Development of Android-Based Teaching Material in Software Engineering Subjects for Informatics Engineering Students

https://doi.org/10.3991/ijep.v11i2.16299

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Abstract—The research aimed to develop Android-based teaching material to improve the understanding of Software Engineering of Informatics Engineering students whose validity and effectiveness are measured. The method used in this paper is Research and Development (R&D) with the Analysis, Design, Development, Implementation, and Evaluation (ADDIE) model which is used to develop Android-based teaching material. The validity of teaching material product has confirmed by media experts and material experts in their fields. The effectiveness of the product was measured through the post-test only control group design with two groups of Informatics Engineering students in Higher Education involving 57 people. Data collection was carried out through questionnaires and tests, with descriptive analysis for the results of the validation of teaching material and pilot tests and t-tests for testing the effectiveness of teaching material. The results showed that Android-based teaching material is easy to use and has video tutorial features and quiz menus that provide direct feedback to users, so teaching material can be applied as a valid and effective learning media in increasing student understanding of Software Engineering material which has never been applied in the research location so far. Based on the results obtained, further research can be carried out on a broader subject and pay attention to other aspects such as increasing motivation and metacognitive students of Informatics Engineering.

Keywords—Android-based teaching material, software engineering, informatics engineering, higher education

1 Introduction

The important thing to prepare Information Engineering graduates in the 4.0 Industrial Revolution era is the integration of technology in the realm of learning [1], [2]. In developing countries, the integration of technology in learning becomes an aspect that is considered to provide more effective learning [3], [4]. In the realm of learning, technology becomes one of the bases for developing learning materials ranging from the application of learning technology to the integration of technology in teaching material [5], [6]. Innovative technology-based teaching material is useful to facilitate the implementation of learning, which leads to the success of learning [7], [8]. Supported by the results of previous studies, learning innovations such as teaching material that integrate technology can improve student learning outcomes [9], [10].

Currently, Android device technology is on first ranks from mobile devices which used by the public, especially devices owned by students [11], [12]. At the moment, Android-based devices are not only used for telephone or chatting but also additional functions like learning devices based on mobile learning [13]–[15]. This is in line with one of UNESCO's missions to integrate ICT into learning [16], [17]. One form of integration can be in the kind of learning innovations using Android-based devices.

However, Informatics Engineering teaching material, especially Software Engineering materials, are generally still in the form of conventional teaching material such as text-based teaching material and eBooks that are often considered by students as monotonous learning media [18]. Mobile technology-based teaching material such as Android are still few and have not varied [19], [20]. Moreover, Software Engineering material is one of the focuses of the Informatics Engineering study program. This is because students will get the ability to carry out software development that can be applied by students after graduating in the world of work through Software Engineering material [21], [22] according to the embodiment of vocational education in the realm of tertiary institutions to match the criteria of their field [23]–[25].

The explanation above inspired the writer to develop innovative Android-based teaching material to increase students' understanding of Software Engineering material. Therefore, this research aimed to make Android-based teaching material innovation that could improve the understanding of Software Engineering students of Informatics Engineering as well as the measurement validity and effectiveness.

1.1 Research purpose

The research objective in this paper is to develop valid and effective Android-based teaching material. The validity of Android-based teaching material is tested through validation by both media and material experts, while its effectiveness is measured based on the increased understanding of Informatics Engineering Software Engineering students.

1.2 Research question and hypotheses

The research question of this paper is: "How is the effectiveness of Android-based teaching material?" The answers to this research question can be revealed by measuring the difference between the understanding of students who learn Software Engineering material using conventional teaching material and students who use Android-based teaching material. Therefore, the research hypothesis can be formulated as follows:

- H_0: The use of Android-based teaching material is not effective for increasing students' understanding of Software Engineering.
- H_a: The use of Android-based teaching material is effective for increasing students' understanding of Software Engineering.

The hypothesis is measured by calculating the significance of differences in the understanding of students who use conventional teaching materials with those of students who use Android-based teaching material. If there is a significant difference and the students' mastery of understanding using Android-based teaching material is higher than students' mastery of understanding using conventional teaching material, then the Android-based teaching material is said to be effective.

2 Literature Review

2.1 Android-based teaching materials

Teaching materials will be useful in learning, especially learning in class. With the teaching materials, learning materials from the teacher will be transmitted to students so that the knowledge and abilities expected according to the learning outcomes will be obtained by [26]. Nowadays, the integration of information technology into the subject is done by teachers to be able to assist student learning, such as the integration of technology in teaching materials [27]. Recent technological advances in education have encouraged the implementation of technology in its integration in teaching materials, which are expected to help teacher to teach and increase the student interest [28]. Android as one of the popular mobile devices used by the public [11], [12] became one of the platforms that began to be used as a medium for student learning in class. Therefore, Android-based teaching materials are learning materials that are embedded into the Android platform, such as mobile phones and tablets. Android-based devices can act as mediators in learning experiences and allow learning designs that provide authentic learning experiences [29].

2.2 Previous research review

Technology integration as a teaching material platform is expected to improve students' learning outcomes. This is based on the results of previous studies as follows. Research related to learning using mobile-based devices shows a positive contribution to student achievement [30]. Group that uses Android-based mobile learning show

better performance than group that does not use mobile learning. The developed mobile learning can be used as an appropriate complementary course delivery method.

Research related to the development of an Android-based music learning platform shows an increase in the achievement and quality of students in learning music [31]. Music learning can be enhanced with an Android-based learning platform. In addition, the awareness and understanding of students in music major can be increased, as well as providing innovation in music teaching.

The development of Android-based instructional media shows an increase in scientific literacy of students [32]. Android-based instructional media can be used as an effective teaching material. This is shown by the results of the pretest-posttest in the group of students who use Android-based media is higher than the group of students who does not use the media.

Research related to the development of an Android-based Listening Learning System shows a positive effect on students [33]. The produced Android-based Listening Learning System is very effective and in accordance with the needs of students. The results showed an increase in students' listening skills after they use of the developed Android-based Listening Learning System.

Another research related Android-based teaching material such as the development of English Vocabulary Mobile Apps shows an increase in understanding and motivation of kindergarten students in English learning [34]. Construction of quiz education mobile games in this mobile application shows the curiosity of student in using that developed mobile application. Student interest in learning can be enhanced with this mobile app.

Development of Math Trails for Enhanced by mobile learning realistic mathematics education shows good results in primary education [35]. Mobile devices are used by students to measure the dimensions of objects in the real world to solve mathematical problems. The results show that student learning can be improved through mobile teaching materials developed by applying what is learned in the classroom to authentic situations.

3 Method

The Research and Development (R&D) model used in this study was the Analysis, Design, Development, Implementation, and Evaluation (ADDIE) model with steps including Analysis, Design, Development, Implementation, and Evaluation [36]–[38]. The representation of ADDIE steps can be seen in Figure 1.

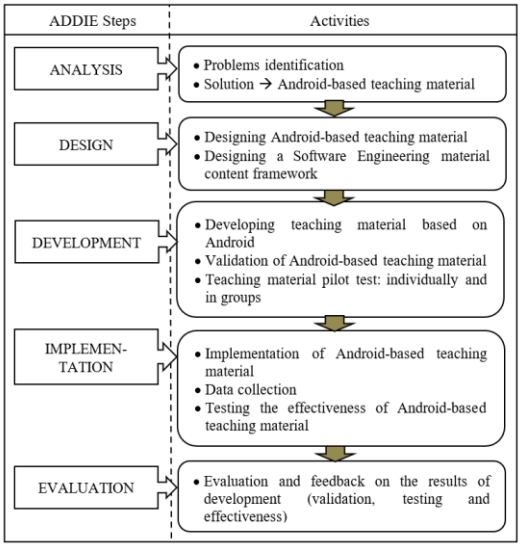

Fig. 1. ADDIE Research and Development Flow

(Source: study of reference [36]–[38] and adapted to the product being developed)

Figure 1 can be explained as follows. The Analysis phase was marked by the identification of problems that needed to be solved and overcome with solutions in the form of teaching material products to be developed [36]. Design phase was the elaboration of the analysis phase for the expected product development design starting from the design of Android-based teaching material and the design of the material framework [37]. The Development phase was characterized by facilitating the design phase by integrating technology into the process of developing teaching material product for later validation and testing [38]. The Implementation phase was marked by the implementation of Android-based teaching material in the classroom to test its effectiveness [36]. The Evaluation phase was marked by justifying the achievement of goals from Android-based teaching material developed [37].

Data collection techniques used in this article were questionnaires and tests. The questionnaire was created to find out the feasibility of the media, the truth of learning material in the media, and students' interest in the media that had been developed. The instrument used in this study was closed questionnaire sheets in the form of questionnaires with 4 Likert scales, including worst or very improper, bad or improper, good or feasible, and excellent or very decent [39]. The frame of the questionnaire used referred to the aspects and criteria of assessment of instructional media including aspects of the application in software, learning design, and visual communication [40], [41]. The assessment criteria were obtained from the average value of these aspects: (1) if the average value is in the range of 1.00 to 1.75, teaching material are invalid and forbidden to use; (2) if the average value is in the range of 1.76 to 2.51, the teaching material are invalid and need major improvement; (3) if the average value is in the range of 2.52 to 3.27, the teaching material are valid and need minor improvement; and (4) if the average

value is in the range of 3.28 to 4.00, the teaching material is very valid and is suitable to be used as teaching material.

The test was used at the implementation stage to measure the effectiveness of developed Android-based teaching material. The effectiveness of Android-based teaching material was measured by using a posttest-only control group in 57 Informatics Engineering students in Higher Education who were divided into two groups, namely control groups with learning using conventional teaching material and experimental groups with learning using Android-based teaching material. The data obtained were analyzed using an independent sample t-test (significance 5%) using IBM SPSS Statistics 25. If sig $\leq \alpha$ (5%), it is concluded that there is a significant influence between the use of Android-based teaching material on student understanding [42].

4 Results

This section is describing results and presenting it based on ADDIE Steps. The explanation is following.

Step 1: Analysis

The Analysis phase was carried out with the identification of problems and overcome with solutions in the form of teaching material products [38]. Problem identification carried out at the analysis stage shows that students who received Software Engineering courses tend not to be able to apply the Software Engineering theory into real practice. This was partly due to the lack of innovative teaching material and not easily understood by students. So far, the teaching material available are only text-based teaching material and eBooks.

The solution offered from these problems was Android-based teaching material. Android-based teaching material was developed in Software Engineering courses that were expected to measure their validity and effectiveness.

Step 2: Design

The Design phase was characterized by designing teaching materials based on the needs that have been outlined in the Analysis phase [36]. The design of Android-based teaching material developed had valid Software Engineering materials and had video tutorials and quizzes to measure student understanding. The design of instructional materials was developed based on instructional analysis by determining the expected final abilities along with indicators and competency mapping from the syllabus for later integrated into Android-based teaching material by following the indicators.

The design content framework for teaching material is shown in Figure 2.

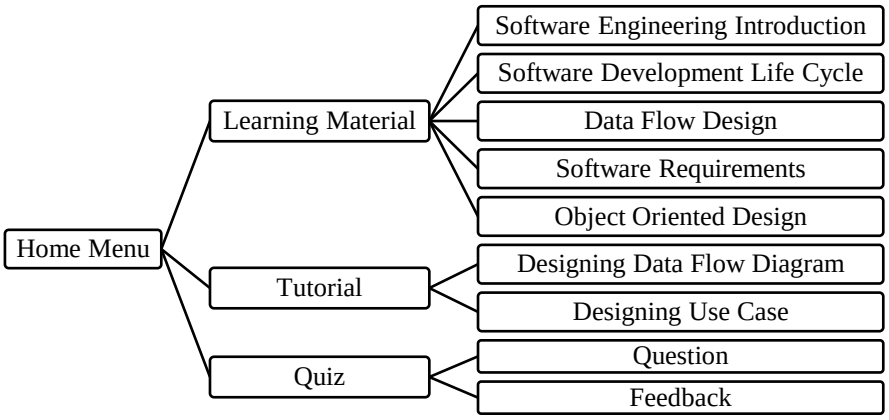

Fig. 2. Content Framework for Teaching Material

(Source: review from the material from the Software Engineering text book [43], [44])

Based on Figure 2, it is known that Android-based teaching material developed have 3 main menus namely (1) material, (2) video tutorials, and (3) quizzes. The material was obtained based on instructional analysis of Software Engineering courses and obtained 5 main materials including (1) Software Engineering Introduction, (2) Software Development Life Cycle, (3) Data Flow Design, (4) Software Requirements, and (5) Object-Oriented Design. The tutorial menu included video tutorials in Data Flow Diagram design and Use Case Diagram. The quiz menu included questions on each material accompanied by feedback to users.

Step 3: Development

Software Engineering materials with video tutorials were integrated into Android-based teaching material using Adobe Flash CC with AIR for Android target output. Android device specifications that can be used to operate Android-based teaching material are (1) at least have an Android OS version 4.0 Ice Cream Sandwich, (2) at least ARMv7 / x86 processor with FPU vector with minimum speed of 550MHz, OpenGL ES 2.0, H.264 and AAC HW decoders, and (3) the recommended device resolution is 9:5 with an optimum resolution of 720 × 1280 pixels. The screenshot of Android-based teaching material is shown in Figure 3.

Fig. 3. Screenshot of Android-Based Teaching Material, from left to right: home menu, material display, and menu quiz display

(Source: output of development results)

Figure 3 shows that Android-based teaching material has 3 main menus (material, video tutorials, and quizzes) and 1 additional menu in the form of information on the use of teaching material. The material menu displayed materials related to Software Engineering dividing into 5 chapters according to the material framework in Figure 2. In the quiz menu, students could measure their understanding of teaching material with direct feedback displayed on the screen.

Validation was carried out to determine the validity of Android-based teaching material product including validation by media experts and material experts. The follow up of the validation results was in the form of revision of teaching material and subject material if there were suggestions for improvement to Android-based teaching material.

The pilot test run was used to determine the feasibility of Android-based teaching material with Informatics Engineering study program students as the object of the pilot test. The pilot test design included individual pilot tests (one to one) and field pilot tests in groups [36]. The revision of teaching material was carried out to improve teaching material as feedback from the pilot test questionnaire. The results of the validation questionnaire from each expert and pilot test are shown in Table 1.

Table 1. Android-Based Teaching Material Validation Results

No.	Aspect	Mean Score			
		Media Expert	***Material Expert***	***Individual Pilot test***	***Group Pilot test***
1.	Application in Software	3,54	3,56	3,20	3,35
2.	Learning Design	3,22	3,37	3,08	3,68
3.	Visual Communication	3,70	3,62	3,20	3,28
Average		**3,53**	**3,49**	**3,16**	**3,43**

(Source: calculation results using IBM SPSS Statistics at the 5% significance level)

The Table 1 illustrates the mean of media experts and material experts in the range of 3.01 to 4.00 which indicated that the Android-based teaching material produced was very feasible or excellent. These results were in line with the results of individual pilot tests that produced a mean of 3.16 and group pilot test results that produced a mean of 3.43. From these results, it can be concluded that Android-based teaching material was very decent and excellent. Although overall this teaching material was declared to be very valid and does not need to be revised, improvements still need to be done to produce better teaching material. Some of the revisions that were done including general revisions were made based on the findings obtained during the development of learning media products. General revisions made included (1) improvement of illustration images that are still unvivid and too small, (2) video tutorial integration into YouTube because if it is included in the application the application size will be too large, and (3) giving explanations in several illustrations.

Step 4: Implementation

The implementation phase was marked by the implementation of Android-based teaching material into classroom learning. Data collection was carried out by conducting student understanding tests using Android-based teaching material. The data collected was used for testing the effectiveness of Android-based teaching material and compared to groups using conventional teaching material such as textbooks and eBooks. Fifty-seven students were involved in this stage with 29 students in the control group (with conventional teaching material) and 28 students in the experimental group (with Android-based teaching material). The test used was a test of student understanding after using Android-based teaching material then the test results of each group were tested using an independent sample t-test. Rumusan hipotesis yang dapat dirumuskan adalah sebagai berikut.

– H_0: $\mu_{conventional} = \mu_{android}$

There is no significant difference between students' mastery of understanding using conventional teaching material and students' mastery of understanding using Android-based teaching material.

– Ha: $\mu conventional \neq \mu android$

There is a significant difference between students' mastery of understanding using conventional teaching material and students' mastery of understanding using Android-based teaching material.

The summary of the results of the t-test using IBM SPSS Statistics 25 is shown in Table 2.

Table 2. Summary of t-test results

No.	Group	Number of Samples	Mean	Standard Deviaton	t-test for Equality of Means		
					t	*df*	*sig*
1.	Control group (conventional)	29	73,52	6,081	-7,111	55	0,000
2.	Experimental group (Android)	28	83,57	4,434			

(Source: calculation results using IBM SPSS Statistics at the 5% significance level)

Table 2 shows the sig value on the t-test of 0,000 (t value of -7,111). This shows that there is a significant difference between students' mastery of understanding using conventional teaching material and students' mastery of understanding using Android-based teaching material with an average value of student understanding using Android-based teaching material (73.52) higher than the average value understanding of students who used conventional teaching material (83.57). Furthermore, the use of Android-based teaching material had a significant effect on student understanding. Therefore, H0 is rejected. In other words, the use of Android-based teaching material is effective for students' in increasing student understanding of Software Engineering. This follows some previous research results that the use of teaching material based on Android can increase students' understanding [30], [32].

Step 5: Evaluation

Based on the previous stages, it is known that Android-based teaching material successfully developed with 3 main menus, namely material, video tutorials, and quizzes. Teaching material developed that ran on devices with a minimum operating system Android version 4.0 Ice Cream Sandwich can be used as one of the valid and effective learning media. The t-test results of the average understanding of students were significantly different with an average difference in student understanding who used Android-based teaching material with those who used conventional teaching material as big as 10.05. Since this research only focused on the development of teaching material from the instructional analysis of Software Engineering courses, it was not considered the motivation and metacognitive aspects of students according to previous research that both aspects also have a positive effect on student understanding [45], [46]. Therefore, the development of Android-based teaching material can give more attention to these aspects.

5 Discussion

In this study, the ADDIE method was used to develop Android-based teaching material in the Software Engineering course. The ADDIE method implemented in this study is referred to theoretical and previous studies [36]–[38] which are adapted to the

product being developed and material from the Software Engineering text book [43], [44].

Based on the review of previous scholars, the ADDIE is an effective method in developing learning media products [36], [37], including teaching materials. This is reinforced by the results of this study which indicate that Android-based teaching material that have been successfully developed are considered valid and effective as shown in steps 3 (Development) and 4 (Implementation).

The validation stage is an important stage in developing instructional media products [47]. Validation involving both media and material experts will direct the teaching material product to be better and more suitable for use before being pilot tested to prospective users [48], [49]. Individual and group pilot tests show the satisfaction of prospective users of the teaching materials being developed, so that researchers can find out the shortcomings that can arise if Android-based teaching material products are actually implemented in step 4 (Implementation).

The effectiveness stage in this study proves the successness of Android-based teaching material in increasing student understanding of Software Engineering material. The effectiveness test was shown by the results of different tests between the results of students' mastery of understanding using conventional teaching material and students' mastery of understanding using Android-based teaching material. The result shows that there is a significant difference between students' mastery of understanding using conventional teaching material and students' mastery of understanding using Android-based teaching material. In addition, the average value of student understanding using Android-based teaching material is higher than the average value understanding of students who used conventional teaching material. This shows that the use of Android-based teaching material can encourage better understanding of Software Engineering material so that it is more effectively used than conventional teaching materials, in line with the results of other studies [15], [50]. Based on the review of previous scholars, it is known that Android-based teaching materials are more practical and can be used anywhere [51], [52]. In addition, the use of Android-based teaching material is an innovation in Software Engineering learning which so far only uses eBooks and text-based media, like the results of previous studies [53], [54]. Therefore, the research question in this study was answered by proving the hypothesis that the use of Android-based teaching material is effective to increase student understanding of Software Engineering material.

As the results of the study in step 5 (Evaluation), research has not considered the student motivation and metacognitive aspects which according to previous research that both aspects also have a positive effect on student understanding [55], [56]. This is caused by the limitation of the research with Software Engineering material which is based on instructional analysis conducted by researchers at the research location. In addition, the implementation of the test is limited to two classes with a limited number of students. Therefore, further research can be carried out on: (1) a wider subject; (2) broader material and develop advanced material in accordance with instructional analysis such as Software Design Analysis material; and (3) paying attention to other aspects such as student motivation and metacognitive.

6 Conclusion

Android-based teaching material is successfully developed through the ADDIE steps. Step 1 (Analysis) is characterized by identifying problems related to the lack of innovative teaching materials and describing solutions in the form of Android-based teaching material. Step 2 (Design) is characterized by designing teaching materials through instructional analysis in the form of indicators and competencies mapping from the syllabus of the Software Engineering course. Stage 3 (Development) is marked by the integration of Software Engineering material and video tutorials into Android-based teaching material that can be run on devices with an Android operating system at least version 4.0 Ice Cream Sandwich. This stage leads to validation both of media and material experts as well as individually and groups pilot testing of potential users. Stage 4 (Implementation) is characterized by the integration of developed Android-based teaching material into classroom learning and testing its effectiveness. Based on effectiveness testing, it is known that Android-based teaching material can be used to improve student understanding of Software Engineering material effectively. Based on stage 5 (Evaluation) it is concluded that developed Android-based teaching material is empirically proven to be used as one of valid and effective learning media in increasing students' understanding of Software Engineering material. The existence of quiz features to measure student understanding with direct feedback and video tutorial features facilitated students in learning Software Engineering material. Besides, Android-based teaching material can be easily installed on Android devices with a minimum version of 4.0 Ice Cream Sandwich so that they can be used as teaching material that can be accessed by anyone and anywhere.

The limitations of this study only focused on the results of the instructional analysis of the Software Engineering material and the implementation of testing was limited to two classes with a limited number of students. Therefore, further research can be carried out on broader subjects or advanced material and pay attention to other aspects such as students' motivation and metacognitive aspects.

7 Acknowledgement

Our sincere thanks are addressed to the Endowment Fund for Education (LPDP) Ministry of Finance Republic of Indonesia (Kemenkeu Republik Indonesia) as a funder of this research project through BUDI-DN scholarship.

8 References

[1] P. C. Lin, Y. C. Liour, and H. M. Chen, "How incorporation of information technology in teaching affects learning satisfaction: A case study," World Trans. Eng. Technol. Educ., vol. 14, no. 3, pp. 387–393, 2016.

[2] D. G. H. Divayana, A. Adiarta, and I. G. Sudirtha, "Instruments Development of Tri Kaya Parisudha -Based Countenance Model in Evaluating the Blended Learning," *Int. J. Eng. Pedagog.*, vol. 9, no. 5, pp. 55–74, 2019. https://doi.org/10.3991/ijep.v9i5.11055

[3] A. L. Cloete, "Technology and education: Challenges and opportunities," *HTS Teol. Stud. / Theol. Stud.*, vol. 73, no. 4, pp. 1–7, 2017, doi: 10.4102/hts.v73i4.4589.
[4] T. Mcaleavy, A. Hall-Chen, S. Horrocks, and A. Riggall, "Technology-supported professional development for teachers: lessons from developing countries London Connected Learning Centre," Berkshire, 2018.
[5] M. R. Ahmadi, "The Use of Technology in English Language Learning: A Literature Review," *Int. J. Res. English Educ.*, vol. 3, no. 2, pp. 115–125, 2018.
[6] H. J. Chen, L. L. Liao, Y. C. Chang, C. C. Hung, and L. C. Chang, "Factors influencing technology integration in the curriculum for taiwanese health profession educators: A mixed-methods study," *Int. J. Environ. Res. Public Health*, vol. 16, no. 14, pp. 1–16, 2019, https://doi.org/10.3390/ijerph16142602
[7] C. A. Monserate, "Impact of Technology on the Academic Performance of Students and Teaching Effectiveness," *Int. J. Interdiscip. Res. Innov.*, vol. 6, no. 1, pp. 47–87, 2018.
[8] W. Y. Hsiung, "The use of e-resources and innovative technology in transforming traditional teaching in chemistry and its impact on learning chemistry," *Int. J. Interact. Mob. Technol.*, vol. 12, no. 7, pp. 86–96, 2018, https://doi.org/10.3991/ijim.v12i7.9666
[9] N. H. Hashim, M. F. M. Yaakob, M. R. Yusof, and M. Y. Ibrahim, "Innovative behavior among teachers: Empirical evidence from high-performance schools," *Int. J. Innov. Technol. Explor. Eng.*, vol. 8, no. 10, pp. 1395–1399, 2019, doi: 10.35940/ijitee.J9015.0881019.
[10] D. A. Udu, "Innovative practices in science education: a panacea for improving secondary school students' academic achievement in science subjects in Nigeria," *Glob. J. Educ. Res.*, vol. 17, no. 1, p. 23, 2018, https://doi.org/10.4314/gjedr.v17i1.4
[11] M. Haris, B. Jadoon, M. Yousaf, and F. H. Khan, "Evolution of Android Operating System: a Review," *Asia Pacific J. Contemp. Educ. Commun. Technol.*, vol. 4, no. 1, pp. 178–188, 2018, doi: 10.25275/apjcectv4i1ict2.
[12] P. Hendikawati, M. Z. Zahid, and R. Arifudin, "Android-based Computer Assisted Instruction development as a learning resource for supporting self-regulated learning," *Int. J. Instr.*, vol. 12, no. 3, pp. 389–404, 2019, https://doi.org/10.29333/iji.2019.12324a
[13] H. Elmunsyah, W. N. Hidayat, and K. Asfani, "Interactive learning media innovation: Utilization of augmented reality and pop-up book to improve user's learning autonomy," *J. Phys. Conf. Ser.*, vol. 1193, no. 1, 2019, https://doi.org/10.1088/1742-6596/1193/1/012031
[14] M. Saputra, T. F. Abidin, B. I. Ansari, and M. Hidayat, "The feasibility of an Android-based pocketbook as mathematics learning media in senior high school," *J. Phys. Conf. Ser.*, vol. 1088, 2018, https://doi.org/10.1088/1742-6596/1088/1/012056
[15] S. Kadry and B. Ghazal, "Design and assessment of using smartphone application in the classroom to improve students' learning," *Int. J. Eng. Pedagog.*, vol. 9, no. 2, pp. 17–34, 2019, https://doi.org/10.3991/ijep.v9i2.9764
[16] A. S. Ahmar and A. Rahman, "Development of teaching material using an Android," *Glob. J. Eng. Educ.*, vol. 19, no. 1, pp. 72–76, 2017, doi: 10.26858/gjeev19i1y2017p7376.
[17] R. F. Daling, "Accepting ICT Integration : A Challenge to School and Curriculum," *Int. J. Educ. Res.*, vol. 6, no. 9, pp. 163–180, 2018.
[18] I. Agustina and D. Astuti, "The Use of Pocket Mobile Learning to Improve Critical Thinking Skills in Physics Learning," *Int. J. Recent Contrib. from Eng. Sci. IT*, vol. 6, no. 4, pp. 80–86, 2018. https://doi.org/10.3991/ijes.v6i4.8877
[19] G. Lovászová, M. Cápay, and V. Michaličková, "Learning Activities Mediated by Mobile Technology: Best Practices for Informatics Education," in *CSEDU 2016 - Proceedings of the 8th International Conference on Computer Supported Education*, 2016, vol. 2, no. Csedu, pp. 394–401, https://doi.org/10.5220/0005862303940401

[20] O. D. Nurhayati and K. T. M, "Mobile-based learning design with android development tools," *2014 1st Int. Conf. Inf. Technol. Comput. Electr. Eng.*, pp. 203–207, 2015.
[21] T. Verhoeff, "Programming, software development, and computer science – the golden triangle," *Olympiads in Informatics*, vol. 13, pp. 157–170, 2019, https://doi.org/10.15388/ioi.2019.10
[22] G. Pour, "Component-based development refining the blueprint of software engineering education," *World Trans. Eng. Technol. Educ.*, vol. 2, no. 1, pp. 45–48, 2003.
[23] A. P. Sasmito, "Work Readiness of Software Engineering Student in Batu City," 2017, vol. 116, no. International Conference On Vocational Education And Training (ICOVET 2017) Work, pp. 67–70. https://doi.org/10.2991/icovet-17.2017.13
[24] D. Almog, H. Chasidim, and S. Mark, "Quality and testing - new teaching approaches for software engineers," *World Trans. Eng. Technol. Educ.*, vol. 16, no. 2, pp. 140–145, 2018.
[25] A. P. Sasmito, D. Kustono, Purnomo, and H. Elmunsyah, "Role of Self Efficacy in Dual Expertise Vocational Teacher Achievement," *Int. J. Innov. Creat. Chang.*, vol. 11, no. May, pp. 219–236, 2020.
[26] R. Bušljeta, "Effective Use of Teaching and Learning Resources," *Czech-Polish Hist. Pedagog. J.*, vol. 5, no. 2, pp. 55–69, 2013, doi: 10.2478/cphpj-2013-0014.
[27] M. Lin, H. Chen, and K.-S. Liu, "A Study of the Effects of Digital Learning on Learning Motivation and Learning Outcome," *EURASIA J. Math. Sci. Technol. Educ.*, vol. 13, no. 7, pp. 3553–3564, 2017, https://doi.org/10.12973/eurasia.2017.00744a
[28] T. Koparan, "Analysis of Teaching Materials Developed by Prospective Mathematics Teachers and Their Views on Material Development.," *Malaysian Online J. Educ. Technol.*, vol. 5, no. 4, pp. 8–28, 2017.
[29] I. K. Suartama, P. Setyosari, Sulthoni, and S. Ulfa, "Development of an instructional design model for mobile blended learning in higher education," *Int. J. Emerg. Technol. Learn.*, vol. 14, no. 16, pp. 4–22, 2019, https://doi.org/10.3991/ijet.v14i16.10633
[30] B. Klimova, "Impact of mobile learning on students' achievement results," *Educ. Sci.*, vol. 9, no. 2, 2019, doi: 10.3390/educsci9020090.
[31] J. Tong, "Design and implementation of music teaching platform in college based on android mobile technology," *Int. J. Emerg. Technol. Learn.*, vol. 11, no. 5, pp. 4–9, 2016, https://doi.org/10.3991/ijet.v11i05.5686
[32] I. I. Farida, J. Jumadi, W. Wilujeng, and S. Senam, "Developing android-based science instructional media to improve scientific literacy of junior high school students," *J. Phys. Conf. Ser.*, vol. 1006, no. 1, 2018, https://doi.org/10.1088/1742-6596/1006/1/012034
[33] H. Huang, "Design and Implementation of a College English Listening Learning System Based on Android Platform," *Int. J. Emerg. Technol. Learn.*, vol. 13, no. 7, pp. 43–56, 2018, https://doi.org/10.3991/ijet.v13i07.8779
[34] G. I. W. Tamtama, P. Suryanto, and Suyoto, "Design of english vocabulary mobile apps using gamification: An Indonesian case study for kindergarten," *Int. J. Eng. Pedagog.*, vol. 10, no. 1, pp. 105–162, 2020, https://doi.org/10.3991/ijep.v10i1.11551
[35] G. Fessakis, P. Karta, and K. Kozas, "Designing math trails for enhanced by mobile learning realistic mathematics education in primary education," *Int. J. Eng. Pedagog.*, vol. 8, no. 2, pp. 49–63, 2018, https://doi.org/10.3991/ijep.v8i2.8131
[36] N. Aldoobie, "ADDIE Model," *Am. Int. J. Contemp. Res.*, vol. 5, no. 6, pp. 68–82, 2015.
[37] I. Göksu, K. V. Özcan, R. Cakir, and Y. Göktas, "Content analysis of research trends in instructional design models: 1999-2014," *J. Learn. Des.*, vol. 10, no. 2, p. 85, 2017, https://doi.org/10.5204/jld.v10i2.288
[38] A. Rossett and J. W. Arwady, *Training Needs Assessment Techniques in Training and Performance Development Series*. New Jersey: Educational Technology Publications, 2002.

[39] A. Joshi, S. Kale, S. Chandel, and D. Pal, "Likert Scale: Explored and Explained," *Br. J. Appl. Sci. Technol.*, vol. 7, no. 4, pp. 396–403, 2015, https://doi.org/10.9734/bjast/2015/14975.
[40] R. S. Wahono, "Aspek dan Kriteria Penilaian Media Pembelajaran," 2006. .
[41] S. Siagian, P. N. J. M. Sinambela, and Y. Wau, "Development of an interactive e-learning model for an instructional design course," *World Trans. Eng. Technol. Educ.*, vol. 15, no. 3, pp. 298–304, 2017.
[42] M. R. Spiegel and L. J. Stephens, *Theory and Problems of Statistics*. New York: The McGraw-Hill Companies, Inc, 2008.
[43] I. Sommerville, *Software Engineering*, 6th editio. Wokingham: Addison-Wesley Pub Co, 2000.
[44] R. S. Pressman, *Software Engineering: A Practitioner's Approach*, 5th editio. Auckland: Mc Graw-Hill, 2001.
[45] N. Ahmad, N. F. Jumaat, N. A. Samah, Z. M. Ashari, A. H. Abdullah, and D. F. Ali, "The effect of metacognitive scaffolding framework towards students' performance," *Int. J. Recent Technol. Eng.*, vol. 7, no. 6, pp. 1584–1593, 2019.
[46] Y. D. Puspitarini and M. Hanif, "Using Learning Media to Increase Learning Motivation in Elementary School," *Anatol. J. Educ.*, vol. 4, no. 2, pp. 53–60, 2019.
[47] T. Alodwan and M. Almosa, "The Effect of a Computer Program Based on Analysis, Design, Development, Implementation and Evaluation (ADDIE) in Improving Ninth Graders' Listening and Reading Comprehension Skills in English in Jordan," *English Lang. Teach.*, vol. 11, no. 4, p. 43, 2018, https://doi.org/10.5539/elt.v11n4p43
[48] F. S. Arista and H. Kuswanto, "Virtual physics laboratory application based on the android smartphone to improve learning independence and conceptual understanding," *Int. J. Instr.*, vol. 11, no. 1, pp. 1–16, 2018, https://doi.org/10.12973/iji.2018.1111a
[49] S. M. Alnajdi, "The Effectiveness of Designing and Using a Practical Interactive Lesson based on ADDIE Model to Enhance Students' Learning Performances in University of Tabuk," *J. Educ. Learn.*, vol. 7, no. 6, p. 212, 2018, https://doi.org/10.5539/jel.v7n6p212
[50] E. Kartikadarma, T. Listyorini, and R. Rahim, "An Android mobile RC4 simulation for education," *World Trans. Eng. Technol. Educ.*, vol. 16, no. 1, pp. 75–79, 2018.
[51] R. D. Agustin and M. Ambarawati, "Mathematics encyclopedia media as android based learning," *Int. J. Sci. Technol. Res.*, vol. 8, no. 9, pp. 1–4, 2019.
[52] S. V. Susilo, T. P. Ferga, Y. Abidin, and T. Mulyati, "Mobile learning android based teaching materials: Efforts to provide Indonesian learning based on technology in elementary school," *J. Phys. Conf. Ser.*, vol. 1477, no. 4, 2020. https://doi.org/10.1088/1742-6596/1477/4/042034
[53] F. Hasyim, T. Prastowo, and B. Jatmiko, "The Use of Android-Based PhET Simulation as an Effort to Improve Students' Critical Thinking Skills during the Covid-19 Pandemic," *Int. J. Interact. Mob. Technol.*, vol. 14, no. 19, p. 31, 2020, https://doi.org/10.3991/ijim.v14i19.15701
[54] M. Zatulifa, Riswandi, H. Fitriawan, and Akla, "Application Based Android As A Development Of English Learning Media," *IOSR J. Res. Method Educ.*, vol. 8, no. 4, pp. 66–72, 2018, doi: 10.9790/7388-0804036672.
[55] R. Yulika, U. Rahman, and A. M. Sewang, "The Effect of Emotional Intelligence and Learning Motivation on Student Achievement," in *1st International Conference on Advanced Multidisciplinary Research (ICAMR 2018) Part of series*, 2019, vol. 227, no. Icamr 2018, pp. 386–389, https://doi.org/10.2991/icamr-18.2019.94

[56] Purnamawati, U. Mulbar, and Saliruddin, "The development of metacognition-based learning media for the industrial electronics field in a vocational high school," *World Trans. Eng. Technol. Educ.*, vol. 15, no. 1, pp. 82–87, 2017.

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Article submitted 2020-06-14. Resubmitted 2021-01-06. Final acceptance 2021-01-06. Final version published as submitted by the authors.