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# Empowering Math Learning with Android: Ethnomathematics Media for 3D Shapes in Elementary Education

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***ABSTRAK***

*Penggunaan smartphone dalam aktivitas pembelajaran memiliki potensi besar, terutama melalui media pembelajaran berbasis Android, yang memungkinkan smartphone menjadi alat untuk mengoperasikan media pembelajaran dalam proses belajar. Potensi ini semakin didukung oleh karakteristik siswa saat ini yang telah terbiasa dengan gadget dalam kehidupan sehari-hari, sehingga baik guru maupun siswa tidak merasa kesulitan dalam penyesuaian. Penelitian ini bertujuan untuk mengembangkan produk inovasi media pembelajaran etnomatika berbasis Android untuk materi bangun ruang bagi siswa sekolah dasar. Jenis penelitian ini adalah penelitian dan pengembangan (R&D) yang mengadopsi model Alessi & Trollip, yang mencakup tahapan perencanaan, desain, dan pengembangan. Penelitian ini melibatkan dua ahli media, dua ahli materi, dua guru kelas V, dan enam siswa kelas VI sebagai subjek penelitian. Teknik pengumpulan data menggunakan teknik non-tes dengan instrumen berupa angket validasi/angket uji kelayakan untuk ahli media, ahli materi, guru, dan siswa. Data yang diperoleh dari angket dianalisis secara deskriptif untuk mencari rata-rata dari masing-masing penilaian. Hasil penelitian menunjukkan bahwa media pembelajaran Android berbasis etnomatika memperoleh skor rata-rata total 4,65 dari ahli media, yang termasuk dalam kualifikasi "sangat baik", 4,5 dari ahli materi dengan kualifikasi "sangat baik", 4,5 dari dua guru dengan kualifikasi "sangat baik", dan 4,3 dari siswa dengan kualifikasi "baik". Berdasarkan hasil penilaian yang positif dari ahli dan pengguna, media pembelajaran berbasis Android yang dikembangkan dalam penelitian ini dinyatakan "layak" untuk digunakan dalam aktivitas pembelajaran matematika di sekolah dasar.*

**ABSTRAK**

The use of smartphones in learning activities holds great potential, especially through Android-based learning media, which allows smartphones to serve as tools for operating learning media in the educational process. This potential is further supported by the characteristics of today's students, who are accustomed to gadgets in their daily lives, so both teachers and students do not face difficulty in adjustment. This study aims to develop an innovative Android-based ethnomathematics learning media product for the topic of 3D shapes for elementary school students. This research is a research and development (R&D) study adopting the Alessi & Trollip model, which includes the stages of planning, design, and development. The subjects of this study include two media experts, two content experts, two fifth-grade teachers, and six sixth-grade students. Data were collected using non-test techniques with instruments in the form of validation questionnaires/feasibility questionnaires for media experts, content experts, teachers, and students. The data obtained from the questionnaires were analyzed descriptively to find the average score of each assessment. The results of the study show that the Android-based ethnomathematics learning media received an average total score of 4.65 from media experts, which falls into the "very good" qualification, 4.5 from content experts with the "very good" qualification, 4.5 from two teachers with the "very good" qualification, and 4.3 from students with the "good" qualification. Based on the positive assessments from experts and users, the Android-based learning media developed in this study is deemed "feasible" for use in mathematics learning activities at the elementary school level.

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## 1. INTRODUCTION

Mathematics is one of the scientific disciplines taught at elementary school level. Mathematics is a branch of knowledge that is fundamental and abstract, which requires an understanding of these abstract concepts so that they can be applied into more concrete concepts, thereby facilitating more effective understanding (Abadi & Ekawati, 2018; Syarifuddin et al., 2022). The approach to learning Mathematics aims to provide students with skills and abilities in developing logical thinking, communication and the ability to solve problems faced in everyday life (Nasir & Nirfayanti, 2020; Parimita Dewi & Bayu, 2022). Mathematics plays a very significant central role in everyday life, by providing the foundation for technological development in this modern era, playing an important role in the education sector, and spurring progress in human thinking power (Kenedi et al., 2019; Yakub et al., 2019). In implementing Mathematics teaching, it is necessary to emphasize that students develop logical, critical, systematic and objective thinking skills (Khadka et al., 2023; Ramlee et al., 2019). Therefore, teachers must ensure that teaching is carried out with a variety of approaches. There are various variations that can be utilized by teachers in implementing teaching, including variations in the use of models, methods, strategies, and even the use of innovative learning media that suit learning characteristics and student needs.

However, the facts show that the lack of student motivation in participating in mathematics learning is caused by a lack of variation in the teaching methods used, a mismatch between learning models and the material being taught, and a lack of use of innovative learning media. This results in students having difficulty understanding the material provided (Machaba, 2018; Son et al., 2020). Teachers tend to adopt conventional methods involving questions and answers and lectures, as well as using printed teaching materials and conventional media in the learning process. An approach where the teacher only provides one-way explanations without any interaction between the teacher and students produces feelings of anxiety and fear in students, which in turn reduces students' motivation and involvement in the mathematics learning process, and has a negative impact on their academic achievement (Kenedi et al., 2019; Marbán et al., 2021; Tang et al., 2021; Yakub et al., 2019). Mathematics learning should be carefully designed to become a vehicle that facilitates the comprehensive development of students' attitudes and competencies.

In line with this, the results of direct observations of learning activities in class V of Diponegoro Islamic Elementary School, Surakarta revealed that the use of learning media in the learning process looked monotonous and not dynamic. The media used is limited to presentations with designs that are less attractive to students. Apart from that, students also face difficulties in understanding and retaining learning material, especially in Mathematics lessons, which results in low understanding of mathematical concepts for some students. This finding is one of the factors that influences the effectiveness of teaching and learning activities in class V, as well as reducing students' interest in learning mathematics. If this condition is not treated immediately, it can have a negative impact on students' understanding of concepts and their learning achievement. Therefore, innovation is needed to support the mathematics learning process to overcome these problems.

As an alternative solution, efforts that can be made are to develop interactive learning media that can be accessed via smartphone devices. Smartphone-based interactive learning media is a type of learning tool that utilizes information technology and has great potential to improve the quality of the learning process (Lavrenova et al., 2020; Lim et al., 2020). Using a smartphone as an Android learning medium has several advantages, including that it can be implemented flexibly anytime and anywhere because smartphones have high characteristics and portability (Haryanti et al., 2021; Qodr et al., 2021). Apart from that, with smartphones, learning will be effective and efficient. Therefore, this is one solution to overcome limitations in learning and teach content or concepts more easily and clearly without being limited by space and time. Teachers in solving learning problems by creating or developing learning media products should not only focus on learning media design but also learning media content. Mathematics learning content should not only consist of abstract symbols and theorems which may be boring for students (Álvarez et al., 2020; Mutmainah et al., 2019; Pahmi et al., 2023). However, on the contrary, it can integrate mathematics with the culture around students which is contextual according to the surrounding conditions such as culture, customs and so on which are related to mathematics.

As we know that the global technological advances have influenced various aspects, none other than the world of education which has a very important role, both in terms of process and learning (Deshpande & Shesh, 2021; Dron, 2022). Aspects in education must be willing to carry out comprehensive innovation, meaning that all devices in the education system have a role and become very influential factors in the success of the education system. As is the case in learning mathematics at the elementary education level. As is known, many students think and feel that this mathematics subject is difficult for them to understand (Gabriel et al., 2020; Umbara & Suryadi, 2019), As a result, the learning process that takes place

in the classroom becomes less dynamic and tends to be indifferent. In fact, as with other subjects they study, the material contained in mathematics is certainly very important and will be useful for them.

Learning media that uses the Android platform has the capability to create variations in an interesting learning process. Apart from that, this learning media also functions as a tool that is able to convey learning material in a way that is appropriate to the learning objectives, which is based on basic competencies that have been systematically arranged in an Android application format, making it easier for students to use at various times and locations (D. P. E. Putri, 2019; Rosidah et al., 2021). Previous research has shown that Android-based learning media is an effective tool in delivering lesson material by ensuring the achievement of learning objectives in accordance with basic competencies, which is available in APK format which can be accessed via Android smartphone devices (Hasanudin et al., 2022; Kumar & Chand, 2019). This Android-based learning media was developed using Articulate Storyline software, ensuring comfortable use that can be accessed anytime and anywhere (Cueva & Inga, 2022; Melumad & Pham, 2021).

The integration of Android-based learning media with an ethnomatics learning approach is an innovative solution that has been successfully formulated to create fun and interactive mathematics learning. Bearing in mind that learning that facilitates students by observing and analyzing social activities, local advantages and historical places related to the concept of mathematics is ethnomathematics (Mania & Alam, 2021). The application of ethnomathematics in the teaching and learning process in schools can be seen as a bridge to developing logical thinking abilities for students because the use of ethnomathematics material in learning will become more contextual and make someone have the ability to process logical thinking based on the relationship between patterns that can occur naturally or naturally rooted in students (Shahbari & Daher, 2020; Syarifuddin et al., 2022). This is in line with the results of research which concludes that ethnomathematics-based mathematics learning in elementary and middle school can improve students' mathematical understanding and logical thinking abilities (Ayuningtyas & Setiana, 2019; Faiziyah et al., 2020)

However, it should be strongly emphasized that currently, there are very limited references regarding Android-based learning media products that integrate an ethnomatics approach in teaching mathematics in elementary schools. Therefore, in this research, we attempt to combine these two elements not just as an incremental addition but as a significant innovation that is distinct from previous studies. The learning media that we have developed brings a unique advantage, namely that the material has been meticulously adapted to an ethnomatics approach and provides examples that are closely relevant to everyday life, aiming to greatly enhance students' understanding of the subject matter. Overall, the main aim of this research is to develop an Android-based learning media with an ethnomatics approach that can be used effectively in mathematics learning, especially in spatial material for fifth-grade students in elementary schools. We are confident that the Android-based learning media designed with an ethnomatics approach will not only assist students in their learning process but also contribute positively to students' overall learning achievement and potentially inspire further research and development in this field.

## 2. METHOD

This type of research is research and development (R&D), The selection of this approach is expected to be able to accommodate the research objectives of developing an Android-based learning media (Korsgaard, 2020). One development model is Alessi & Trollipm where this model is used in this research (Alessi & Trollip, 2001). The Alessi & Trollip development model generally has three major steps, namely planning, design and development where at each step an evaluation is always carried out as illustrated in Figure 1.

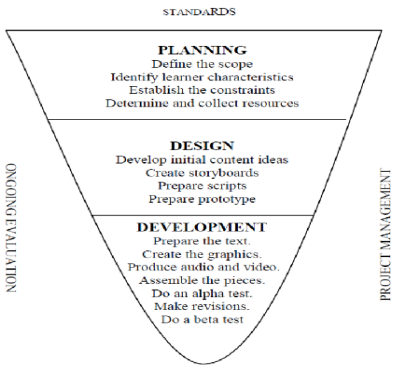


**Figure 1.** Alessi & Trollip Development Model (Alessi & Trollip, 2001)

The implementation of the Alessi & Trollip model in this research involves three key steps: planning, design, and development. In the planning phase, a needs analysis was conducted to identify the requirements for the Android-based learning media. The design phase involved creating detailed storyboards and prototypes, integrating ethnomathematics elements aligned with the curriculum. During development, the media was built using appropriate tools and tested with teachers and students. Continuous evaluation at each step ensured the media met educational objectives and was both feasible and effective, as confirmed by statistical analysis of validation questionnaire data. The research subjects involved in this research will consist of 2 teachers, 6 students, 2 media experts, and 2 material experts in order to create a viable Android-based learning media product (Khatri, 2020). The data collection technique used was non-test with the instruments namely media validation questionnaires and Android-based media design documents (Simanjuntak, 2019). The media validation questionnaire used has adopted a Likert scale questionnaire with a scale of 1 to 5 (Susanti et al., 2021). The validity of the instrument is carried out so that it is declared valid for use. In this research, the validity of the instrument used is through expert assessment by consulting with experts (Permatasari et al., 2019). The following are several instrument grids for assessing the feasibility of Android-based learning media products. The instrument grid is presented in Table 1, Table 2, and Table 3.

**Table 1.** Content Expert Assessment Instruments

| No | Indicator | Question Items |
|---|---|---|
| 1 | Content/Material Coverage | 1,2,3,4 |
| 2 | Content/Material Accuracy | 5,6 |
| 3 | Up to date information | 7,8,9 |
| 4 | Stimulate Curiosity | 10,11,12 |
| 5 | Contextual | 13,14 |

Adapt from (Purwaningsih & Wangid, 2021; Shahbari & Daher, 2020)

**Table 2.** Media Expert Assessment Instruments

| No | Indicator | Question Items |
|---|---|---|
| 1 | General View | 1 – 5 |
| 2 | Content Presentation | 6 – 10 |
| 3 | Supporting Content | 11,12,13 |

Adapt from (Putri et al., 2021)

**Table 3.** Teacher and Student Assessment Instruments

| No | Indicator | Question Items |
|---|---|---|
| 1 | Material/Content | 1 – 5 |
| 2 | Design | 6,7,8 |
| 3 | Language | 9,10,11 |

Adapt from (Dinayusadewi et al., 2020; Suryanda et al., 2019)

The various response results obtained through the above instruments will then be analyzed using descriptive statistics by calculating the average score (Ngabekti et al., 2019). The following is a table of average assessment conversion results to determine the level of feasibility of the Android learning media product being developed, with reference to research results (Aurum & Surjono, 2021; Lestari et al., 2019).

**Table 4.** Android-Based Media Eligibility Criteria

| Score | Category | Decision |
|---|---|---|
| $4.5 \leq x \leq 5.0$ | Excellent | Feasible |
| $3.5 \leq x \leq 4.4$ | Good | |
| $2.5 \leq x \leq 3.4$ | Poor | Not Feasible |
| $1.0 \leq x \leq 2.4$ | Very Poor | |

Adapt from (Lestari et al., 2019; Aurum & Surjono, 2021)

## 3. RESULT AND DISCUSSION

### Results

It should be noted that this research is a continuation of the previous article, where the previous article contained the needs analysis process so that in this section the researcher will briefly describe the findings identified during the planning process and the results of the needs analysis as part of the implementation of the Alessi & Trollip model. . Through the results of planning activities carried out with interviews in previous research, it was said that teachers provided descriptions of the use of learning media which so far tended to not be interactive. Teachers more often use PowerPoint learning media and videos from YouTube because they are easier to make. Apart from that, other findings were also identified that the learning media used did not contain ethnomathematics. Apart from that, it turns out that the learning media used so far does not contain a mathematical literacy component. This is because teachers only emphasize content, not mathematical literacy. Even though teachers already have an understanding of the importance of mathematical literacy, limited production time causes teachers to use learning media with material obtained from books or the internet. In fact, if you look at current developments, of course the opportunity for the internet and technology to optimize the learning process can be a basis for creating innovation. As one innovation, of course Android-based learning media can be proposed to bridge the gaps identified at the preliminary study stage.

Therefore, in line with the objectives of this research, an Android-based learning media will be developed by integrating an appropriate ethnomathematics approach for mathematics learning in elementary schools. The results of this research will describe several stages in creating a learning innovation product. Starting from the flowchart design, validation results by media experts, material experts, teachers and students and the appearance of the final product. Designing and formulating a flowchart is the first step taken by researchers, this aims to ensure that when developing Android-based learning media products there will be fewer errors, so that it does not take a long time to develop the product. The results of formulating a flowchart for ethnomathematics-based Android learning media in Figure 2.

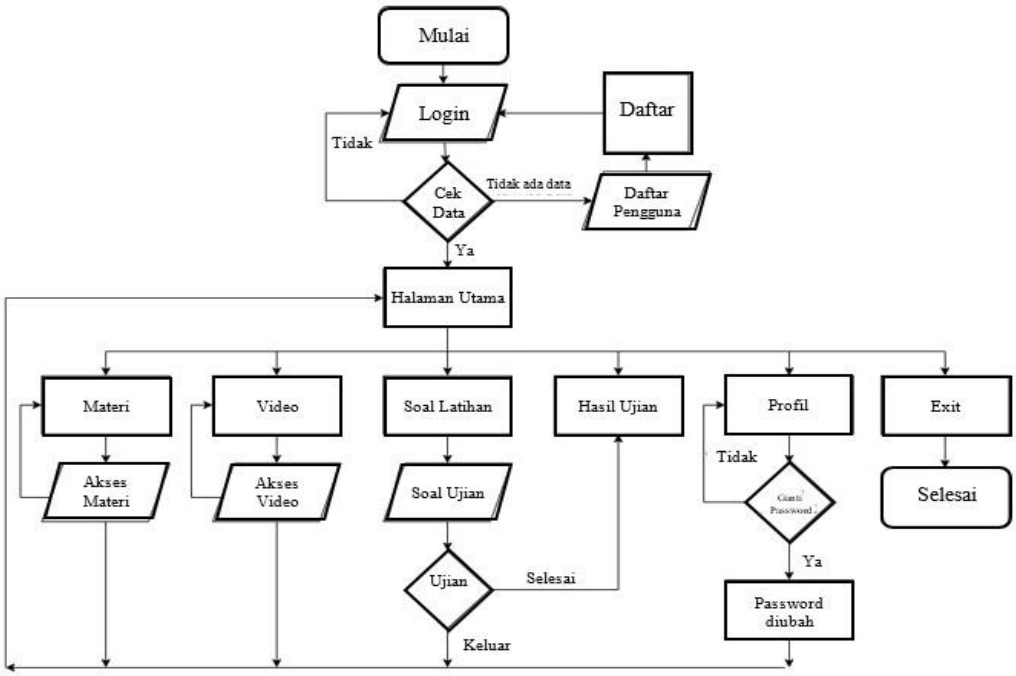


**Figure 2.** Ethnomathematics Based Android Media Flowchart

After compiling a flowchart as a flowchart for the media program, the researcher then continued to create a prototype of Android-based ethnomathematics learning media developed using Smart Apps Creator 3 (SAC 3) software based on the program flow that had been designed. The results of this creation were then validated by several experts and potential users, namely teachers and students. The following are the assessments of media experts and material experts which have been analyzed according to the techniques used. Results of Assessment by Media Experts in Figure 3.

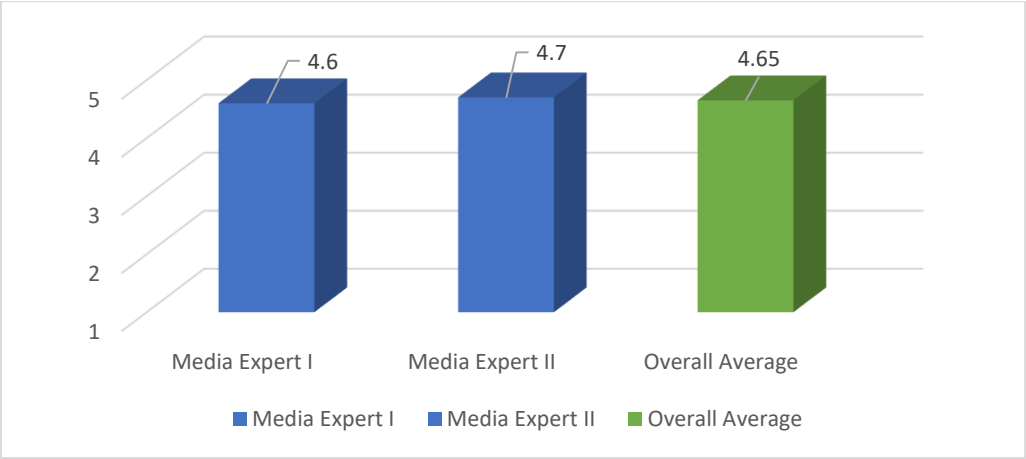


**Figure 3.** Results of Assessment by Media Experts

It was identified from the results of the media expert assessment analysis that media expert I obtained an average score of 4.6 which was included in the "Very Good" category. Meanwhile, media expert II received the "Very Good" category with an average score of 4.7. Overall, the average result obtained from media experts I and II was 4.65, which according to the media feasibility conversion table was included in the "very good" category with a decision of "feasible". Thus, according to media experts, Android-based media can be tested to the next stage. The results of the next assessment are those carried out by material experts. The following is an illustration of the assessment carried out by material experts. Results of Assessment by Content Experts in Figure 4.

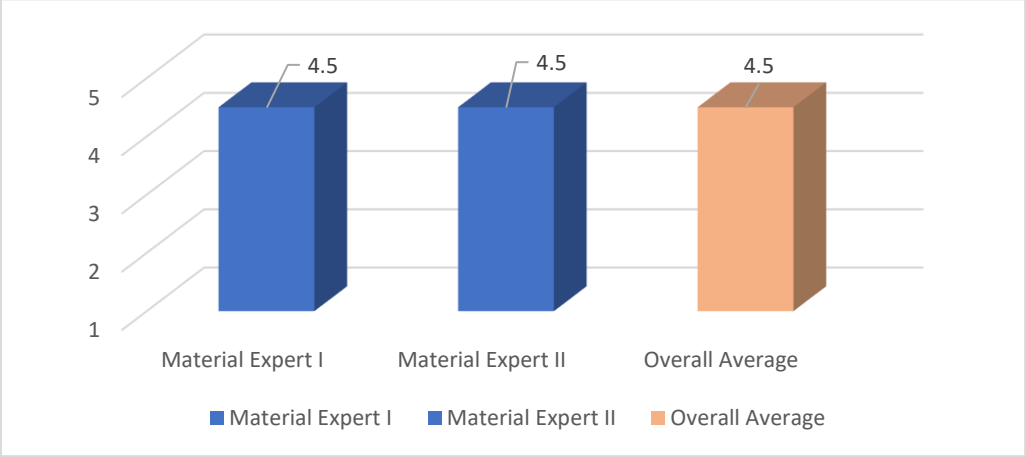


**Figure 4.** Results of Assessment by Content Experts

Based on the results of the overall material expert validation assessment from material expert I, the media developed was in the "Very Good" category with an average score of 4.5. Meanwhile, from media experts II, media is included in the "Very Good" category with an average score of 4.5. Thus, the total average score for all aspects assessed by material experts is 4.5 with the category being "very good" and entitled to receive a "decent" decision according to the media suitability conversion table. In this way, media that has been validated by experts can be tested to the next stage, namely testing on potential users consisting of teachers and students. Media Assessment Results by Teachers in Table 5. Results of Media Trials by Students in Table 6.

**Table 5.** Media Assessment Results by Teachers

| Validator | Mean Score | Category | Decsions |
|---|---|---|---|
| Teacher I | 4.5 | Very good | |
| Teacher II | 4.5 | Very good | Eligible |
| Overal Mean Score | 4.5 | Very good | |

**Table 6.** Results of Media Trials by Students

| Validator | Mean Score | Category | Decsions |
|---|---|---|---|
| Students I | 4 | Good | |
| Students II | 4.2 | Good | |
| Students III | 4.2 | Good | |
| Stdents IV | 4.2 | Good | Eigible |
| Students V | 4.5 | Very Good | |
| Students VI | 4.7 | Very Good | |
| Overal Mean Score | 4.3 | Good | |

From the two stages of testing by users, namely teachers and students, it was identified that the teacher's assessment was in the "very good" category with a total average rating of 4.5, so that the Android learning media developed could receive an appropriate decision, and could be tested to the next stage. Namely a trial by students. Meanwhile, the results of testing by students appear to have received a positive response where, the total average assessment result of students who participated in media testing is 4.3 and is included in the "good" category with the decision attached to it according to the data analysis technique being "Decent". Thus, the product that has been developed and analyzed the results of the assessment has obtained a 'feasible' decision at each stage of testing. Whether by media experts, material experts, teachers and students. So, it can be decided based on the results of this assessment that Android-based ethnomathematics learning media is declared suitable for use in mathematics learning activities in elementary schools. The following is the final display of Android-based ethnomathematics learning media which has been developed and declared suitable for application into the learning process. Android-Based ethnomathematics Learning Media showed in Figure 5.

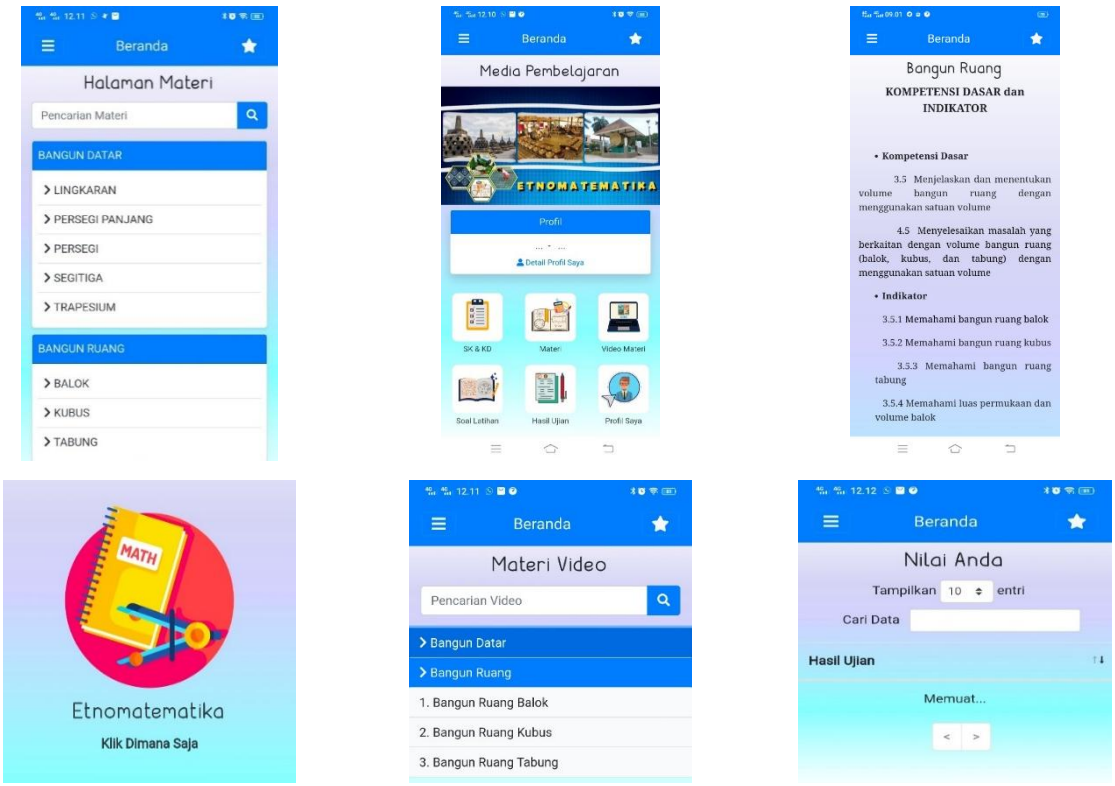


**Figure 5.** Android-Based Ethnomathematics Learning Media

**Discussion**

Mathematics is a subject that is able to represent the level of mathematical logical thinking ability. Therefore, it is necessary for teachers to create a learning atmosphere that is able to develop students' mathematical logical thinking abilities. The mathematics learning process at Diponegoro Islamic Elementary School, Surakarta, when observations and interviews were carried out with several teachers and students, provided several descriptions regarding the learning media used.

The learning media used at Diponegoro Islamic Elementary School, Surakarta, shows that the learning media used is still not interactive. Teachers more often use PowerPoint learning media and videos from YouTube because they are easier to make. A teacher should develop learning media that integrates current technological developments (Sarsar et al., 2021; Sousa & Rocha, 2019). One solution in learning is so that learning material can be conveyed well through mobile learning. Mobile learning is a learning medium that students can operate without being limited by space (Nisiotis, 2021; Zaheer et al., 2018). Android-based smartphones which consist of all the sophisticated features can be used to help students in learning, such as mobile apps which are used as learning media with high prospects in the future (Candra Dewi & Negara, 2021; Chiappe-Laverde & Paz-Balanta, 2021; Ewais et al., 2021). This is based on mobile apps which have high flexibility and portability in mathematics learning which requires a high level of understanding (Matzavela & Alepis, 2021; Uther, 2019). Therefore, mobile apps can be used as learning media that can be repeated whenever and wherever students need them and are representative (Alowayr & Al-Azawei, 2021; Lisana & Suciadi, 2021).

The feasibility of learning media in phase I trials is based on the validation results of media experts and material experts, which is an alpha test to produce an initial assessment of learning media. There are three general aspects assessed by learning media experts in the alpha test, namely general appearance, learning presentation, and supporting material presentation. The results of the interactive media assessment by material experts generally show five aspects assessed in the alpha test in the form of; material coverage, up-to-dateness, stimulating curiosity, media accuracy and containing global insight. Based on the material expert's assessment of all aspects of interactive media, a total average score of 4.5 (very good) was obtained so that it was declared "fit" to be used or tested in the field. The use of Android-based mobile has been carried out by previous studies. Research regarding the use of mobile Android includes the development of Android-based learning media to improve critical thinking skills (Dewi et al., 2022; Ismail et al., 2018), supporting teaching materials on health and healthy lifestyles through the development of Android-based digital books (Haryati et al., 2021; Prasetyo et al., 2019), development of Android-based electronic pocket books on various subjects (Hasanudin et al., 2022; Qohar et al., 2021; Setiawardhani, 2021), development of Android-based digital books on matrix topics based on the 2013 curriculum (Muslim et al., 2021; Riyanto et al., 2020).

Apart from that, the learning media used at Diponegoro Islamic Elementary School, Surakarta, does not yet contain a mathematical literacy component. This is because teachers only emphasize content, not mathematical literacy. Even though teachers already have an understanding of the importance of mathematical literacy, limited production time causes teachers to use learning media with material obtained from books or the internet. One way to introduce mathematical literacy can be done through the integration of ethnomathematics (Jung et al., 2019; Machaba, 2018). Ethnomathematics is mathematics that develops in a culture, both in a collection of norms and rules that apply in society, beliefs and values that are recognized by groups of people belonging to the same ethnic or national group (Ayuningtyas & Setiana, 2019; Faiziyah et al., 2020). Ethnomathematics was chosen because it is very relevant and coexists with students' daily lives, which makes learning more interesting for students and easier to understand because it is directly related to students' daily lives (Shahbari & Daher, 2020; Syarifuddin et al., 2022).

Based on various relevant research results, it can be concluded that the use of Android devices in the learning context facilitates technology integration, increases student accessibility, and provides an interactive and interesting learning experience. Furthermore, the use of Android-based learning media with an ethnomathematics approach allows the application of content that is more contextually appropriate and more practical, which in turn increases students' understanding of concepts and skills. Therefore, Android-based learning media that focuses on problems is a learning tool that is in accordance with technological developments and has the potential to be improved in the learning process.

However, this study presents certain shortcomings and limitations. This study is limited to evaluating the feasibility of using Android media, without conducting a comprehensive analysis regarding the impact of using this media, especially in the context of mathematics learning at the elementary school level. Previous research has noted that learning mathematics at this level can be a significant challenge for some students. Therefore, further research is needed that can explore the impact of using Android media on the achievement of competencies and the level of success in learning carried out by students.

## 4. CONCLUSION

The findings of this research highlight that the development of Android-based ethnomathematics learning media for spatial construction material in elementary school mathematics is not only necessary as an innovation to address the lack of variety in current teaching methods but also demonstrates significant potential for improving educational outcomes. The research results indicate that this learning media is of

high quality and has been validated as feasible through rigorous testing. Its application in real-world learning activities is expected to positively impact student learning outcomes and contribute to the achievement of essential competencies. Ultimately, this innovation could serve as a valuable tool in enhancing the effectiveness of mathematics education at the elementary level.

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