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Potential Implementation of Android-Based Interactive Multimedia for Student Learning Activities

Khotimatunnisa Utami[1], Muhammad Akhyar[2], Sudiyanto[3]

[1] Sebelas Maret University, Indonesia; khotimatunnisautami@student.uns.ac.id
[2] Sebelas Maret University, Indonesia; akhyar@staff.uns.ac.id
[3] Sebelas Maret University, Indonesia; soeddie.fkipuns@gmail.com

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ABSTRACT

The development of technology in the field of 21st century education has become the main complement in the teaching and learning process. Various innovations were created to support learning activities such as the use of android technology. The emergence of COVID-19 makes interactive multimedia based on Android very important to help students and teachers achieve maximum learning. The purpose of this study was to determine students' perceptions of the use of Android-based interactive multimedia in learning mathematics during the covid-19 period. This study used a survey research method using a questionnaire which involved 53 randomly selected fifth grade elementary school students. The data collection technique was carried out using a questionnaire which was distributed to a sample of the fifth grade elementary school student population. From the results of the study, it showed that 91% of students had never used interactive multimedia based on Android while 9% had used it. Data on student perceptions of the use of media during online learning shows that 85% of students agree to adopt interactive multimedia, 9% of students agree to adopt audio-visual media, and 6% agree to adopt visual media. The results of this research succeeded in identifying that most students had never used interactive multimedia during learning activities, even though in fact and interest, it turned out that students were willing to carry out the learning process using interactive multimedia, as evidenced by the results of a survey conducted regarding the types of media they agreed to adopt. . The results of this research can be used as a basis for developing an instructional product in an interactive multimedia format.

Corresponding Author:
Khotimatunnisa Utami
Sebelas Maret University, Indonesia; utamynissa67@gmail.com

1. INTRODUCTION

In this era of the industrial revolution 4.0, technology has developed very rapidly. Education providers are faced with demands to be able to create quality human resources and be able to compete both individually and collaboratively (Kowang et al., 2020; Azmi & Widiaty, 2021). Quality Human Resources (HR) will affect a person's perspective in understanding and applying their knowledge and the benefits that will be felt by oneself and the surrounding community and have more creative, critical, and professional abilities (Alvarez-Cedillo et al., 2019). The development of technology has changed human life, especially in the world of education. The use of technology in education can help teachers and students have creative and innovative learning experiences so that they can produce quality graduates (Goldin & Katz, 2018; Lim et al., 2020). The tense conditions due to COVID-19 have left students with no other choice but to study at home and learning to be carried out online (Nikou & Maslov, 2021; Pramana et al., 2021). Therefore, information technology is needed to facilitate the learning process. The use of learning media is considered important so that the learning process has variety (Shurygin et al., 2021), learning media can provide students with experience in exploring when the learning process takes place (Li & Lu, 2020; Capuno et al., 2019).

Meanwhile, mathematics is a science that has an important role needed by humans to advance their thinking power (G. L. Saputri et al., 2019). Mathematics learning is very important to be studied by elementary school students so that later they can have critical, logical qualifications, and can think systematically and creatively so that students can compete in the world of education and technology (Isnawan & Wicaksono, 2018; Samosir, 2022). Mathematics learning in schools requires a design so that students can be encouraged to have mathematical skills and understanding, communication, connections, reasoning, and problem solving (Hwang & Ham, 2021). These skills really need to be possessed by students so that students can use information to seek the widest possible experience so that they can develop and have a competitive spirit.

At school, mathematics is a compulsory subject that must be followed by all students at every level (Anwar et al., 2019). This is because mathematics is believed to be a tool as a solution to various problems in everyday life. During the process of extracting data in the field which was carried out through observing the implementation of learning activities, information was obtained if the teacher was still applying a learning model that tends to be one-way, such as lectures and assignments. It is also seen that students who take part in learning activities tend to be more passive and inactive to do practice questions in front of their friends. On the other hand, the use of learning media during the learning process is also indicated to be quite monotonous where the teacher uses print modules, student worksheets and sometimes uses audio-visual media such as shows on YouTube, this is then indicated to be one of the factors causing the low curiosity of students.

Multimedia can be used as a learning media device to improve the quality of learning. The use of interactive multimedia based on Android is considered very suitable to support students in learning, especially for explaining material and implementing learning evaluations (Budiarto et al., 2021; Han & Niu, 2019; Weng et al., 2018). Android-based media is a learning style in the 21st century generation (Mohid et al., 2018; Setiawardhani, 2021). This makes interactive multimedia based on android get the attention of researchers who finally use interactive multimedia based on android as a medium in the learning environment. Thus, teachers and students must be able to adapt to changes so that learning can take place even online at home (Drigas et al., 2020; Anderson & Rivera-Vargas, 2020). Various ways are done by teachers so that students can still study at home. Teachers are expected to show creativity and new innovations to support the learning process so that it continues well, such as using zoom media, google meet, whatsapp, google classroom, to carry out online learning or using media such as Kahoot!, Quizizz, Google form for evaluation media students (Sulistio & Qohar, 2020; Martínez-Jiménez et al., 2021; Wibawa et al., 2019; Fahmi et al., 2021). To carry out learning that is interesting and fun for students, it is necessary to have teacher skills in choosing an appropriate learning media (Nikolopoulou et al., 2021), in situations and conditions as well as the material presented, so that it can stimulate students to obtain the expected competencies.

The presence of Android as a supporting medium in the learning process makes learning easier because various kinds of information can be faster and easier (Agustini et al., 2020; Hartiyani & Ghufron, 2020). Android-based interactive multimedia is used as a learning medium because it will make it easier for teachers to deliver material to students and encourage students to study independently both in the classroom and at home (Nasrulloh & Ismail, 2018; Alfan et al., 2021; Sari et al., 2019; Hidayati et al., 2019). The learning process becomes less boring and more fun so that interactive multimedia based on Android is deemed appropriate to support students in learning mathematics (Komaro et al., 2021; Amelia & Harahap, 2021; Rahman & Aeni, 2021; Syahputra & Maksum, 2020). Other studies have also succeeded in showing that the use of android-based interactive multimedia can positively improve student learning (Sekarwangi et al., 2021; Guan et al., 2018; Untari et al., 2020). Likewise, the student's response to Android-based interactive multimedia in learning is very enjoyable.

Several research results have shown that interactive multimedia has various good impacts on improving student academic achievement. As mentioned earlier as in the research conducted by Sekarwangi et al. (2021), Guan et al. (2018), Untari et al. (2020), Nasrulloh & Ismail (2018) Alfan et al. (2021), Sari et al. (2019), Hidayati et al. (2019). This is certainly a reminder to all people that the importance of the presence of ICT-based learning media in this case is Android-based interactive multimedia to support the student learning process. The successful implementation of these learning products to improve student academic achievement certainly cannot be separated from a preliminary study that has been carried out, several researches that have been conducted by Budiarto et al. (2020), Widya et al. (2021), Ambarsari et al. (2021) shows the importance of a needs analysis study for a product development. This research adopts by adjusting several things such as the type of media that will be used as an innovation, which is focused on interactive multimedia based on Android, and research subjects that focus on elementary school students. Considering some of these studies, the focus of research is on subjects with higher levels of education, such as colleges, high schools, and junior high schools.

In line with this, the use of technology is currently mostly used in communication technology, both cellular and using internet technology (Li & Lu, 2020; Machmud et al., 2021). The presence of android communication technology makes a great opportunity in the world of education to be able to develop learning media (Qodr et al., 2021; Sari et al., 2019). Multimedia can be explained as an integrated presentation on a computer-based interactive communication system (Raji, 2019; Roemintoyo et al., 2022). Multimedia consists of elements of text, animation, graphics, video, and sound that are arranged and presented in different ways (Weng et al., 2018; Jabar & Ahmad, 2018). The use of interactive multimedia will be effective if the development of learning uses guidelines in designing both in terms of appearance and material (D. Y. Saputri et al., 2018; Budiarto et al., 2021b). Not only interesting learning media are obtained by the teacher, but students are also given space to imagine and engage effectively by the teacher during the learning process (Rais Ruli, 2019; Manurung & Panggabean, 2020).

Learning media innovation is still an obstacle for teachers, it is true that there are many factors that need to be considered in order to develop a learning media innovation product. The first step, of course, is to conduct a needs analysis, as will be done in this study. Where the research will focus on identifying student needs for the presence and innovation of learning media needed and in accordance with student characteristics. On the other hand, the development and improvement of the quality of learning is expected to help students master various competencies that are relevant and they need. Interactive multimedia is one type of innovation and solution for learning mathematics. Taking the theme of the material that focuses on learning mathematics certainly cannot be separated from several researches which show that there is very little of a product and preliminary research activities that identify the need for ICT-based learning media innovations, especially with elementary school students research subjects. We know that currently the presence of technology can certainly provide hope to facilitate the learning process to be more dynamic and interactive. As one of the subjects that is considered sufficient to require repetition of training, the integration between ICT and mathematics material is expected to be able to provide options for students to practice and learn interactively.

Based on the various descriptions and research results presented, it is important to be able to bring innovation in the learning process. Interactive multimedia that can be operated on a smartphone is seen to be able to have a positive impact on the achievement of student competencies. Therefore, this study aims to identify the needs of students in presenting innovations that are in accordance with the characteristics and needs of the field, namely the identification of smartphone-based interactive multimedia needs.

2. METHODS

Adopting this type of qualitative research with survey methods (Sugiyono, 2018), this research is expected to be able to explore the potential for developing and utilizing Android-based interactive multimedia, so that there is a match between needs and future applications. The population of this study was elementary school students in Bulus Pesantern District, Central Java, with a total sample of the study selected at random (random sampling) in certain schools of 53 elementary school students who were in class Five (5).

The data collection technique uses a non-test technique, namely a questionnaire (Elangovan & Sundaravel, 2021) followed by the research instrument in the form of questionnaire items that explore students' opinions regarding the use of Android-based interactive multimedia. The instrument items used in this study adopted questions from the needs analysis research conducted by (Hanif et al., 2018; Qodr et al., 2021). The validity of the instrument is measured by consulting experts or commonly known as expert judgment (Widoyoko, 2018), before all the questions are distributed to the entire research sample. The results of the student responses were then analyzed using the percentage technique (Bustanil S et al., 2019; Qodr et al., 2021) to then find out the number of student responses to several items they answered in the needs analysis questionnaire.

Data retrieval is done by way of the researcher enters the class and introduces himself and tries to show various types of media that can be used during learning activities. After that, the researchers distributed a needs analysis questionnaire regarding the potential for developing and utilizing Android-based interactive multimedia as one of the media that will be used in schools in the next few periods. This study focuses on students' perceptions of the use of Android-based interactive multimedia in learning mathematics in fifth grade elementary school. The questionnaire used in this study was in the form of questions about the types of media used during the mathematics learning process. In addition, questions related to students' experiences in using Android-based interactive multimedia.

3. FINDINGS AND DISCUSSION

Referring to Figure 1, regarding the types of media used by the teacher when delivering mathematical material. The results of student responses indicate that, a total of 66% of teachers have used or utilized audio-visual media which is usually presented in the form of learning videos, as a medium in explaining learning materials. This was followed by the opinion of students who stated that 28% of teachers had used visual media which were usually presented in the form of pictures, posters, and infographics. In addition, student responses also stated that 6% of teachers had used audio media, such as podcasts and radio, to be integrated into mathematics learning in elementary schools. These results are also strengthened through observation activities carried out during learning activities, from observations that was confirmed that the learning process is still using printed material books, and other materials in the form of audio-visual sources from YouTube.

These data indicate that the media that is often used by teachers is audio-visual media, considering that teachers seem to find it easier to find learning resources in the form of audio-visuals through various kinds of videos, as well as animations to make it easier for students to learn the material. This is one indicator that shows the large opportunity to use digital media in interactive multimedia format, because most students are used to learning to use pictorial media, combined with voice narration in the learning media they use.

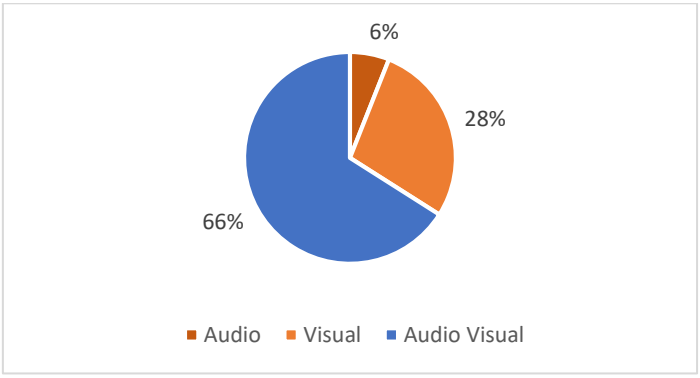

Figure 1. Types of Media Used by Teachers

It can be seen in Figure 2, related to the results of students' exploration of experiences in using Android-based interactive multimedia devices or applications. Student responses showed that almost 91% of students stated that they had never used Android-based interactive multimedia, and 9% of students stated that they had never used interactive multimedia in Android format and installed it on their smart devices, besides that they sometimes access The Ministry of Education and Culture's Learning House and Teacher's Room are interactive multimedia applications that can be run on Android. Learning that has not yet fully run normally after the Covid-19 wave requires teachers to be more creative in choosing and being able to integrate the use of various digital media formats for learning activities, specifically learning mathematics.

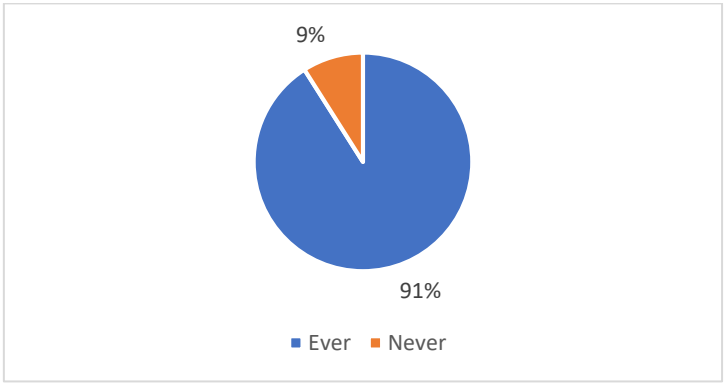

Figure 2. Student Experience Using Android-Based Interactive Multimedia

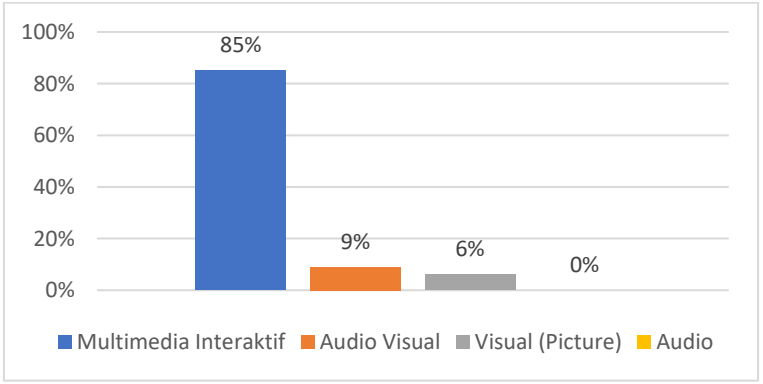

Figure 3. Students' Perception of Android-Based Interactive Multimedia Development

Referring to Figure 3, it can be seen that almost all of the students expressed their agreement and interest in interactive multimedia (85%), followed by 9% of students who stated that they were more likely to adopt media with audio-visual types or formats, a total of 6% of students who agreed to adopt media. visual and no students choose to use audio media to serve as learning media. These results certainly indicate that overall, students expect a learning innovation that comes through the development of ICT-based interactive media, namely interactive multimedia.

Discussion

In line with what is described in the method, the display of data that appears in the research results comes from a description of the percentage of questionnaire results distributed to students. Some of the things identified were regarding the types of media used by teachers, students' experiences in using Android-based interactive multimedia, and how students' opinions on the development of Android-based interactive multimedia could later be applied to learning activities.

The rapid development of technology basically presents great potential to support learning activities (Machmud et al., 2021), the presence of technology such as interactive multimedia based on Android will make it easier for students to achieve learning goals and master various 21st century skills (Martínez-Marquez, 2021; Tabrani et al., 2021). Besides that, subject matter packaged into interactive multimedia tends to be more interactive, dynamic, fun and informative as the characteristics inherent in it (Kasim et al., 2021; Hasyim et al., 2020), and are able to include various other elements such as audio, visual, text, animation to audio visual (Lutfi et al., 2021; Mohid et al., 2018).

In line with the results of the study which showed that teachers had basically used learning media in audio, visual and audio-visual formats. However, in its utilization, it still tends to be separate and not integrated with one another, this indicates that ICT has not been optimally utilized for the learning process considering that currently there are many learning media formats that are more interactive, innovative and flexible to use. Considering the benefits and positive impacts, the results of optimal use of ICT to manage the learning process will also come, where students will be more motivated to learn, so that students' independence will increase to study wherever and whenever (Hakim, 2021; Kursch, 2021). One technology that can facilitate learning activities without being limited by space and time is a smartphone, especially one that uses the Android operating system (Sari et al., 2019; Haryanti et al., 2021). It is undeniable that currently, Android (smartphones) are widely used in various fields of human life (Elmunsyah et al., 2019). Based on the results of the questionnaire distributed to research subjects, it shows that smartphones have a very large opportunity to support learning activities, through integration between learning media in interactive multimedia format but can be operated on smartphones. This opportunity arises, one of which is due to the function of the smartphone as a technological device, affordable, high flexibility, easy to supervise its use when in class and almost all students are familiar with the presence of smartphones (Qodr et al., 2021; Alfan et al., 2021).

The real form of the presence of ICT in the learning process is the emergence of a variety of new models, strategies and learning media. One of them is interactive multimedia, interactive multimedia is one of the trends in learning media formats that are familiarly used at various levels of education throughout the world (Syawaludin et al., 2019; Roemintoyo et al., 2022; Kurniawan et al., 2019). The current trend of using multimedia for learning can be said to have increased, this is suspected to be the demand for education in which graduates are not only proficient in cognitive aspects, but also must be able to master skills in other aspects according to the needs of the 21st century where interactive multimedia has quite a contribution to make. facilitate the needs of these graduates (Sulaiman & Ismail, 2020; ÖNÜR & KOZİKOĞLU, 2020; Han & Niu, 2019). This is in line with the results of the study which showed that the majority of students agreed to the development and use of interactive multimedia to support learning activities, as seen from the survey obtained that 85% of students were interested in the presence of interactive multimedia. One of the factors that causes high student interest in the presence of multimedia is the various advantages inherent in it, such as interactive, dynamic, attractive

appearance, and having the ability to stimulate independent learning activities (Rais Ruli, 2019; Manurung & Panggabean, 2020; Ruth Iwanger, 2018).

In addition, interactive multimedia technology can also be filled with material that is not only in the form of text or narration, but can be filled with material, text, images, to audio-visual (Lutfi et al., 2021), as the results of this study show that so far Media with audio-visual format has been used by teachers, the presence of interactive multimedia will be able to accommodate this, not eliminate it. Another thing that becomes the advantage of interactive multimedia is the flexibility of operating interactive multimedia which is also quite good where interactive multimedia can later be operated via computers and smartphones (Han & Niu, 2019; Qodr et al., 2021).

ICT-based learning media innovation is very much needed in the education aspect which is currently leading to the era of society 5.0 (Lim et al., 2020). The many benefits of Android-based interactive multimedia as a learning medium to support and facilitate student learning activities can be a form of real innovation for educators to implement in the learning process (Alfan et al., 2021; Widodo et al., 2020). Innovation in this case certainly has the aim of making it easier for students to participate in learning activities. It can be seen that the magnitude of the potential for using Android-based interactive multimedia cannot be separated from the many empirical facts that have proven that those who have previously used Android-based interactive multimedia have succeeded in having a significant impact and contribution in achieving learning goals (Shamir et al., 2019; Hussain, 2018; Dewi et al., 2019). Then, the results of this study are certainly important considering that needs analysis research is the initial step and foundation so that there is a match between the conditions of field facts and needs in the field with learning products that are expected to solve problems that occur in the field.

Based on various studies related to the positive impact of using interactive multimedia in learning activities as well as needs analysis research as a foothold so that problem solving is right on target, it can be seen that Android-based interactive multimedia can be said to have the potential to be an innovative learning media for elementary school students to make it easier for them to learn mathematics. The results of the distribution of questionnaires that show students' interest in the presence of interactive multimedia based on Android can be a need that must be fulfilled and realized, so that later it can have a positive impact on student academic achievement.

Through the results of this study, other researchers can use it as a basis for developing Android-based interactive multimedia products for learning activities in other subjects, while taking into account student characteristics, user resource capabilities, and the availability of facilities (eg smartphones). However, this research is still limited to the needs analysis process, which of course can still be developed further by other researchers who have an interest in improving and innovating in the ICT-based learning process.

4. CONCLUSION

In general, this study shows the results that there are great opportunities for the development of Android-based interactive multimedia for learning activities in the classroom, not only because students are interested but also many benefits that will be obtained by students in understanding the learning material. This can be seen from the responses of students who almost agree to the presence of Android-based interactive multimedia in learning activities, especially learning mathematics. It is also undeniable that, many research results find empirical facts that the use of Android-based interactive multimedia is preferred by students, because it is interactive, dynamic, and easily accessible to both students and teachers. This research can be used as a basis for teachers to improve their competence in designing digital learning media for the subjects being taught. Other researchers can try to develop an interactive multimedia learning application based on smartphones in various subjects to measure the level of effectiveness.

Conflicts of Interest: The authors declare no conflict of interest.

REFERENCES

Agustini, M., Yufiarti, & Wuryani. (2020). Development of learning media based on android games for children with attention deficit hyperactivity disorder. *International Journal of Interactive Mobile Technologies*, *14*(6). https://doi.org/10.3991/IJIM.V14I06.13401

Alfan, M., Khasairi, M., Nurhidayati, N., & Maziyah, L. (2021). Interactive Android Based Learning Media sebagai Inovasi Pembelajaran Membaca Bahasa Arab di Perguruan Tinggi: Desain Pengembangan Rekursif, Reflektif, dan Kolaboratif. *Jurnal Pendidikan: Teori, Penelitian, Dan Pengembangan*, *5*(10). https://doi.org/10.17977/jptpp.v5i10.14112

Alvarez-Cedillo, J., Aguilar-Fernandez, M., Sandoval-Gomez, R. J., & Alvarez-Sanchez, T. (2019). Actions to be taken in Mexico towards education 4.0 and society 5.0. *International Journal of Evaluation and Research in Education (IJERE)*, *8*(4), 693–698. https://doi.org/10.11591/ijere.v8i4.20278

Ambarsari, R., Sartono, E. K. E., Mustadi, A., Zubaidah, E., Jhon, W., & Rafsanzani, M. A. (2021). Needs Analysis for the Development of Electronic Story Calender Media to Improve Spirit of Nationalism. *Journal of Education Research and Evaluation*, *5*(3), 398–405. https://ejournal.undiksha.ac.id/index.php/JERE/article/view/33281

Amelia, D. P., & Harahap, A. (2021). Application of Interactive Multimedia-Based Mathematics Learning Media to Increase Students' Interest in Learning. *Budapest International Research and Critics Institute (BIRCI-Journal): Humanities and Social Sciences*, *4*(2), 3153–3161. https://doi.org/10.33258/birci.v4i2.2040

Anderson, T., & Rivera-Vargas, P. (2020). A Critical look at Educational Technology from a Distance Education Perspective. *Digital Education Review*, *37*, 208–229. https://doi.org/10.1344/der.2020.37.208-229

Anwar, M. S., Choirudin, C., Ningsih, E. F., Dewi, T., & Maseleno, A. (2019). Developing an Interactive Mathematics Multimedia Learning Based on Ispring Presenter in Increasing Students' Interest in Learning Mathematics. *Al-Jabar : Jurnal Pendidikan Matematika*, *10*(1), 135–150. https://doi.org/10.24042/ajpm.v10i1.4445

Azmi, C., & Widiaty, I. (2021). ICT-based e-learning implementation. *IOP Conference Series: Materials Science and Engineering*, *1098*(2), 022109. https://doi.org/10.1088/1757-899x/1098/2/022109

Budiarto, M. K., Joebagio, H., & Sudiyanto, S. (2020). Student's View of Using Digital Learning Media in Classroom Activities: A Case of Public Senior High School in Cirebon, Indonesia. *Jurnal Pendidikan Progresif*, *10*(1), 47–54. https://doi.org/10.23960/jpp.v10.i1.202006

Budiarto, M. K., Rejekiningsih, T., & Sudiyanto, S. (2021a). Students' opinions on the need for interactive multimedia development for entrepreneurship learning. *International Journal of Evaluation and Research in Education (IJERE)*, *10*(4), 1290–1297. https://doi.org/http://doi.org/10.11591/ijere.v10i4.21411

Budiarto, M. K., Rejekiningsih, T., & Sudiyanto, S. (2021b). Students' opinions on the need for interactive multimedia development for entrepreneurship learning. *International Journal of Evaluation and Research in Education (IJERE)*, *10*(4), 1290. https://doi.org/10.11591/ijere.v10i4.21411

Bustanil S, M., Asrowi, & Adianto, D. T. (2019). Pengembangan Media Pembelajaran Interaktif Berbasis Video Tutorial Di Sekolah Menengah Kejuruan. *JTP - Jurnal Teknologi Pendidikan*, *21*(2), 119–134. https://doi.org/10.21009/jtp.v21i2.11568

Capuno, R., Revalde, H., Etcuban, J. O., Aventuna, M., Medio, G., & Demeterio, R. A. (2019). Facilitating Learning Mathematics Through the Use of Instructional Media. *International Electronic Journal of Mathematics Education*, *15*(1). https://doi.org/10.29333/iejme/5785

Dewi, R. K., Wardani, S., Wijayati, N., & Sumarni, W. (2019). Demand of ICT-based chemistry learning media in the disruptive era. *International Journal of Evaluation and Research in Education*, *9*(2), 265–270. https://doi.org/10.11591/ijere.v8i2.17107

Drigas, A., Dede, D. E., & Dedes, S. (2020). Mobile and other applications for mental imagery to improve learning disabilities and mental health. In *International Journal of Computer …*. https://www.researchgate.net/profile/Athanasios_Drigas/publication/343737338_Mobile_and_ot

her_applications_for_mental_imagery_to_improve_learning_disabilities_and_mental_health/links/5f3ce7c792851cd302039129/Mobile-and-other-applications-for-mental-imager

Elangovan, N., & Sundaravel, E. (2021). Method of preparing a document for survey instrument validation by experts. *MethodsX*, *8*. https://doi.org/10.1016/j.mex.2021.101326

Elmunsyah, H., Hidayat, W. N., & Asfani, K. (2019). Interactive learning media innovation: utilization of augmented reality and pop-up book to improve user's learning autonomy. *Journal of Physics: Conference Series*, *1193*, 012031. https://doi.org/10.1088/1742-6596/1193/1/012031

Fahmi, A. N., Yusuf, M., & Muchtarom, M. (2021). Integration of Technology in Learning Activities: E-Module on Islamic Religious Education Learning for Vocational High School Students. *Journal of Education Technology*, *5*(2), 282–290. https://doi.org/10.23887/jet.v5i2.35313

Goldin, C., & Katz, L. F. (2018). The Race Between Education and Technology. In *Inequality in the 21st Century* (pp. 49–54). Routledge. https://doi.org/10.4324/9780429499821-10

Guan, N., Song, J., & Li, D. (2018). On the Advantages of Computer Multimedia-aided English Teaching. *Procedia Computer Science*, *131*, 727–732. https://doi.org/10.1016/j.procs.2018.04.317

Hakim, B. (2021). Role of ICT in the process of EFL teaching and learning in an Arab context. *Humanities and Social Sciences Letters*, *9*(1), 58–71. https://doi.org/10.18488/JOURNAL.73.2021.91.58.71

Han, M., & Niu, S. (2019). Effect of Computer Multimedia Assisted Word Annotation on Incidental Vocabulary Acquisition of English Reading. *International Journal of Emerging Technologies in Learning (IJET)*, *14*(13), 21. https://doi.org/10.3991/ijet.v14i13.10705

Hanif, M., Asrowi, A., & Sunardi, S. (2018). Students' Access to and Perception of Using Mobile Technologies in the Classroom: the Potential and Challenges of Implementing Mobile Learning. *Journal of Education and Learning (EduLearn)*, *12*(4), 644–650. https://doi.org/10.11591/edulearn.v12i4.8398

Hartiyani, S. D., & Ghufron, A. (2020). Pengembangan dan kelayakan multimedia berbasis android untuk pembelajaran bahasa arab di islamic boarding school bina umat. *Kwangsan: Jurnal Teknologi Pendidikan*, *8*(2), 275. https://doi.org/10.31800/jtp.kw.v8n2.p275--289

Haryanti, A., Yusuf, M., & Agung, L. (2021). Students' Perceptions About the Use of Android-Based Learning Media in Physical Education Learning. *AL-ISHLAH: Jurnal Pendidikan*, *13*(2), 836–842. https://doi.org/10.35445/alishlah.v13i2.633

Hasyim, N., Gani, H. A., & Hatta, S. (2020). Android Based Multimedia Learning for Vocational High Schools. *Journal of Educational Science and Technology (EST)*. https://doi.org/10.26858/est.v6i2.14275

Hidayati, N., Pangestuti, A. A., & Prayitno, T. A. (2019). Edmodo mobile: developing e-module biology cell for online learning community. *Biosfer*, *12*(1). https://doi.org/10.21009/biosferjpb.v12n1.94-108

Hussain, Z. (2018). the Effects of Ict-Based Learning on Students' Vocabulary Mastery in Junior High Schools in Bandung. *International Journal of Education*, *10*(2), 149–156. https://doi.org/10.17509/ije.v10i2.7592

Hwang, J., & Ham, Y. (2021). Relationship between mathematical literacy and opportunity to learn with different types of mathematical tasks. *Journal on Mathematics Education*, *12*(2), 199–222. https://doi.org/10.22342/JME.12.2.13625.199-222

Isnawan, M. G., & Wicaksono, A. B. (2018). Model Desain Pembelajaran Matematika. *Indonesian Journal of Mathematics Education*, *1*(1), 47. https://doi.org/10.31002/ijome.v1i1.935

Jabar, S. A., & Ahmad, A. C. (2018). The Design of Multimedia Interactive Courseware for Teaching Reading to Hearing Impaired Students. *International Journal of Academic Research in Progressive Education and Development*, *7*(4). https://doi.org/10.6007/ijarped/v7-i4/4849

Kasim, J. J. F., Haryanto, H., & Katili, F. (2021). Design of interactive multimedia mobile learning base on Android operating system for Biology subjects. *IOP Conference Series: Materials Science and Engineering*, *1098*(3), 032016. https://doi.org/10.1088/1757-899x/1098/3/032016

Komaro, M., Suherman, A., Arifn, M. F. T., Putra, R. H., Darmawan, B., Ana, A., & Muktiarni, M. (2021). Development of android-based multimedia application to overcome the difficulty of problem-solving in the Fe-C Phase Diagram subject. *Journal of Engineering Science and Technology*, *16*(5),

4149–4159.

Kowang, T. O., Bakry, M. F., Hee, O. C., Fei, G. C., Yew, L. K., Saadon, M. S. I., & Long, C. S. (2020). Industry 4.0 competencies among lecturers of higher learning institution in Malaysia. *International Journal of Evaluation and Research in Education (IJERE)*, *9*(2), 303. https://doi.org/10.11591/ijere.v9i2.20520

Kurniawan, W., Darmaji, D., Astalini, A., Kurniawan, D. A., Hidayat, M., Kurniawan, N., & Farida, L. Z. N. (2019). Multimedia physics practicum reflective material based on problem solving for science process skills. *International Journal of Evaluation and Research in Education*, *8*(4), 590–595. https://doi.org/10.11591/ijere.v8i4.20258

Kursch, M. (2021). Impact of a one-off demonstration on the use of ict in the teaching of andragogy students on their change of attitude towards the use of ict in education. *International Journal of Cognitive Research in Science, Engineering and Education*, *9*(1), 121–134. https://doi.org/10.23947/2334-8496-2021-9-1-121-134

Li, Y., & Lu, S. J. (2020). Research on physical education system model using multimedia technology. *Multimedia Tools and Applications*, *79*(15–16), 10461–10474. https://doi.org/10.1007/s11042-019-08366-7

Lim, C. P., Ra, S., Chin, B., & Wang, T. (2020). Leveraging information and communication technologies (ICT) to enhance education equity, quality, and efficiency: case studies of Bangladesh and Nepal. *Educational Media International*, *57*(2), 87–111. https://doi.org/10.1080/09523987.2020.1786774

Lutfi, S., Ismatullah, K., & Nur Kholiso, Y. (2021). Developing Interactive Learning Multimedia for Mathematics Subject in Junior High School Grade VIII Student East Lombok. *Indonesian Journal of Innovation and Applied Sciences (IJIAS)*, *1*(2), 105–112. https://doi.org/10.47540/ijias.v1i2.237

Machmud, M. T., Widiyan, A. P., & Ramadhani, N. R. (2021). The development and policies of ICT supporting educational technology in Singapore, Thailand, Indonesia, and Myanmar. *International Journal of Evaluation and Research in Education (IJERE)*, *10*(1), 78–85. https://doi.org/10.11591/ijere.v10i1.20786

Manurung, S. R., & Panggabean, D. D. (2020). Improving students' thinking ability in physics using interactive multimedia based problem solving. *Jurnal Cakrawala Pendidikan*, *39*(2), 460–470. https://doi.org/10.21831/cp.v39i2.28205

Martínez-Jiménez, R., Pedrosa-Ortega, C., Licerán-Gutiérrez, A., Ruiz-Jiménez, M. C., & García-Martí, E. (2021). Kahoot! as a tool to improve student academic performance in business management subjects. *Sustainability (Switzerland)*, *13*(5). https://doi.org/10.3390/su13052969

MARTÍNEZ-MARQUEZ, M. A. (2021). ICT uses in education. Theoretical framework proposal for its characterization and analysis. *Journal of Systems and Educational Management*, 16–23. https://doi.org/10.35429/jsem.2021.22.8.16.23

Mohid, S. Z., Ramli, R., Rahman, K. A., & Shahabudin, N. N. (2018). Teknologi multimedia dalam pendidikan abad 21. *International Research Management & Innovation Conference*, 1–9. http://rmc.kuis.edu.my/irmic/wp-content/uploads/2018/09/IRMIC18-pendidikan-alaf-21-multimedia-Dr-Zaharah.pdf

Nasrulloh, I., & Ismail, A. (2018). Analisis kebutuhan pembelajaran berbasis ict. *Jurnal Pendiidkan Teknologi Informasi Dan Komunikasi (PETIK)*, *3*(1), 28–32. https://doi.org/10.31980/jpetik.v3i1.355

Nikolopoulou, K., Gialamas, V., Lavidas, K., & Komis, V. (2021). Teachers' Readiness to Adopt Mobile Learning in Classrooms: A Study in Greece. *Technology, Knowledge and Learning*, *26*(1), 53–77. https://doi.org/10.1007/s10758-020-09453-7

Nikou, S., & Maslov, I. (2021). An analysis of students' perspectives on e-learning participation – the case of COVID-19 pandemic. *International Journal of Information and Learning Technology*, *38*(3), 299–315. https://doi.org/10.1108/IJILT-12-2020-0220

ÖNÜR, Z., & KOZİKOĞLU, İ. (2020). The Relationship between 21 st Century Learning Skills and Educational Technology Competencies of Secondary School Students. *Journal of Theoretical Educational Science*, *13*(1), 65–77.

http://dergipark.gov.tr/akukegDOInumber:http://dx.doi.org/10.30831/akukeg.535491

Pramana, C., Susanti, R., Ernawati, K., Darmawan, I. P. A., Miftah, M. Z., Lestyowati, J., Werdiningsih, R., & Ramadhani, R. (2021). Distance Learning In Primary Schools During The Covid-19 Pandemic In Indonesia: Challenges, Solutions, And Projections. *Turkish Journal of Computer and Mathematics Education (TURCOMAT)*, *12*(4), 263–270. https://doi.org/10.17762/turcomat.v12i4.502

Qodr, T. S., Efendi, A., & Musadad, A. A. (2021). Opportunities for Using Smartphones in the Digital Era to Facilitate Students in Learning Sociology in High Schools. *Journal of Education Technology*, *5*(2), 263–271. https://doi.org/10.23887/jet.v5i2.34806

Rahman, T., & Aeni, S. Q. (2021). Android-based learning media design for introduction to sunda culture for early children. *Journal of Early Childhood Education (JECE)*, *3*(1), 52–64. https://doi.org/10.15408/jece.v3i1.20229

Rais Ruli, A. (2019). Aplikasi Modul Pembelajaran Berbasis Interactive Multimedia Learning Pada Paud Garasi Jakarta Menggunakan Metode Mimba – Aiueo. *IKRA-ITH INFORMATIKA : Jurnal Komputer Dan Informatika*, *3*(2), 49–58. https://journals.upi-yai.ac.id/index.php/ikraith-informatika/article/view/318

Raji, B. (2019). Significance and challenges of computer assisted education programs in the UAE: A case study of higher learning and vocational education. *Education and Information Technologies*, *24*(1), 153–164. https://doi.org/10.1007/s10639-018-9767-6

Roemintoyo, R., Miyono, N., Murniati, N. A. N., & Budiarto, M. K. (2022). Optimising the utilisation of computer-based technology through interactive multimedia for entrepreneurship learning. *Cypriot Journal of Educational Sciences*, *17*(1), 105–119. https://doi.org/10.18844/cjes.v17i1.6686

Ruth Iwanger, S. (2018). Effect of Multimedia Instructional Approach on Mid Basic Ii Pupils' Interest and Retention in Basic Science. *International Journal of Scientific and Research Publications (IJSRP)*, *8*(11), 343–384. https://doi.org/10.29322/ijsrp.8.11.2018.p8339

Samosir, E. (2022). Kemampuan Literasi Matematika: Kaitannya dengan Kemampuan Pemecahan Masalah. *Jurnal Riset Pendidikan Matematika Jakarta*, *4*(1), 60–72. https://doi.org/10.21009/jrpmj.v4i1.23026

Saputri, D. Y., Rukayah, R., & Indriayu, M. (2018). Need Assessment of Interactive Multimedia Based on Game in Elementary School: A Challenge into Learning in 21st Century. *International Journal of Educational Research Review*, *3*(3), 1–8. https://doi.org/10.24331/ijere.411329

Saputri, G. L., Wardono, W., & Karisudin, I. (2019). Pentingnya Kemampuan Literasi Matematika dan Pembentukan Kemampuan 4C dengan Strategi REACT (Relating, Experiencing, Applying, Cooperating, Transferring). *PRISMA, Prosiding Seminar Nasional Matematika*, *2*, 563–571.

Sari, A. I., Suryani, N., Rochsantiningsih, D., & Suharno. (2019). The development of Android-based smartphone learning application on teaching reading comprehension. *AIP Conference Proceedings*, 020112. https://doi.org/10.1063/1.5139844

Sekarwangi, T., Sartono, K. E., Mustadi, A., & Abdulah, A. (2021). The Effectiveness of Problem Based Learning-Based Interactive Multimedia for Elementary School Students. *International Journal of Elementary Education*, *5*(2), 308. https://doi.org/10.23887/ijee.v5i2.31603

Setiawardhani, R. T. (2021). Android-Based Multimedia Development and Worthiness for Economic Learning in High School. *AL-ISHLAH: Jurnal Pendidikan*, *13*(2), 1185–1193. https://doi.org/10.35445/alishlah.v13i2.559

Shamir, H., Yoder, E. H., Pocklington, D. B., & Feehan, K. C. (2019). Computer-Assisted Instruction: Long-Term Effects on Early Literacy Skills of Low Socioeconomic Status Students. *International Journal of Information and Education Technology*, *9*(4), 263–267. https://doi.org/10.18178/ijiet.2019.9.4.1210

Shurygin, V., Berestova, A., Litvinova, T., Kolpak, E., & Nureyeva, A. (2021). Universal Models and Platforms in E-Learning. *International Journal of Emerging Technologies in Learning*, *16*(9), 63–75. https://doi.org/10.3991/ijet.v16i09.19697

Sugiyono. (2018). Metode penelitian kuatintatif , kualitatif dan R & D. In *Bandung: Alfabeta*.

Sulaiman, J., & Ismail, S. N. (2020). Teacher competence and 21st century skills in transformation schools 2025 (TS25). *Universal Journal of Educational Research*, *8*(8), 3536–3544. https://doi.org/10.13189/ujer.2020.080829

Sulistio, W., & Qohar, A. (2020). Development of Instructional Media "Game Math Comic Story" Based Android on Number. *Journal of Education Research and Evaluation*, *4*(2), 109. https://doi.org/10.23887/jere.v4i2.22370

Syahputra, F., & Maksum, H. (2020). The Development of Interactive Multimedia Learning in Information and Communication Technology Subjects. *Journal of Education Research and Evaluation*, *4*(4), 428–434. https://doi.org/10.23887/jere.v4i4.29931

Syawaludin, A., Gunarhadi, G., & Rintayati, P. (2019). Development of Augmented Reality-Based Interactive Multimedia to Improve Critical Thinking Skills in Science Learning. *International Journal of Instruction*, *12*(4), 331–344. https://doi.org/10.29333/iji.2019.12421a

Tabrani, M. B., Puspitorini, P., & Junedi, B. (2021). Pengembangan multimedia interaktif berbasis Android pada materi kualitas instrumen evaluasi pembelajaran matematika. *Jurnal Inovasi Teknologi Pendidikan*, *8*(2). https://doi.org/10.21831/jitp.v8i2.42943

Untari, R. S., Kamdi, W., Dardiri, A., Hadi, S., & Nurhadi, D. (2020). The development and application of interactive multimedia in project-based learning to enhance students' achievement for 2D animation making. *International Journal of Emerging Technologies in Learning*, *15*(16), 17–30. https://doi.org/10.3991/ijet.v16i16.16521

Wanyama, T. (2017). Using industry 4.0 technologies to support teaching and learning. *International Journal of Engineering Education*, *33*(2), 693–702.

Weng, F., Yang, R.-J., Ho, H.-J., & Su, H.-M. (2018). A TAM-Based Study of the Attitude towards Use Intention of Multimedia among School Teachers. *Applied System Innovation*, *1*(3), 1–9. https://doi.org/10.3390/asi1030036

Wibawa, R. P., Astuti, R. I., & Pangestu, B. A. (2019). Smartphone-Based Application "quizizz" as a Learning Media. *Dinamika Pendidikan*, *14*(2), 244–253. https://doi.org/10.15294/dp.v14i2.23359

Widodo, W., Sudibyo, E., Suryanti, Sari, D. A. P., Inzanah, & Setiawan, B. (2020). The effectiveness of gadget-based interactive multimedia in improving generation z's scientific literacy. *Jurnal Pendidikan IPA Indonesia*, *9*(2), 248–256. https://doi.org/10.15294/jpii.v9i2.23208

Widoyoko, E. P. (2018). Teknik Penyusunan Instrumen Penelitian Pendidikan Kimia. *Yogyakarta: Pustaka Pelajar*, *15*(April).

Widya, Maielfi, D., & Alfiyandri. (2021). Need Analysis for Physics E-Module Based on Creative Problem Solving Integrated 21st Century Skills. *Journal of Physics: Conference Series*, *1940*(1). https://doi.org/10.1088/1742-6596/1940/1/012110