# Development of Android Media Based on a Realistic Approach in Blended Learning to Improve Students' Problem Solving and Mathematical Critical Thinking Skills

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**Abstract.** This study aimed to assess the validity, practicality and effectiveness of Android media based on a realistic approach to improve students' mathematical problem-solving and critical thinking skills. The research adhered to the Plomp & Nieveen Development model, which consists of a preliminary, development or prototyping, and assessment stage. The findings from Trial I and Trial II indicate that the developed Android media based on a realistic approach meets the requirements of being valid, practical, and effective. Furthermore, the application has improved the problem-solving and critical thinking skills of the students who used it. The N-gain value for problem-solving skills in trial I was 0.55, which increased to 0.60 in trial II, indicating a medium level of improvement. The N-gain value for mathematical critical thinking skills in trial I was 0.63, which increased to 0.67 in trial II, also indicating a medium level of improvement.

**Keywords:** android, realistic approach.

## 1 Introduction

As life progresses, it undergoes constant change and development. Education, being a crucial aspect of one's life, is also evolving at a rapid pace. This is because humans are innately curious and have an insatiable desire to learn about everything. According to Rahman et al.[1], education is a deliberate effort to transmit cultural knowledge from one generation to the next, ensuring that the current generation embodies the teachings of the previous one. However, education is a multifaceted concept that is challenging to define entirely, given its diverse target audience, which is humanity.

Education and the learning process are inextricably linked, with mathematics being one of the many subjects taught from early childhood education to higher education. As Harahap & Lubis [2] note, mathematics is a universal science that plays a vital role in the development of modern technology and various disciplines, while also sharpening human cognitive abilities.

Developing problem-solving abilities is crucial for students when learning mathematics. Das [3] has highlighted the benefits of problem-solving for students, including enhanced thinking skills, the ability to apply procedures, and a deeper conceptual understanding. These skills are crucial for preparing students to confront the challenges of a rapidly evolving world. Alongside problem-solving, critical thinking is also vital for students to possess, particularly in

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light of technological and economic advancements. By fostering the habit of mathematical critical thinking, students can develop their ability to logically and rationally navigate information, providing them with the tools to overcome obstacles and challenges in their daily lives [4].

Mathematics is a fundamental subject that serves as the building block for various sciences. It involves the study of assumptions, properties, and applications, which helps students to think systematically and logically. Despite its significance, many students tend to avoid math lessons. According to Widjajanti [5], students find math to be a challenging subject that lacks practicality, except for counting. Moreover, the teaching methods used by educators are less diverse and less captivating. Therefore, teachers must reflect on math learning to make it more engaging and enjoyable for students.

There are several strategies or methods in learning mathematics that can be utilized as a variety of teaching in the classroom. One of them is the Realistic Mathematics Education (RME) approach, also known as Indonesian Realistic Mathematics Education. Agustina et al. [6] stated that the RME approach is a learning approach that commences from things that are "real" for students. It emphasizes their skills, encourages discussion and argumentation with other students, and enables them to solve problems both individually and in groups.

Research has shown that taking a realistic approach to teaching mathematics can greatly benefit students' problem-solving and critical-thinking abilities. A recent study by Damarjati and Miatun [7] titled "Development of Android-Based Educational Games as Learning Media Oriented to Critical Thinking Skills" also supports this idea, showing that students who were assessed based on critical thinking indicators achieved better learning outcomes, with 78.26% of students reaching the Minimum Completion Criteria (KKM) value.

Since the turn of the 21st century, technology has been advancing at an unprecedented pace. In today's globalized world, it is essential for humans to create new machines and electronic devices to aid in their work and achieve the goals of the 21st-century revolution. According to Haryanto [8], technological advancements have permeated every aspect of life, including education. Teachers and students alike must possess the necessary skills to teach and learn in the 21st century, facing both challenges and opportunities in the age of information. One such development in the field of education is the use of Information and Communication Technology, including electronic learning (e-learning), as a learning medium from early childhood education to the university level.

Smartphones have become a highly innovative learning tool that supports the development of Information and Communication Technology. Parents and teenagers alike use them extensively, with Android-based gadgets being especially well-liked. Android has a 63.15% market share in Indonesia, making it the most popular mobile operating system. Windows is at 26.73%, iOS is at 5.93%, unidentified is at 1.8%, OS X is at 1.61%, and Linux is at 0.7% [9].

The open platform of Android allows developers to create their own applications, making it a highly sought-after platform. Teachers can leverage this by developing innovative learning media through Android-based media.

Mobile Learning is one such media that can aid the learning process, especially with the widespread use of mobile devices and smartphones in the 21st century, particularly Android-based media. Smartphones, especially Android, are easily accessible and portable, making them a convenient way to access learning materials. They also provide opportunities for independent learning and serve as an evaluation and feedback tool for students.

Based on observations, that traditional teaching methods, such as lectures with blackboard media, are still prevalent in mathematics education. After interviewing a math teacher, it was discovered that students struggle with problem-solving skills due to a lack of comprehension of

the material's concepts. According to Firdaus et al. [10], the ability of pupils to solve problems, think rationally, analytically, methodically, creatively, and critically convey ideas based on knowledge gathered is the ultimate purpose of learning mathematics.

To address the lack of technology-based learning media, the researcher has developed worksheets or teaching materials in the form of an Android application using the Blended Learning Realistic approach. Blended learning combines face-to-face and virtual learning methods to optimize the learning experience and achieve learning objectives. This model is sustainable with the use of Android-based learning media and can be a solution for teachers to facilitate students' learning.

Problem-solving and critical thinking skills are crucial for learning mathematics. However, the current state of affairs indicates that students' problem-solving and critical-thinking skills are still inadequate. To address this issue, the researcher plans to conduct a study titled "*Development of Android Media Based on Realistic Approaches in Blended Learning to Improve Students' Mathematical Problem Solving and Critical Thinking Skills at PKBM Global Lentera Kasih Batam*".

## 2 Review Of Literature

### 2.1 Realistic Mathematics Education (RME) or Realistic Approach

RME is distinguished by its emphasis on "realistic" scenarios. RME is distinguished, according to Panhuizen and Drijvers [11], by the utilization of rich, real-world scenarios that are essential to the learning process. These scenarios give students a framework for learning mathematical ideas, methods, and tools as well as a real-world setting in which to use what they have learned. As so, their knowledge eventually loses context-specificity and becomes more formal and universal.

### 2.2 Android-Media Development

Ismayani [12] notes that Android-based media have gained popularity as a learning tool due to their effectiveness and efficiency. Developed by Google Corporation, the world's leading search engine company, Android is an open-source mobile operating system that allows developers to create applications for various mobile devices. Its convenience and flexibility make it a popular choice for educational purposes, enabling independent learning for individuals both in school and at home. This highlights the potential of Android-based learning media to provide accessible and enjoyable learning opportunities for all.

### 2.3 Blended Learning

Friesen [13] said that blended learning is learning that is presented by combining the internet and digital media by establishing a classroom form that requires the physical presence of teachers and students. Meanwhile, according to Fatirul & Walujo [14], Online and traditional classroom training are used in blended learning or a hybrid technique, while also incorporating social interaction. Additionally, educators and students can engage in virtual meetings to exchange feedback, ask questions, and collaborate, regardless of their physical location.

### 2.4 Problem-Solving Skill

According to Polya [15], there are four problem-solving processes that we need to follow. Firstly, we must understand the problem and identify what is required. Secondly, we need to analyze how the different elements are connected and how the unknown is related to the data to come up with a solution plan. Thirdly, we execute the plan. Finally, we review and discuss the completed solution. In this research, Polya's steps and indicators are used to measure mathematical problem-solving abilities. It follows that before students can actually apply the solution, they must first solve the problem by considering how to do so. Therefore, it is evident that problem-solving can influence a person's thought process in generating new ideas that are useful for problem-solving.

### 2.5 Mathematical Critical Thinking Skill

As per the research of Rosnawati [16], critical thinking can be classified as a form of convergent thinking that aims to arrive at a single point in a multitude of mental tasks, such as problem-solving, decision-making, enticing argumentation, presumption examination, and logical examination, critical thinking is a systematic and well-organized process, according to Johnson [17].

There are four important indicators in this research to measure mathematical critical thinking abilities according to Minarni, et al [18] which are as follows: 1) Interpretation; 2) Analysis; 3) Evaluation; and 4) Inference.

## 3 Method

Preparatory investigation, advancement or prototyping, and appraisal are the three stages that make up this research paradigm. Based on a modified version of Plomp and Nieveen's development model, this study examines media development.

The Android media created employing a practical approach must meet the criteria of being substantial, viable, and compelling. It is considered valid if it falls under the valid category of $4 \leq Va < 5$ or is very valid if $Va = 5$. It is practical if the average score obtained from the learning media implementation sheet in class is at least good ($3 \leq Ok < 4$). It is effective if: 1) The least test score for students' problem-solving capacities and the least test score for students' numerical basic considering capacities is 70, and at least 85% of students achieve learning mastery, 2) Based on student responses, it is considered positive if it meets the criteria for being effective with the media, which is reaching a percentage of ≥ 80%.

To calculate the increment in problem-solving and basic scientific considering aptitudes after using Android media development based on a realistic approach, the normalized N-Gain formula [19] as follows:

$$N - Gain = \frac{S_{post} - S_{pre}}{S_{max} - S_{pre}}$$

Description:

| | | | |
|---|---|---|---|
| N – Gain | = | Normalized gain score |
| $S_{post}$ | = | Final test score |
| $S_{pre}$ | = | Initial test score |
| $S_{max}$ | = | Maximum test score |

**Table 1.** Normalized Gain Criteria

| Score | Criteria |
|---|---|
| 0,00 < N - Gain ≤ 0,30 | Low |
| 0,30 < N - Gain ≤ 0,70 | Medium |
| N – Gain > 0,70 | High |

# 4 Research result

## 4.1 Preliminary Stage

After conducting a series of observations and interviews with mathematics teachers at PKBM Global Lentera Kasih Batam, the study identified the obstacles they encountered. The data obtained from the analysis was then used to determine the need for developing learning media.

Based on observations made at PKBM Global Lentera Kasih, it shows that the learning media used by teachers in the classroom is the blackboard. From the results of interviews with mathematics teachers, it is known that student learning outcomes are still quite low due to students' problem-solving skills which are also low. It is known that the percentage of students whose scores do not meet the minimum completeness criteria (KKM) from the results of the daily test assessment of row material in class XI in the 2022 school year only reaches 69.57%.

Then a literature study was conducted and it was found that students' mathematical problem-solving and critical thinking skills in Indonesia were quite low. This is consistent with the results of observations that have been made previously.

## 4.2 Development or Prototyping Stage

**Product Design.** At this stage, researchers designed a draft android media with a realistic approach along with supporting devices in the form of lesson plans, and product quality assessment instruments. The taking after Figure 1. is an case of a item plan show utilizing Kodular.


**Fig. 1.** Product Design View

**Evaluation dan Revision.** Android media things, lesson plans, and thing quality assessments were made based on a commonsense approach (Draft I) and looked into by three pros. The average value of the validation results is as follows: 1) media experts amounted to 4.13; 2) material experts amounted to 4.47; 3) the test of problem-solving skill and mathematical critical thinking skill of students as an assessment instrument met the criteria of valid and reliable. A few revisions from the experts regarding the selection of images and the resolution of the images and text used were considered and adjusted so that it became draft II.

### 4.3 Assessment Stage

After obtaining the draft II which has met the valid criteria and has been revised according to the suggestions of the experts, then conducted field trials on the subject of research students of class XI PKBM Global Lentera Kasih Batam.

#### 4.3.1 Result of Trial I

In class XI-B, the product (draft II) was put to the test for its practicality and effectiveness. Unfortunately, the first trial yielded poor results, with an average score of 2.88 ($2 \leq Ok < 3$), falling short of the practicality criteria. Moreover, the classical completeness of students' problem-solving skill and mathematical critical thinking skill did not meet the required standards, scoring 73.68% and 68.42%, respectively. Despite this, the student's overall response was positive, with an average score of 87.67%.

Given the unsatisfactory results of the first trial, it was evident that the product needed revision before the second trial could be conducted. As such, a third draft (draft III) was created.

#### 4.3.2 Result of Trial II

During Trial II, a product (draft III) was tested in class XI-A to assess its practicality and effectiveness. The comes about of perception demonstrated that the learning usage was effective, with a normal score of 3.74, assembly the criteria for a common sense of learning media. Besides, the classical completeness of students' problem-solving capacity and scientific basic considering ability in Trial II was 89.47%, assembly the criteria for classical completeness. The normal understudy reaction was 93.09%, showing a ideal reaction to the learning strategy.

### 4.4 Description of the Improvement of Students' Problem-Solving Skill

Amid the primary trial, students' problem-solving abilities had an normal pre-test score of 47.62 and a post-test score of 78.95. The normal N-gain was 0.55, which is considered "medium" ($0.30 <$ n-gain $\leq 0.70$). Within the moment trial, the normal pre-test score was 53.18, and the post-test score was 80.81. The normal N-gain was 0.60, too falling within the "medium" category. Based on these comes about, it can be concluded that the utilize of android media, created with a reasonable approach, driven to an increment in students' problem-solving aptitudes from trial I to trial II, as prove by the overall normal esteem and the normal esteem of N-Gain.

### 4.5 Description of the Improvement of Students' Mathematical Critical Thinking Skill

During the first trial, the pre-test score averaged at 49.88, while the post-test score was 80.83. The N-gain average was 0.63, which is classified as "medium" ($0.30 < \text{n-gain} \leq 0.70$). In the second trial, the pre-test score averaged at 56.40, while the post-test score was 84.71. The N-Gain average was 0.67, also classified as "medium". The increase in the total average value and the average value of N-Gain indicates that the students' mathematical critical thinking skills increased from trial I to trial II, according to these results. This improvement was achieved through the use of android media based on the realistic approach developed.

## 5 Discussion

A legitimacy test was carried out to evaluate the primary adaptation of an Android media application. The application was made to address the challenges confronted by Course XI PKBM Global Lentera Kasih Batam. The development team consisted of three experts who utilized a practical approach. The validation results from the three validators indicated that the application was valid, with an average media expert validity of 4.13 and material expert validity of 4.47. The problem-solving skill test instrument and mathematical critical thinking skilltest were also deemed valid based on the test results, which showed tcount > ttable. The reliability of the pre-test and post-test for both tests was high, with scores ranging from 0.697 to 0.717 for problem-solving skill and 0.724 to 0.715 for mathematical critical thinking skill.

Based on the above analysis, it can be concluded that the android media developed using a realistic approach has met the validity criteria as judged by experts. The success of this approach can be attributed to several factors. Firstly, the android media developed using a realistic approach has met the content validity, meaning it has been developed in accordance with the demands of the existing curriculum. These demands are related to the core and basic competencies that students must achieve in learning activities that are adapted to the material or content of the lessons given, and are based on the realistic mathematics learning approach.

Recent research indicates that android media developed with a realistic approach has demonstrated construct validity. This implies that the development of android media based on a realistic approach is consistent with the concepts and indicators of mathematical problem-solving skill and mathematical critical thinking, which are then integrated with a realistic approach. The resulting media is intended to enhance lesson plans and worksheet, which are tailored to learning through a realistic approach, in order to assess students' mathematical problem-solving and mathematical critical thinking skills.

Based on the assessment results from the validators, all of them stated that the android media developed using a realistic approach was feasible to use with minor revisions.

A study was conducted to assess the effectiveness of android-based learning tools that utilized a realistic approach. The evaluation was conducted from three perspectives: the implementation of learning steps, social systems, and management principles with support systems. The study was carried out in class XI-B PKBM Global Lentera Kasih Batam with 19 students as research subjects. The average observation score for learning implementation was 2.881, indicating that the product did not meet the practicality criteria for effective learning implementation.

In the initial trial of the new learning media (draft II), it was discovered that the media did not meet the practicality standards that had been established beforehand. This was due to a lack

of readiness in managing student activities during the course of the activities. To address this issue, a second trial was conducted, known as trial II. During this trial, the practicality aspects that had not been met previously were taken into account. The trial was conducted in class XI-A PKBM Global Lentera Kasih Batam, with 19 students serving as test subjects. The learning process was carried out over three sessions, following the lesson plan. In trial II, the teacher was better prepared to manage the learning process and was able to guide students so that learning using the new learning media (draft III) was more practical and efficient. The implementation of learning in trial II was observed and received an average score of 3.738, which falls into the "Well Implemented" category. This indicates that the criteria for product practicality in terms of learning implementation were met.

Based on the results of trials I and II, it can be inferred that the android media utilizing a realistic approach has proven to be practical and user-friendly for both teachers and students. The android media components developed using this approach have been well-received by students, as demonstrated by the positive outcomes of the trials.

During trial I, the android media fell short of meeting the classical completeness criteria for problem-solving skills, achieving only 73.68%. This may have been due to limitations in the learning media utilized during the initial trial.

However, in trial II, the android media based on the realistic approach successfully met the classical completeness criteria for problem-solving skills, achieving an impressive 89.47%. As a result, it can be concluded that the android media developed using this approach is highly effective in enhancing students' problem-solving skills.

The initial trial's post-test results for students' mathematical critical thinking skills fell short of the classical completeness criteria, with only a 68.42% achievement rate. Consequently, it can be inferred that the android media, which was based on a realistic approach and developed in the first trial, did not meet the criteria for achieving classical completeness. The subpar classical completeness of students' mathematical critical thinking ability may have been due to the inadequacies of the learning media utilized in the first trial.

The use of android media based on the realistic approach developed has proven to be effective in helping students achieve classical completeness. In trial II, the post-test results of students' mathematical critical thinking skills showed a percentage of 89.47%, meeting the criteria for achieving classical completeness. The android media components based on the realistic approach developed have also received positive feedback from students, with a score of 87.67% in trial I and 93.09% in trial II. Additionally, the pre-test and post-test analysis of mathematical problem-solving ability in both trials showed an increase in students' ability. Overall, the android media based on the realistic approach developed has positively contributed to students' learning outcomes.

The analysis of the improvement of students' mathematical problem-solving skills in both pre-test and post-test results shows that there was an increase in the average mathematical problem-solving skill in trial I from 53.62 to 78.95, and in trial II from 53.18 to 80.81. The increase in mathematical problem-solving skill was also evident in the average normalized gain. In trial I, there was a score of 0.55 with "medium" criteria ($0.30 < \text{n-gain} \leq 0.70$), and in trial II, there was a score of 0.60 with "medium" criteria. This indicates that the use of Android media based on the realistic approach had a positive impact on improving students' mathematical problem-solving skills.

Upon analyzing the pre-test and post-test comes about of scientific basic considering abilities in both trial I and trial II, it was found that there was a critical increment in students' numerical basic considering aptitudes. This increment was apparent from the normal comes

about of the pre-test and post-test of numerical basic considering aptitudes gotten by the understudies.

Further analysis revealed that the average mathematical critical thinking skills in trial I increased from 49.88 to 80.83, while in trial II, there was an increase in the average value of students' mathematical critical thinking skills from 56.40 to 84.71. The increase in mathematical critical thinking skills was also observed based on the average normalized gain. In trial I, there was an increase in students' mathematical critical thinking skills with a "medium" criteria score of 0.63 ($0.30 < \text{n-gain} \leq 0.70$), while in trial II, there was an increase with a "medium" criteria score of 0.67 ($0.30 < \text{n-gain} \leq 0.70$). These findings suggest that the use of android media based on the realistic approach developed has a positive impact on improving students' mathematical critical thinking skills.

## 6 Conclusion

After analyzing the research findings and engaging in a thorough discussion, it is evident that android media based on a realistic approach, satisfies the requirements of being valid, practical, and effective. Notably, the utilization of android media has resulted in a notable improvement in students' mathematical problem-solving skills and critical thinking skills. As such, it is advisable to incorporate android media based on a realistic approach in learning activities.

## References


[1] Rahman, Abd., et al.: Definition of Education, Science of Education and Elements of Education. Al Urwatul Wutsqa, 2(1), 1-8 (2022)

[2] Harahap, H. H & Lubis, S.: Development of Android-Based Mathematics Learning Media for Junior High School Level. Journal of Education and Cultural Sciences (MIND), 1(1), 1-6 (2021)

[3] Hidayat, R., dkk.: Analisis Faktor-Faktor Rendahnya Kemampuan Pemecahan Masalah Matematis Siswa di SMK Swasta Teruna Padangsidimpuan. *Mathematic Education Journal*. 5(3), 114-120 (2022)

[4] Somakim.: Improving Mathematical Critical Thinking Ability of Junior High School Students with the Use of Realisitic Mathematics Education. Journal of MIPA Forum, 14(1), 42-48 (2011)

[5] Widjajanti, D.B.: Mengembangkan Keyakinan Siswa Sekolah Dasar terhadap Matematika Melalui Pembelajaran Realistik. *Prosiding Seminar Nasional Penelitian, Pendidikan dan Penerapan MIPA Fakultas MIPA*. Universitas Negeri Yogyakarta: Yogyakarta (2009)

[6] Agustina, N., dkk.: Penggunaan Pendekatan Realistic Mathematics Education (RME) dalam Meningkatkan Pemahaman pada Materi Penjumlahan Pecahan di Kelas V Sekolah Dasar. *PEDADIDAKTIKA: Jurnal Ilmiah Pendidikan Guru Sekolah Dasar*, 7(4), 91–99 (2020)

[7] Damarjati, S & Miatun, A.: Pengembangan Game Edukasi Berbasis Android sebagai Media Pembelajaran Berorientasi pada Kemampuan Berpikir Kritis. *ANARGYA: Jurnal Ilmiah Pendidikan Matematika*, 4(2), 164-175 (2021)

[8] Haryanto, R.: Tranformasi Pendidikan Abad 21 Melalui Rumah Belajar, (Online), (http://pena.belajar.kemdikbud.go.id/2019/07/tranformasi-pendidikan-abad-21-melalui-rumah-belajar/, html, diakses 20 Januari 2022) (2019)

[9] StatCounter.: Mobile Operating System Market Share in Indonesia. (Online), (https://gs.statcounter.com/os-market-share/all/indonesia#, html, diakses 20 Januari 2022) (2022)

[10] Firdaus, A., dkk.: Kemampuan Berpikir Kritis Siswa pada Materi Barisan dan Deret Berdasarkan Gaya Berpikir. *Kreano, Jurnal Matematika Kreatif-Inovatif*. 10. 68-77 (2019)

[11] Panhuizen, M. V. D. H & Drijvers, P.: Realistic Mathematics Education. *Encyclopedia of Mathematics Education*, 521-534 (2014)
[12] Ismayani, A.: *Cara Mudah Membuat Aplikasi Pembelajaran Berbasis Android dengan Thunkable*. Jakarta: Elex Media Komputindo (2018)
[13] Tabunan, H., dkk,.: *Blended Learning dengan Ragam Gaya Belajar*. Medan: Yayasan Kita Menilis (2020)
[14] Fatirul, A. N & Walujo, J. A.: *Desain Blended Learning: Desain Pembelajaran Online Hasil Penelitian*. Surabaya: Scopindo Media Pustaka (2020)
[15] Polya, G.: *How to Solve it, Second Edition*. Princeton: New Jersey Princeton University Press (1973)
[16] Rosnawati.: Berpikir Kritis melalui Pembelajaran Matematika untuk Mendukung Pembentukan Karakter Siswa. Makalah, *Seminar Nasional. Yogyakarta: Universitas Sanata Dharma* (2012)
[17] Johnson, E. B.: *Contextual Teaching and Learning: Menjadikan Kegiatan Belajar Mengajar Mengasyikkan dan Bermakna*. Bandung: Mizan Learning Center (MLC) (2007)
[18] Minarni, A., dkk.: *Kemampuan Berpikir Matematis dan Aspek Afektif Siswa*. Medan: Harapan Cerdas Publisher (2020)
[19] Susanto, J.: Pengembangan Perangkat Pembelajaran Berbasis Lesson Study Dengan Kooperatif Tipe Numbered Heads Together Untuk Meningkatkan Aktivitas Dan Hasil Belajar Ipa Di Sd. *Journal of Primary Education*, *1*(2), 71–77 (2012)