Adv Mobile Learn Educ Res, 2022, 2(1): 216-224
DOI: 10.25082/AMLER.2022.01.005

RESEARCH ARTICLE

Designing Android learning media to improve problem-solving skills of ratio

Anisa Verawati[1] **Denik Agustito**[1] **Widowati Pusporini**[2] **Wikan Budi Utami**[3] **Sri Adi Widodo**[1*]

[1] Department of Mathematics Education, Universitas Sarjanawiyata Tamansiswa, Yogyakarta, Indonesia
[2] Department of Education Research and Evaluation, Universitas Sarjanawiyata Tamansiswa, Yogyakarta, Indonesia
[3] Department of Mathematics Education, Universitas Pancasakti Tegal, Central Java, Indonesia

Correspondence to: Sri Adi Widodo, Department of Mathematics Education, Universitas Sarjanawiyata Tamansiswa, Yogyakarta, Indonesia;
Email: sriadi@ustjogja.ac.id

Received: November 30, 2021;
Accepted: January 15, 2022;
Published: January 19, 2022.

Citation: Verawati, A., Agustito, D., Pusporini, W., Utami, W. B., & Widodo, S. A. (2022). Designing Android learning media to improve problem-solving skills of ratio. *Adv Mobile Learn Educ Res*, **2**(1), 216-224. https://doi.org/10.25082/AMLER.2022.01.005

Abstract: This study aims to determine the process of developing android-based learning media on comparative material to improve mathematical problem-solving skills and find validation through android-based learning media to improve mathematical problem-solving abilities. This research was conducted through research and development, where this research refers to 4D development, which consists of four steps: define, design, develop, and disseminate. This research was carried out to develop measures due to restrictions on the activities of emergency communities affected by the COVID-19 pandemic; this is one of the limitations of this research. Researchers use documents such as curriculum to collect data at the define and design stages, while a validation sheet is used for the development stage. The data analysis technique used descriptive qualitative at the define and design stage, and the development stage uses quantitative descriptive analysis. The main finding in this research is the prototype of android learning media on ratio. The results showed that V Aiken obtained more than 0.750, so this media prototype can be used for the following research stage.

Keywords: learning media, Android, mathematical problem solving

1 Introduction

The development of science and technology brings swift changes in all human activities; besides, science and technology also change the human paradigm in obtaining news so quickly (Kates, 2010). All activities that were previously carried out manually by humans have now been replaced by technology, thus requiring humans to have forward-thinking in all respects so as not to be considered backward (Imene & Imhanzenobe, 2020). One of the technologies that continue to develop is the smartphone used by many people (Aktipis et al., 2020; Alexander & Joshi, 2016). Electronic devices, especially information and communication technology, have provided the latest products by developing the functions they have and continue to be developed by the latest technology so that it can be used to assist the learning process in the field of education and development in other fields (Papadakis & Kalogiannakis, 2022). Currently, the smartphone has experienced many advances and updates. Today, smartphones that have undergone many advances and developments have made it easier for humans to connect without being limited by distance, space, and time (Wellman, 2001; Green, 2002). In addition, this smartphone can provide various benefits and conveniences for its users, especially students. For instance, the DuBot application connected to a smartphone can be used for educational robotics and science, technology, engineering, mathematics (STEM) in K12 students (Chatzopoulos et al., 2021). Similarly, the MIT App Inventor program is used for weather forecasting that can be applied to project learning for STEM (Papadakis, 2020). Students' most widely used smartphone is cellphones equipped with the Android operating syste (Walker, 2011; Jesse, 2015; Kouser et al., 2014). Android is an unpaid platform, unlike platforms such as Windows, and this condition makes Android the most preferred system by the public (Wei et al., 2012).

Mobile technology combined with an interdisciplinary approach to knowledge and the organization of meaningful learning experiences for children can create a creative and interactive learning environment different from traditional teaching (Papadakis & Kalogiannakis, 2019). One of the platforms used for mobile is the Android platform. Android is a mobile operating system currently being developed (Kushwaha & Kushwaha, 2011; Tilson et al., 2012). Apart from being an operating system favored by the public, Android is also an open-source platform designed for mobile devices (Paul & Kundu, 2010; Kaur & Sharma, 2014), so that Android has a significant influence on the development of science and technology (Ogawa et al., 2018; Ishiguro, 2016). Making good use of mobile learning with appropriate devices is thought to

increase students' learning motivation and help them produce positive performance (Papadakis & Kalogiannakis, 2019). In connection with these conditions, it is necessary to consider using the Android platform on smartphones for learning.

One of the technologies that can affect education is learning media. It is a process of exchanging information that contains knowledge and skills. The exchange of information between educators and students occurs where educators are sources of information, students are recipients of information, and the media is a means to introduce educational ideas and materials (Ashari et al., 2020; Widodo et al., 2018; Murtafiah, 2020). Media is a tool to make it easier for teachers to explain the material to students who still have difficulty understanding the learning material (Hakim et al., 2019). The existence of media in the learning process is expected to help students understand the learning material to be studied (Widodo, 2018; Salomon, 2012).

One of the cooperative learning using learning media is mathematics. Before the pandemic, mathematics learning in Indonesia was mainly delivered directly from teachers to students (Rufiana & Nurhidayah, 2021; Sujatmika et al., 2019; Hidayah, 2015; Nurlaily et al., 2019). The teacher only conveys the mathematical material in the book without any improvisation to understand it more easily. The effect of learning mathematics given to students loses its meaning (Bolondi & Ferretti, 2021). Not to mention the learning tools that have been compiled in hardcopy form must be immediately converted into digital form so that mathematics learning during the pandemic can be carried out correctly. In Indonesia, most teachers are still compiling learning tools that are not digital (Sujatmika et al., 2019; Wijayanti et al, 2021). In connection with this condition, it is necessary to prepare learning media installed on smartphones to study anywhere and anytime.

Mathematics material that is still difficult for students to understand is the problem of comparison. Choosing comparative material because comparisons are closely related to everyday life, the problem can be solved with several solutions from researchers' observations that comparative material is always included in national exam questions. One of the problems experienced by students in comparative material is that the number of formulas in the material makes students confused about using any formula when working on questions (Suraji et al., 2018). Formulas in mathematics make it difficult for students to solve problems. As the results of interviews conducted by Hendikawati et al. (2019). To the students that there are still many students who have difficulty in applying the concept of comparison, and there are still many students who have difficulty changing sentences from story questions into mathematical form. Because there are still many students who still have difficulty in doing math problems on comparative material, problem-solving is needed.

Problem-solving is a means to learn mathematical ideas and solve problems because problem-solving is an essential part of the mathematics learning process (Ibrahim et al., 2021; Mustafia & Widodo, 2018). Therefore, steps are needed to solve problems related to learning mathematics in comparative material. The steps needed to solve the problem, according to Polya, are (1) Understanding the problem that occurs, (2) Developing a plan to solve the problem, (3) Implementing a problem-solving plan (4) Rechecking the solution to the problem (Widodo & Ikhwanudin, 2018; Schoenfeld, 1987; Polya, 2004). According to the National Council of Teacher Mathematics, solving problems is good to learn and resolve problems with appropriate solutions in learning mathematics (Martin, 2000; Sheffield, 1994). Mathematics learning that studies comparisons also occurs in everyday life. Learning mathematics in comparative material will be more suitable when taught using Android-based learning media. Using Android-based learning media, students are expected to understand mathematics learning in solving problems that occur in comparative material.

Thus, it is necessary to research the development of mathematics learning media using the android platform to carry out mathematics learning during the pandemic correctly. Therefore, this research aims to find out the process of developing the Android-based learning media on the comparisons material to increase the ability of mathematical problem solving and find validation through Android-based learning media to increase the ability of mathematic problem-solving.

2 Methods

This research is a type of research and development (R & D); the purpose of this research is to develop android-based learning media on comparative material to improve problem-solving skills. Development research is a research method used to produce specific products and test the product's effectiveness (Gall et al., 1996; Thiagarajan et al., 1974). Research Development Procedure is a method to produce a particular product or improve an existing product and test the effectiveness. This research used the 4D model consists of four stages, namely Define, Design, Develop, and Disseminate (Thiagarajan et al., 1974). The stages of this research can be

seen in Figure 1.

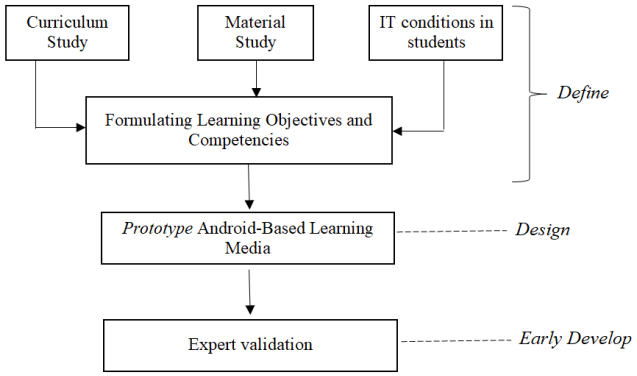

Figure 1 This research stage

The first is the define stage; the purpose of this stage is to define the learning requirements. At this early stage, an analysis is carried out to determine the objectives and subject matter to be developed. The steps used in the definition are as follows: early-late analysis, student analysis, task analysis, concept analysis, and formulation of learning objectives. In this stage, Data Analysis Techniques at the definition stage used qualitative description. Qualitative descriptive methods explain learning during the covid-19 pandemic, syllabus, formulation of learning objectives, competency of the material used, and mathematical problems in ratio material.

The Second Stage of design begins after the learning objectives are set. In this study, the design stages were carried out where the preparation of tests, learning media, selection of formats, initial design. At this stage, the data analysis technique used is descriptive, describing the process of designing and developing android-based learning media.

Third Stage of Development: This stage aims to produce the final form of the design stage learning device in two activities: expert validation and development testing. This stage uses quantitative descriptive analysis, which explains the validity of the android-based learning media developed using content validation. This study uses a Likert scale score with an interval of 1 to 5. The formula used to calculate the average score uses the Aiken formula (Aiken & Patrician, 2000; Aiken, 1999; Aiken, 1980). The calculation results are interpreted based on categories according to Retnawati (2016), as shown in Table 1. However, when this research was conducted in Indonesia, restrictions on community activities were implemented to prevent an increase in COVID-19 cases. Activities such as learning must be done online and should not crowd community activities. Considering these conditions, developmental testing and disseminated stage cannot be carried out in this study.

Table 1 Category of validity

Index V-Aiken	Category of validity
$0.0 \leq V < 0.4$	Low
$0.4 \leq V \leq 0.8$	middle
$0.8 < X \leq 1.0$	High

3 Result and discussion

3.1 Define

3.1.1 Front-end analysis

During the COVID-19 pandemic, learning is done online. This learning is carried out as one way to control the spread of the coronavirus. Online and distance learning is an alternative to learning during the Covid pandemic when learning cannot be done face-to-face directly, and learning must be done so that the loss of learning effect does not further widen the gap. The use of online learning is practical because it can be used anywhere and anytime (Bourne et al., 2005; Means, 2010; Nakamura et al., 2018). However, do not turn a blind eye that the application of online learning poses problems (Hung & Chou, 2015). These problems come from teachers who have to prepare learning devices made in electronic form. Therefore, to prepare for online learning, teachers need to know how to use online applications (Zaharah & Kirilova, 2020) and prepare electronic learning tools. In learning mathematics, especially in comparative material,

there is a tendency for students to have difficulty solving these problems. Especially the problem of story context or daily life related to comparison.

From this condition, it is necessary to develop teaching materials that can facilitate the comparison of materials for online learning during the pandemic (Hendikawati et al., 2019). One alternative that can be developed is teaching materials in electronic form using the Android platform.

3.1.2 Learner analysis

This stage describes the analysis of the characteristics of students in learning mathematics by the development of learning media on comparative material to find out the difficulties students face when learning mathematics. The preliminary study results found that students experienced a very high level of anxiety in learning mathematics conducted online (Nurjanah & Alyani, 2021). The high anxiety of students in online mathematics learning is because they cannot understand the mathematical concepts taught by the teacher, the load of the material provided by the teacher during the pandemic is very high, there is no teaching material as an independent learning companion, even students hope that learning can be carried out face-to-face for mathematics. Although it was found that students had a moderate level of anxiety (Akmalia & Ulfah, 2021), they thought that learning mathematics gave online and offline would not affect their mastery of mathematical concepts.

Regarding the condition of the absence of independent learning companion teaching materials on mathematics material, Afriani & Fitria (2021) stated that the need for android-based media that students can use as independent learning companions. In addition, the presence of media in the learning process is expected to help students understand the learning material to be studied (Radiansah, 2018).

3.1.3 Concept and Task analysis

This analysis ensures a comprehensive scope of tasks in learning that is adjusted to the Competency Standards and Basic Competencies based on the applicable curriculum in Indonesia. A curriculum is a set of subjects and educational programs offered by an institution and includes lesson plans provided to students during the teaching period (Arifianto & Liana, 2015; Marjito & Juniardi, 2019). The curriculum in secondary schools focuses on curriculum development in education units includes developing learning tools such as syllabus, lesson plans, student worksheets, Learning Outcomes Tests, and media of learning. This research focuses on developing comparative media for junior high school students. Following the regulation of the Minister of Education and Culture of the Republic of Indonesia Number 37 of 2018 (Permendikbud RI No 37, 2018), the essential competencies of mathematics subjects for core competencies of knowledge in comparative material are (1) Explaining the ratio of two quantities (the units are the same and different); (2) Distinguishing comparisons of worth and inverse values by using data tables, graphs, and equations. Still, by the same regulations, the essential competencies of mathematics subjects for core competency skills in comparative material are (1) Solving problems related to the ratio of two quantities (the units are the same and different), and (2) solving problems related to the comparison of worth and reverse value.

While the core competencies in the spiritual and social aspects include (1) respecting and living the teachings of the religion they adhere to, (2) showing honest behavior, discipline, responsibility, caring (tolerant, cooperation), polite, and confidence in interacting effectively. With the social and natural environment within reach of the association and its existence (Permendikbud RI No 37, 2018). Competence in spiritual attitudes and social attitudes can be achieved through indirect teaching, namely exemplary, habituation, and school culture, by taking into account the characteristics of the subjects and the needs and conditions of students (Ariantini & Sutama, 2014; Sijal & Sijal, 2020). For this reason, the growth and development of attitude competencies, both social attitudes and spiritual attitudes, are carried out throughout the learning process and can be used as teacher considerations in developing the character of students further (Fauzi et al., 2018; Sulistyani & Sa'dijah, 2017). By considering the focus of the material developed in this study, the learning objectives of the comparative material can be seen in Table 2.

Table 2 Objectives of comparative learning in the 2013 Indonesian Education curriculum

Knowledge Learning Objectives	Skills Learning Objectives
3.3.1 Students can explain the ratio of two quantities.	4.3.1 Students can solve problems related to the ratio of two quantities.
3.4.1 Students will differentiate between worth and value comparisons using data tables, graphs, and equations.	4.4.1 Students can solve problems related to the comparison of values and inverse values.

3.2 Design

The results of the design in this study are an android-based learning media product to improve students' mathematical problem-solving skills on the subject of comparison. This media is designed to make it easier for students to understand comparative material using Android-based learning media. After obtaining the learning objectives as shown in Table 1, the next step is to design a form of android-based learning media. Android also provides an open platform for programmers to create new applications or modify existing applications. The programmers develop android applications because the platform is open and some of the applications in the play store are free, and some are paid. Android in question here is an application that can be installed on smartphones with the Android operating system. This app was created with the help of Ispring Suite 9 and Website 2 APK Builder. This application can also be run on smartphones offline.

Media is a learning aid that can distribute information in the teaching and learning process (Widodo et al., 2018; Widodo, 2018). Learning media is an educational message delivered using tools to convey the message to the recipient (Widodo & Ikhwanudin, 2018; Widodo, 2018). Learning media, in general, serves to create a more effective and fun learning atmosphere (Nurseto, 2011).

At this stage, the learning media is designed by adjusting the characteristics of online learning with devices to carry out mathematics learning. For this reason, mathematics learning media is designed based on Android so that the implementation of online learning can be carried out using devices. Android-based learning media is designed similar to the PowerPoint on the Windows platform.

The initial design made is an Android-based learning media. The components contained in the media consist of the initial display and the start button to go to the next page, namely the Menu (basic competency, indicators, subject matter, instructions, about applications, summaries, practice questions, and quizzes). Furthermore, practice questions included improving skills to help students solve mathematical problems on comparative material and improve their ability to solve them. The last part is a quiz where a student can see the value automatically at the end of the quiz. The initial display of one of the media can be seen in Figure 2, while the menu display on one of the media can be seen in Figure 3.

Figure 2 Initial view of one of the media

Figure 3 Menu display on one of the media

3.3 Develop

An Android-based learning media has been designed on comparative material to improve problem-solving skills at the design stage. The media is validated to obtain an assessment related to the validity and feasibility. As for the Android-based Media Validator, it consists of 8 people. In addition to providing expert assessments, they also provide advice regarding android-based learning media. Desired, as for the buttons that do not work, namely in the practice section, there is a back button that does not work, so what can be done in the navigation section is to fix the buttons that do not work, namely, in the practice section there is a back button that does not work to return to the previous page and navigation adds many buttons do not just get the material button.

Secondly, in the content section, the expert conveys that the KD and Indicators section should be made into one page with the material in the material section. There are typos; it is recommended to check the typo section. The material section lacks solutions with graphs so that graphs are added according to indicators. There are still sentences that come out of the text box, correct the definition of the comparison of sentences neatly arranged again, and add a few more practice questions so that students can practice increasing the ability of students to solve mathematical problems in the comparison material. Thus, what needs to be done is to look back/check the writing on the material and add graphics to the material. Then for the

summary results of the assessment calculations from experts can be seen in Table 3. Based on Table 3, it is found that the V Aiken range is different from 0.843 to 1.093.

Table 3 V-Aiken calculation summary

Aspect	Item	V Aiken	Category
Navigation	1	1	High
	2	0.750	Medium
	3	0.906	High
Text	4	0.906	High
	5	0.875	High
	6	0.906	High
	7	0.937	High
Language	8	0.906	High
	9	0.843	High
Appearance	10	0.843	High
	11	0.968	High
	12	0.906	High
Content	13	0,812	High
	14	0.906	High
	15	0.843	High
	16	0.968	High
	17	0.968	High
	18	0.968	High
	19	0.968	High
Presentation	20	0.906	High
	21	0.937	High
	22	0.937	High

The validator consists of 8 people giving quantitative and qualitative values from a mathematical point of view. The eight validators came from practitioners (lectures in mathematics education) and academics (math teachers at the junior high school level). The assessment results of the mathematics education validator show that the android-based learning media on comparative material to improve mathematical problem-solving skills that have been validated by the media validator designed by the researcher is in the high validity category. The results of calculations using the V-Aiken formula, the experts' assessment is worth 0.750 – 1.00 from the results of the expert's assessment. It can be concluded that the android-based learning media has a high validity value.

Then for the qualitative descriptive results from criticism, suggestions, and improvements, it can be seen that the android-based learning media is feasible to use with improvements. Thus, it is necessary to improve the media in the navigation section so that there are more buttons for others, not just options for the material section. Then graphics in the material section and writing correction is necessary so that it does not come out of the box, add mathematical symbols so that students know better than the medium for math and look more attractive.

This research generally uses the development stage of Thiagarajan et al. (1974), which consists of 4 stages, namely define, design, develop, and disseminate. Nevertheless, the pandemic conditions that hit Indonesia, the research team had difficulty gathering many students to carry out development tests at the final and dissemination stages. Researchers also have not been able to carry it out, so this research can only be carried out until validation from the expert. So that this research still needs to be seen based on research results whether the prototype that has been developed has a potential effect on students' skill to solve ratio problems.

4 Conclusion

Based on the research results that have been done, it can be concluded that this research has produced a prototype of Android-Based Learning Media on comparative material. The expert validators' assessment results found that the Android-based learning media prototype had a validity index of more than 0.750 with an average assessment, including the high validity category. These results indicate that theoretically, the learning media developed are good conditions for navigation, text, language, appearance, content, and presentation so that the media of learning can be used for the following stages of development. Meanwhile, to see the level of practicality and effectiveness of the prototype, it is necessary to carry out the following stages, namely developmental testing and dissemination.

Acknowledgements

We want to thank the Institute for Research and Community Service (LPPM), Universitas Sarjanawiyata Tamansiswa, for providing moral and material support so that the research can be carried out correctly.

References

Afriani, L., & Fitria, Y. (2021). Pengembangan Media Pembelajaran Berbasis Teknologi Berbantuan Adobe Flash Cs6 untuk Pembelajaran pada Masa Pandemi Covid-19. Edukatif: Jurnal Ilmu Pendidikan, 3(4), 2141-2148. https://doi.org/10.31004/edukatif.v3i4.1171

Aiken, L. H., & Patrician, P. A. (2000). Measuring organizational traits of hospitals: The revised nursing work index. Nursing Research, 49(3), 146-153. https://doi.org/10.1097/00006199-200005000-00006

Aiken, L R. (1999). Personality assessment methods and practices (3rd Ed). GÃ¶ttingen: Hogrefe & Huber Publishers.

Aiken, L. R. (1980). Content validity and reliability of single items or questionnaires. Educational and Psychological Measurement, 40(4), 955-959. https://doi.org/10.1177/001316448004000419

Akmalia, R., & Ulfah, S. (2021). Kecemasan dan Motivasi Belajar Siswa SMP Terhadap Matematika Berdasarkan Gender di Masa Pandemi COVID-19. Jurnal Cendekia: Jurnal Pendidikan Matematika, 5(3), 2285-2293. https://doi.org/10.31004/cendekia.v5i3.846

Aktipis, A., Whitaker, R., & Ayers, J. D. (2020). Do Smartphones Create a Coordination Problem for Face-to-Face Interaction? Leveraging Game Theory to Understand and Solve the Smartphone Dilemma. BioEssays, 42(4), 1800261. https://doi.org/10.1002/bies.201800261

Alexander, J. C., & Joshi, G. P. (2016). Smartphone applications for chronic pain management: a critical appraisal. Journal of pain research, 9, 731. https://doi.org/10.2147/JPR.S119966

Arifianto, M., & Liana, C. (2015). Profesionalisme Guru SMA di Lamongan Pada Masa Orde Baru Pelita V dan VI (Tahun 1989 sampai 1998). AVATARA: E-Journal Pendidikan Sejarah, 3(3), 391-397.

Ariantini, N. P., Suandi, I. N., & Sutama, I. M. (2014). Implementasi Pengintegrasian Sikap Spiritual dan Sikap Sosial dalam Pembelajaran Bahasa Indonesia Berbasis Kurikulum 2013 di Kelas VII SMP Negeri 1 Singaraja. Jurnal Pendidikan Dan Pembelajaran Bahasa Indonesia, 3(1).

Ashari, N., Suhendri, H., & Widodo, S. A. (2020). Development of Android-Based Mathematics Learning Media. SEMANTIK Conference of Mathematics Education (SEMANTIK 2019), 44-49. https://doi.org/10.2991/assehr.k.200827.115

Bolondi, G., & Ferretti, F. (2021). Quantifying Solid Findings in Mathematics Education: Loss of Meaning for Algebraic Symbols. International Journal of Innovation in Science and Mathematics Education, 29(1). https://doi.org/10.30722/IJISME.29.01.001

Bourne, J., Harris, D., & Mayadas, F. (2005). Online Engineering Education: Learning Anywhere, Anytime. Journal of Engineering Education, 94(1), 131-146. https://doi.org/10.1002/j.2168-9830.2005.tb00834.x

Chatzopoulos, A., Kalogiannakis, M., Papadakis, S., Papoutsidakis, M., Elza, D., & Psycharis, S. (2021). DuBot: An Open-Source, Low-Cost Robot for STEM and Educational Robotics. In Handbook of Research on Using Educational Robotics to Facilitate Student Learning, 441-465. https://doi.org/10.4018/978-1-7998-6717-3.ch018

Fauzi, A., Zainuddin, Z., & Atok, R. (2018). Penguatan karakter rasa ingin tahu dan peduli sosial melalui discovery learning. Jurnal Teori Dan Praksis Pembelajaran IPS, 2(2), 83-93. https://doi.org/10.17977/um022v2i22017p079

Gall, M. D., Borg, W. R., & Gall, J. P. (1996). Educational research: An introduction. Longman Publishing.

Green, N. (2002). On the move: Technology, mobility, and the mediation of social time and space. The information society, 18(4), 281-292. https://doi.org/10.1080/01972240290075129

Hakim, L. L., Alghadari, F., & Widodo, S. A. (2019). Virtual manipulatives media in mathematical abstraction. In Journal of Physics: Conference Series, 1315(1), 012017. https://doi.org/10.1088/1742-6596/1315/1/012017

Hendikawati, P., Zahid, M. Z., & Arifudin, R. (2019). Keefektifitan Media Pembelajaran Berbasis Android terhadap Kemampuan Pemecahan Masalah dan Kemandirian Belajar. In PRISMA, Prosiding Seminar Nasional Matematika, 2, 917-927.

Hidayah, I. (2015). Model of Independent Working Group of Teacher and its Effectiveness towards the Elementary School Teacher's Ability in Conducting Mathematics Learning. Procedia-Social and Behavioral Sciences, 214, 43-50. https://doi.org/10.1016/j.sbspro.2015.11.591

Hung, M. L., & Chou, C. (2015). Students' perceptions of instructors' roles in blended and online learning environments: A comparative study. Computers and Education, 81, 315-325. https://doi.org/10.1016/j.compedu.2014.10.022

Ishiguro, H. (2016). Android science. In Cognitive Neuroscience Robotics A (pp. 193-234). Springer, Tokyo. https://doi.org/10.1007/978-4-431-54595-8_9

Ibrahim, I., Sujadi, I., Maarif, S., & Widodo, S. A. (2021). Increasing Mathematical Critical Thinking Skills Using Advocacy Learning with Mathematical Problem Solving. Jurnal Didaktik Matematika, 8(1), 1-14. https://doi.org/10.24815/jdm.v8i1.19200

Imene, F., & Imhanzenobe, J. (2020). Information technology and the accountant today: What has really changed? Journal of Accounting and Taxation, 12(1), 48-60. https://doi.org/10.5897/JAT2019.0358

Jesse, G. R. (2015). Smartphone and app usage among college students: Using smartphones effectively for social and educational needs. In Proceedings of the EDSIG Conference (No. 3424).

Kaur, P., & Sharma, S. (2014). Google Android a mobile platform: A review. In 2014 Recent Advances in Engineering and Computational Sciences (RAECS), 1-5. https://doi.org/10.1109/RAECS.2014.6799598

Kates, R. W. (2010). Readings in sustainability science and technology. CID Working Paper Series.

Kouser, R., Abbas, S. S., & Azeem, M. (2014). Consumer attitudes and intentions to adopt smartphone apps: Case of business students. Pakistan Journal of Commerce and Social Sciences (PJCSS), 8(3), 763-779.

Kurniawan, S. (2008). Older people and mobile phones: A multi-method investigation. International Journal of Human-Computer Studies, 66(12), 889-901. https://doi.org/10.1016/j.ijhcs.2008.03.002

Kushwaha, A., & Kushwaha, V. (2011). Location based services using android mobile operating system. International Journal of Advances in Engineering & Technology, 1(1), 14.

Marjito, E. R., & Juniardi, K. (2019). PEMBELAJARAN IPS TERPADU DI SMP NEGERI KOTA SINGKAWANG lingkungan hidup kedua sesudah rumah di mana anak didik sekian jam setiap saat. SOSIAL HORIZON: Jurnal Pendidikan Sosial, 6(2), 233-241. https://doi.org/10.31571/sosial.v6i2.1597

Martin, W. G. (2000). Principles and standards for school mathematics (Vol. 1). National Council of Teachers.

Means, B. (2010). Technology and education change: Focus on student learning. Journal of Research on Technology in Education. https://doi.org/10.1080/15391523.2010.10782552

Murtafiah, W., Suwarno, S., & Lestari, N. D. S. (2020). Exploring the types of a material presentation by teachers in mathematics learning during the COVID-19 pandemic. In Journal of Physics: Conference Series, 1663(1), 012043. https://doi.org/10.1088/1742-6596/1663/1/012043

Mustafia, I. D., & Widodo, S. A. (2018). Problem solving skill: Effectiveness on think pair share with comic. International Journal on Teaching and Learning Mathematics, 1(2), 76-83. https://doi.org/10.18860/ijtlm.v1i2.7181

Nakamura, Y., Yoshitomi, K., & Kawazoe, M. (2018). Distance Learning, E-Learning and Blended Learning in Mathematics Education. In Distance Learning, E-Learning and Blended Learning in Mathematics Education. https://doi.org/10.1007/978-3-319-90790-1

Nurjanah, I., & Alyani, F. (2021). Kecemasan Matematika Siswa Sekolah Menengah pada Pembelajaran Matematika dalam Jaringan. Jurnal Elemen, 7(2), 407-424. https://doi.org/10.29408/jel.v7i2.3522

Nurlaily, V. A., Soegiyanto, H., & Usodo, B. (2019). Elementary School Teachers' Obstacles in the Implementation of Problem-Based Learning Model in Mathematics Learning. Journal on Mathematics Education, 10(2), 229-238. https://doi.org/10.22342/jme.10.2.5386.229-238

Nurseto, T. (2011). Membuat Media Pembelajaran yang Menarik. Ekonomi & Pendidikan, 8(1), 19-35. https://doi.org/10.21831/jep.v8i1.706

Ogawa, K., Bartneck, C., Sakamoto, D., Kanda, T., Ono, T., & Ishiguro, H. (2018). Can an android persuade you?. In Geminoid Studies, 235-247. https://doi.org/10.1007/978-981-10-8702-8_14

Papadakis, S. (2020). Evaluating a Teaching Intervention for Teaching STEM and Programming Concepts Through the Creation of a Weather-Forecast App for Smart Mobile Devices. In Handbook of Research on Tools for Teaching Computational Thinking in P-12 Education, 31-53. https://doi.org/10.4018/978-1-7998-4576-8.ch002

Papadakis, S., & Kalogiannakis, M. (Eds.). (2019). Mobile learning applications in early childhood education. IGI Global. https://doi.org/10.4018/978-1-7998-1486-3

Papadakis, S., & Kalogiannakis, M. (2022). Learning computational thinking development in young children with Bee-Bot educational robotics. In Research Anthology on Computational Thinking, Programming, and Robotics in the Classroom, 926-947. https://doi.org/10.4018/978-1-6684-2411-7.ch040

Paul, K., & Kundu, T. K. (2010). Android on mobile devices: An energy perspective. In 2010 10th IEEE International Conference on Computer and Information Technology, 2421-2426. https://doi.org/10.1109/CIT.2010.416

Permendikbud RI No 37 Tahun 2018. (2018). Permendikbud RI Nomor 37 tahun 2018 tentang Perubahan atas Peraturan Menteri Pendidikan dan Kebudayaan Nomor 24 tahun 2016 tentang Kompetensi Inti dan Kompetensi Dasar Pelajaran pada Kurikulum 2013 pada Pendidikan Dasar dan Pendidikan Menengah.

Polya, G. (2004). How to solve it: A new aspect of mathematical method (No. 246). Princeton university press.

Retnawati, H. (2016). Validitas reliabilitas dan karakteristik butir. Yogyakarta: Parama Publishing.

Rufiana, I. S., & Nurhidayah, D. A. (2021). Using a Smartphone Application (Notes) to Improve Math Learning Outcomes in Online Learning During the Covid-19 Pandemic. In 1st International Conference Of Education, Social And Humanities (INCESH 2021), 194-198.

Salomon, G. (2012). Interaction of media, cognition, and learning: An exploration of how symbolic forms cultivate mental skills and affect knowledge acquisition. Routledge.

Schoenfeld, A. H. (1987). Pólya, problem solving, and education. Mathematics magazine, 60(5), 283-291. https://doi.org/10.1080/0025570X.1987.11977325

Sheffield, L. J. (1994). The development of gifted and talented mathematics students and the National Council of Teachers of Mathematics Standards (No. 9404). DIANE Publishing.

Sijal, M. S., & Sijal, M. (2020). Integrasi Sikap Spiritual dan Sikap Sosial dalam Pendidikan Islam. Al-Ishlah: Jurnal Pendidikan Islam, 18(2), 211-231.

Sujatmika, S., Irfan, M., Ernawati, T., Wijayanti, A., Widodo, S. A., Amalia, A. F., & Rahim, R. (2019). Designing E-Worksheet Based On Problem-Based Learning To Improve Critical Thinking. ICSTI 2018, October 19-20, Yogyakarta, Indonesia, 1-8. https://doi.org/10.4108/eai.19-10-2018.2281282

Sulistyani, N., & Sa'dijah, C. (2017). Analisis Kebutuhan Pengembangan Bahan Ajar Berbasis Kearifan Lokal Kota Batu. Seminar Nasional Teknologi Pembelajaran Dan Pendidikan Dasar 2017, 836-844.

Suraji, S., Maimunah, M., & Saragih, S. (2018). Analisis kemampuan pemahaman konsep matematis dan kemampuan pemecahan masalah matematis siswa smp pada materi sistem persamaan linear dua variabel (SPLDV). Suska Journal of Mathematics Education, 4(1), 9-16. https://doi.org/10.24014/sjme.v4i1.5057

Thiagarajan, S., Semmel, D., & Semmel, M. I. (1974). Instructional Development For Training Teachers Of Exceptional Children: A Sourcebook. Minneapolis: Central for Innovation on Teaching the Handicapped.

Tilson, D., Sorensen, C., & Lyytinen, K. (2012). Change and control paradoxes in mobile infrastructure innovation: the Android and iOS mobile operating systems cases. In 2012 45th Hawaii International Conference on System Sciences, 1324-1333. https://doi.org/10.1109/HICSS.2012.149

Walker, L. (2011). My teacher is an Android: Engaging learners through an Android application. Changing Demands, Changing Directions. Proceedings ascilite Hobart, 1270-1274.

Wei, T. E., Mao, C. H., Jeng, A. B., Lee, H. M., Wang, H. T., & Wu, D. J. (2012). Android malware detection via a latent network behavior analysis. In 2012 IEEE 11th international conference on trust, security and privacy in computing and communications, 1251-1258. https://doi.org/10.1109/TrustCom.2012.91

Wellman, B. (2001). Physical place and cyberplace: The rise of personalized networking. International journal of urban and regional research, 25(2), 227-252. https://doi.org/10.1111/1468-2427.00309

Widodo, S A, Turmudi, T., Dahlan, J. A., Istiqomah, I., & Saputro, H. (2018). Mathematical Comic Media for Problem Solving Skills. International Conference on Advance & Scientific Innovation, 101-108. https://doi.org/10.4108/eai.23-4-2018.2277592

Widodo, S. A. (2018). Selection of Learning Media Mathematics for Junior School Students. Turkish Online Journal of Educational Technology-TOJET, 17(1), 154-160.

Widodo, S. A., & Ikhwanudin, T. (2018). Improving mathematical problem solving skills through visual media. In Journal of Physics: Conference Series, 948(1), 012004. https://doi.org/10.1088/1742-6596/948/1/012004

Wijayanti, N., Arigiyati, T. A., Aulia, F., & Widodo, S. A. (2021). Development of E-Worksheet on Linear Equations and Inequalities Topics Based on Tri-N. Journal of Medives: Journal of Mathematics Education IKIP Veteran Semarang, 5(2), 245-260.

Zaharah, Z., & Kirilova, G. I. (2020). Impact of Corona Virus Outbreak Towards Teaching and Learning Activities in Indonesia. SALAM: Jurnal Sosial Dan Budaya Syar-I, 7(3), 269-282. https://doi.org/10.15408/sjsbs.v7i3.15104