group that used the application is higher, as indicated by the larger standard deviation (0.41) and higher variance (0.17) compared to the group that did not use the application (standard deviation of 0.23 and variance of 0.05). Additionally, the data range in the group that used the application is also larger (1.1) compared to the group that did not (0.6). Therefore, using the Algebra Tiles application may enhance the mean score. However, it may also increase the variability and data range within the group.

These differences indicate that the use of the Algebra Tiles application may have a positive effect on students' understanding of mathematical concepts. The students who used the application tended to achieve higher and more consistent scores in their mathematical concept understanding compared to those without the application. These results suggest that the Algebra Tiles application

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Volume 5, Issue 2, November 2022 *p-ISSN 2620-8903*

effectively supports students' learning process in understanding mathematical concepts visually and interactively.

The evaluation results based on the data and criteria in Table 1 are shown in Table 3.

Tabel 3. Summary of Frequency Distribution of Mathematics Concept Understanding Test Results

Category	Number of Students (Learn with Algebra Tiles)	Number of Students (Learn without Algebra Tiles)
Excellent	8	0
Good	5	3
Adequate	5	17

Based on the data in Table 3, it can be concluded that using the Algebra Tiles application is more effective in helping students achieve higher categories, specifically "Excellent" and "Good". In the group that utilized the Algebra Tiles application, 53.3% of students attained "Excellent" results, and 33.3% achieved "Good" results. In contrast, in the group that did not use the Algebra Tiles application, no students could achieve "Excellent" results, and only 15.8% of students attained "Good" results. These findings indicate that the Algebra Tiles application can be a promising tool in enhancing students' comprehension of mathematical concepts and facilitating improved performance in Mathematics Concept Understanding assessments.

Interpreting descriptive analysis results of the data on the Mathematics Concept Understanding test in both groups is an initial step in extracting meaning from the collected data. However, to reinforce the validity of these interpretations, the subsequent step of conducting inferential analysis is crucial. Inferential analysis allows researchers to perform further statistical testing to draw stronger and more objective conclusions about the differences or relationships between variables in the study.

The inferential analysis employed in this study utilized a test of means to examine the differences in Mathematics Concept Understanding achievement between two groups: the group that received instruction with the aid of Algebra Tiles application and the group that learned without the use of such application. Before conducting the test of means, assumptions of normality and homogeneity of variance were checked and found to be met in both datasets. It ensured that the data in each group followed a distribution that closely approximated normality, and that the variances of the two groups were approximately equal. As a result, the t-test was chosen as the appropriate statistical method to compare the means of the Mathematics Concept Understanding scores between the two groups. The summary of the t-test results can be seen in the table 4 below:

Tabel 4. Summary of T-test Results for Mathematics Concept Understanding Test Results

Group	Mean	Standard Deviation	t-statistic	p-value
Group with Algebra Tiles Application	8.18	0.34	4.75	0.00
Group without Algebra Tiles Application	7.77	0.19		

EDUMATIKA: *Jurnal Riset Pendidikan Matematika* *e-ISSN 2620-8911*
Volume 5, Issue 2, November 2022 *p-ISSN 2620-8903*

Table 4 presents the results of a t-test conducted to compare the Mathematics Concept Understanding Test scores between two groups of students: one group that received instruction with the assistance of the Algebra Tiles application and another group that received instruction without the Algebra Tiles application.

The t-test results indicate that the group that received instruction with the Algebra Tiles application had a mean score of 8.18, with a standard deviation of 0.34. On the other hand, the group that received instruction without the Algebra Tiles application had a mean score of 7.77 (standard deviation not provided in the table).

The t-statistic for comparing the two groups was 4.75, with a p-value of 0.00. The small p-value (<0.05) suggests a statistically significant difference between the two groups' Mathematics Concept Understanding Test scores.

Hence, there is a significant difference in the understanding of mathematical concepts between the group that received instruction with Algebra Tiles application and the group that received instruction without Algebra Tiles application. The group that used Algebra Tiles application in their learning process had a higher mean score compared to the group that did not use Algebra Tiles application. This interpretation is supported by the very small p-value, indicating a statistically significant difference between the two groups.

The findings of this study are consistent with previous research suggesting that algebra tiles effectively enhance comprehension and proficiency in algebra (Rahmah & Argaswari, 2020; Rini, 2022). Using algebra tiles as a teaching aid helps visualize algebraic ideas and connect them to student's prior knowledge of concepts such as area. This research finding also aligns with the results of studies that indicate that instructional aids can assist students in constructing knowledge by providing them with tangible, visual experiences that render abstract ideas more comprehensible (Lee et al., 2013).

The results of this study indicate that using the Algebra Tiles application on Android devices is a promising approach to enhancing students' comprehension of mathematical concepts. The findings are consistent with earlier research (Abdillah et al., 2021), demonstrating a significant increase in student learning outcomes, with 80% of students completing their studies. These results provide further evidence of the effectiveness of Android applications in the educational setting, particularly in improving students' achievement in mathematics.

Previous studies have shown that the effective use of Android applications can enhance students' learning outcomes in geometry (Rohman et al., 2019) and that Android game applications effectively improve students' mastery of mathematics (Hidayah et al., 2022). These findings provide a strong foundation for supporting the results of this study on the use of Algebra Tiles

EDUMATIKA: *Jurnal Riset Pendidikan Matematika* *e-ISSN 2620-8911*
Volume 5, Issue 2, November 2022 *p-ISSN 2620-8903*

applications in enhancing students' understanding of mathematical concepts., provide a strong basis for supporting the findings of this study regarding the utilization of Algebra Tiles applications in improving students' understanding of mathematical concepts. These findings indicate that Algebra Tiles applications can be integrated into mathematics education, including geometry, as an effective tool to help students comprehend mathematical concepts visually and interactively.

Furthermore, research on the use of interactive Android applications as a medium for mathematics learning also corroborates the findings of this study (Wahyuni & Ananda, 2022). Using Algebra Tiles applications as an interactive learning medium in mathematics education can provide students with a more engaging and interactive learning experience, thereby effectively enhancing their understanding of mathematical concepts. Therefore, the collective results of the previous studies support the findings of this research regarding the use of Algebra Tiles applications in improving students' understanding of mathematical concepts.

Based on this study's findings, using smartphone technology in the classroom can improve mathematics learning outcomes. This finding contradicts previous research by Dhende (2019), which has linked the use of smartphones to a decline in academic achievement. However, it is important to note that this study used smartphones with subject-appropriate learning applications. These results are consistent with the argument by Dirksen (2015) that integrating learning theory and educational technology can lead to effective learning processes.

Alhady et al. (2018) have argued that when smartphone technology is used in education with proper guidance and instructional goals, it has the potential to positively impact various aspects of learning beyond social skills. For instance, selecting appropriate educational applications or software can facilitate learning in other subject areas such as science and mathematics, as well as improving social competencies. This perspective aligns with the notion that the effectiveness of smartphone technology in education largely depends on how it is integrated into the instructional process and the quality of the applications or interventions used. Furthermore, this study's results have shown that using smartphones in education can enhance active engagement, motivation, and self-directed learning, which are important factors for improving academic performance.

It is crucial to consider the potential benefits of smartphone technology in education beyond its impact on social skills and explore how it can be effectively integrated into instructional practices to enhance learning outcomes in various subject areas, including mathematics. The research findings shed light on the enhanced efficacy of smartphone technology in improving social science proficiency(Alhady et al., 2018). Moreover, the study suggests that smartphones can also effectively enhance mathematics learning outcomes when paired with purposeful instructional design and suitable applications.

EDUMATIKA: Jurnal Riset Pendidikan Matematika *e-ISSN 2620-8911*
Volume 5, Issue 2, November 2022 *p-ISSN 2620-8903*

Qualitative Data From Observations And Interviews On Students' Learning Experiences Using The Algebra Tiles Application

In the thematic analysis, several patterns of student behavior in using the Algebra Tiles application during mathematics instruction were identified. The emerging themes include the initial stage of learning, the development of proficiency in using the application, the transition from technical focus to content focus, and the decline of student enthusiasm and boredom.

The initial stage of learning with the utilization of the Algebra Tiles application was characterized by a vibrant and enthusiastic atmosphere. During the first session, students were eager to try out the application's features and try to understand its functionality. They actively posed questions to the teacher and engaged in discussions about how to use the application and how it could assist them in comprehending the mathematical concepts being taught.

The interview results revealed that students made it sense to factor quadratic equations using Algebra Tiles. They admitted that factoring without Algebra Tiles was difficult because it differed from factoring in arithmetic. Forming a square from the available tiles was also quite challenging, but the students found it fun and rewarding. When they successfully solved a factoring problem, it was a very satisfying moment for them. They were also very curious about the application of Algebra Tiles and often practised using them at home with their smartphones.

Furthermore, the outcomes obtained from using the application were a source of joy for the students. Students appeared happy and satisfied when they successfully used the application and achieved the desired results. They felt supported in understanding the previously challenging mathematical concepts that were difficult to grasp using conventional methods. However, on the other hand, some students were overly excited about using the application, resulting in disruptions in the classroom. They may have been too enthusiastic in answering questions or engaging in discussions with their peers, which disrupted other students' concentration. This calls for the teacher's attention to manage the situation and ensure that the learning process continues smoothly and the classroom environment remains conducive.

In the initial stage of learning, it is evident that using the Algebra Tiles application has positively impacted students, including increased motivation and enthusiasm for learning mathematics. Nevertheless, it is important to manage students' excitement to ensure that it remains orderly and does not disrupt other students' concentration, in line with the principles of effective academic instruction. In subsequent meetings, students began to adapt and become more proficient in using the application as time progressed. They continued to discuss their learning activities using the application, but the level of noise and disturbance in the classroom decreased. Students appeared more confident and pleased with their ability to use the application. They demonstrated a higher level of autonomy and creativity in utilizing the features of the Algebra Tiles application,

EDUMATIKA: *Jurnal Riset Pendidikan Matematika* *e-ISSN 2620-8911*
Volume 5, Issue 2, November 2022 *p-ISSN 2620-8903*

which was evident in their growing mastery, increased confidence, and eagerness to explore further possibilities.

During this stage, students demonstrated a higher level of autonomy and creativity in utilizing the features of the Algebra Tiles application. They were able to manipulate the virtual tiles more efficiently, solve mathematical problems with greater ease, and experiment with different strategies to solve complex equations. The students also showed a greater willingness to collaborate with their peers, engaging in productive discussions and exchanging ideas on optimising the application's use for their learning needs.

Furthermore, the students' motivation and engagement in the learning process were evident as they eagerly sought out new challenges and attempted to push the boundaries of their mathematical abilities using the application. They demonstrated a sense of ownership and control over their learning, as they actively explored the application's functionalities and experimented with various mathematical concepts and operations. This phase marked a significant development in the student's proficiency in the application, with a noticeable shift from novice users to more skilled and autonomous learners.

The analysis revealed that as the students progressed in their learning journey, their proficiency in using the Algebra Tiles application improved significantly. They exhibited a higher level of confidence, creativity, and autonomy in utilizing the application's features, and their motivation and engagement in the learning process were enhanced. This development highlights the positive impact of the application on the student's mathematical learning and underscores the importance of technology integration in modern educational settings.

The transition from a technical focus to a content-focused approach in the students' learning process was evident in subsequent lessons. The discussions became more organized, disciplined, and centered on the mathematical content of the lessons, as opposed to technical issues related to the use of the Algebra Tiles application. As the students gained proficiency in using the application, their enthusiasm grew for completing tasks directed by the teacher with the aid of the Algebra Tiles. They actively engaged in discussions and interactions, generating, and sharing ideas, and collaborating in small groups to approach tasks. This collaborative learning environment fostered creativity and critical thinking as the students explored strategies and solutions using the Algebra Tiles application. This transition showcased their ability to integrate the application into their mathematical learning process, not just as a tool for problem-solving but also to discuss and debate different approaches, reflecting a higher level of understanding and application of mathematical concepts. It exemplified the effectiveness of the application in enhancing student's learning experiences and fostering a deeper understanding of mathematical concepts.

EDUMATIKA: *Jurnal Riset Pendidikan Matematika* *e-ISSN 2620-8911*
Volume 5, Issue 2, November 2022 *p-ISSN 2620-8903*

As the lessons progressed, a decline in enthusiasm and signs of boredom among the students in using the application became apparent. The initial excitement and elation, characterized by smiles and triumphant laughter, seemed to have waned. Some students started to exhibit signs of restlessness and disinterest. A few of them felt that they had already acquired proficiency and familiarity with the application and thus craved new challenges or more difficult problems to sustain their engagement in the learning process.

This decline in enthusiasm could be attributed to a sense of mastery and the need for novelty to maintain motivation. The initial novelty and excitement of using the application had worn off, and students sought new stimuli to sustain their interest. This observation highlights the importance of regularly updating the content and challenges provided through the application to keep students engaged and motivated in the long run. It also underscores the dynamic nature of students' engagement and motivation in the learning process, which requires continuous attention and adaptation to maintain their interest and active participation.

This study demonstrates that students are highly enthusiastic, especially in their initial meetings, displaying a tremendous curiosity. Moments of insight occur frequently. This finding is consistent with Macklem (2015) assertion that using technology wisely, including selecting appropriate learning applications to meet students' needs, can help avoid boredom and enrich the learning experience. Thus, prudent technology integration in the classroom can foster a sense of engagement and excitement among students, leading to better academic outcomes. Likewise Doyle & Zakrajsek (2018) claim that by using simulations or digital experiments, learning technology can give pupils a secure, controlled setting in which to experiment with abstract or difficult subjects. In addition to enhancing their cognitive abilities and conceptual knowledge, this can also help them gain a deeper grasp of occurrences that occur in the real world. The usage of learning applications effectively enhances concept comprehension, according to research, which supports this claim.

Prensky (2010) asserts that today's students are part of the digital native generation. This generation has grown up in the era of digital technology, and teachers must partner with them to achieve meaningful learning. Prensky emphasizes the need for strategies incorporating technology in learning to achieve effective concept comprehension. This research has shown that appropriate learning technology helps students achieve optimal concept comprehension. Therefore, educators must incorporate technology in their teaching practices to better engage students in learning. Additionally, understanding the digital environment of students can aid teachers in developing curricula and instructional materials that resonate with their experiences and meet their learning needs. By bridging the gap between traditional teaching methods and digital technology, teachers can create an effective and dynamic learning environment that can enhance students' overall learning outcomes.

EDUMATIKA: *Jurnal Riset Pendidikan Matematika* *e-ISSN 2620-8911*
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Observations during the learning process have shown a transition in the focus of discussions, both with the teacher and among peers, from technical application issues to learning content-related issues. Discussions regarding applications' technical use have taken up a significant portion of the total learning time. However, this has stimulated curiosity in almost the entire class. Murdoch (2020) suggests that stimulating students' curiosity requires significant time and effort, but it can result in more meaningful learning motivation and help students develop critical and creative thinking skills. This opinion is further supported by Rothstein & Santana (2011), who stated that teaching students to ask questions can motivate their curiosity and tap into their potential for further exploration.

Thus, the technical application discussions have catalyzed students' curiosity, which has paved the way for more substantial learning. This phenomenon highlights the potential of technology to enhance learning outcomes by providing a platform that facilitates the learning process and stimulates curiosity, an essential component of effective learning. Therefore, fostering curiosity in students using technology can be an effective strategy for promoting meaningful and engaging learning experiences.

Based on observations, a significant increase in moments of insight has been observed in Android-based learning aided by applications. Moments of insight are essential to effective learning and should be optimized (Hattie et al., 2016). According to Hattie et al., educators can leverage technology, such as mathematics applications, interactive software, or visual aids, to enhance mathematical learning and stimulate moments of insight. Technology can provide students with engaging, interactive, and adaptive learning experiences, allowing them to engage in exploration, experimentation, and hypothesis testing in mathematical learning. Therefore, educators must capitalize on technology to foster effective and meaningful learning experiences in mathematics. Furthermore, Stuyck et al. (2021) found that moments of insight are part of the problem-solving process, as these insights occur consciously and emerge unconsciously when encountering impasses.

According to the results of the observation and interview conducted with students, it was found that the initial symptoms of boredom began to appear in the sixth and seventh meetings. The study revealed that the students felt disinterested in the activities and tasks during these sessions. The interview findings further revealed that the repetitive nature of the application and assignments contributed to this disinterest. The students reported mastering the content and found the activities and tasks mundane and unchallenging. These findings align with the theoretical framework proposed by Deal (2005), which suggests that repetitive activities can trigger learning boredom. Deal states that when students are repeatedly exposed to similar activities, they may become disinterested and disengaged from the learning process. This disengagement, in turn, can lead to

decreased motivation and academic performance. Therefore, new challenges through multi-level tasks or multi-level features of applications are needed. Challenges in learning can help maintain focus and enhance the ability to generate ideas (Portuguez-Castro & Gómez-Zermeño, 2020).

The findings suggest a pressing need to introduce variation in learning activities, and a diverse range of learning applications may need to be developed. Alternatively, the existing learning applications could be developed further to include different levels corresponding to the varying learning materials. This approach aligns with the academic and pedagogical principles of promoting a dynamic, stimulating, and engaging learning environment and accommodating learners' diverse needs and preferences (Pakpahan et al., 2020). This finding aligns with the previous findings that interactive applications are media that can engage various senses and involve students with different learning styles (Widodo & Wahyudin, 2018). Therefore, it is recommended that educators and instructional designers consider incorporating a range of innovative and challenging learning activities and applications that align with the student's cognitive and affective needs, learning objectives, and developmental levels.

CONCLUSION

The integration of Algebra Tiles applications in mathematics education holds promise in enhancing students' comprehension of mathematical concepts. Students can interactively and visually understand mathematical concepts by incorporating subject-specific learning applications on smartphones. This approach maintains their enthusiasm and curiosity and enriches the learning experience, leading to improved mathematics learning outcomes. When appropriate learning technology is utilized, discussions shift from technical application issues to learning content-related issues, indicating the effectiveness of this approach in achieving optimal concept comprehension.

Based on the research findings, it is recommended that teachers and educators explore the use of appropriate learning applications and design effective learning activities to ensure an effective learning process. Incorporating variations in activities and adding features or levels to learning applications can stimulate students' curiosity and moments of insight, thus preventing boredom during the learning process. Teachers should be bold in allowing students to explore the features of the applications, as their curiosity and interest will likely extend to the learning content. Furthermore, future research should focus on designing learning activities incorporating suitable applications to ensure an optimal learning process.

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