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The Application of Physics Learning Media Based on Android with Learning Problem Based Learning (PBL) to Improve Critical Thinking Skills

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ABSTRACT
One of the abilities that students must have in the 21st century is the ability to think critically. This study aims to see the use of Android-based physics learning media using PBL learning to improve critical thinking skills in Newton's Law material. This type of research is the pretest posttest control group design. The study was aimed at students of class X SMA Negeri 1 Tempilang with sample selection using random cluster sampling. The selected class is X MIPA 1 as the implementation class and X MIPA 2 as the control class. The data collection was in the form of a critical thinking skill test that was tested before and after learning. The collected data were analyzed using the N-gain test to determine the increase in critical thinking skills. The results of the N-gain analysis show that the Android-based physics learning media with the PBL model in the implementation class is in the high category, while the control class is in the medium category.The results of the analysis obtained that the use of Android-based physics learning media with PBL learning can improve students' critical thinking skills.

Keywords: *Physics Learning Media Based on Android, Problem Based Learning, Critical Thinking Skills.*

1. INTRODUCTION

The era of the industrial revolution 4.0 brought major changes to the field of education known as Education 4.0. Education 4.0 is a response to the needs of the 4.0 revolution where humans and technology are harmonized to enable new possibilities [1]. Education 4.0 which focuses on developing education and skills has made learning in the future [2]. In line with the era of the industrial revolution 4.0, 21st century skills are learning that students must have.

21st Century Skills seeks to identify and help students acquire the skills needed. learning skills according to assessment and teaching of the assessment and teaching of twenty-first century skills (ATCS) which categorize 21st century skills into four ways of thinking, ways of working, tools for work, and living in the world [3]. Thinking skills are one of the demands that must be met by students in learning. Regardless of the skills included or the terms used to describe them all, 21st century skills are relevant to aspects of contemporary life in a complex world. Most focus on the complex types of thinking, learning, and communication skills, and all are more demanding for teaching and learning skills rather than memorization. This ability focuses on developing higher-order thinking skills [4]. In addition, the main basis students must have in developing higher-order thinking is by emphasizing critical thinking skills [5]. The ability to think critically is a requirement that must be had in learning physics [6], [7]. The development of students' critical thinking skills is considered as one of the most important goals of education [8], [9]. However, students' critical thinking skills are still lacking [10], [11]. Learners still have difficulty analyzing the relationship between concepts [12],

difficulty understanding formulas, and difficulties in solving problems in learning physics [13]. Contextual learning is still lacking in learning [14]. This problem requires learning that involves students in contextual learning that connects to real life.

Learning that connects students to the completion of contextual life namely Problem Based Learning (PBL) [15] can stimulate students to learn through various real problems in daily life and encourage understanding of scientific knowledge. Besides PBL can also grow students' knowledge personally [16], [17], [18]. PBL learning is able to influence students in improving critical thinking skills [19]. PBL can also be integrated with technology to solve a problem [20]. Technology-assisted learning has a very important role in improving the effectiveness of the learning process [21].

Utilization of technology in instructional media greatly helps improve problem solving abilities and learning outcomes [22]. One use of technology in learning is learning with cellular. The use of cellular as a learning media has a better and more effective impact and can enrich experiences in the learning process of students [23], [24], [25], [26]. Mobile learning provides a variety of application programs that can be accessed by students, for example, Android programs [27].

The application uses Android-based learning media as one of the 21st century learning styles [28]. Android is considered capable of being a medium for delivering appropriate learning especially for high school students because almost every student makes it an inseparable object in daily life activities [29]. Students can access information at any time as needed by using Android [30]. However, many students do not use Android for the learning process [31]. Though the learning process such as understanding physics material can be assisted with android learning media. A media that is able to help explain the concepts possessed by these materials is needed so that students are motivated to learn need explanations in the form of pictures, graphs and real examples in everyday life [32], [33]. Physics material can be packaged in interesting forms in learning media so physics material that tends to be abstract is more easily understood [34].

Potentials and existing problems, this research to implement Android-based physics learning media with PBL learning is expected to improve students' critical thinking skills.

2. RESEARCH METHODS

The research subjects were selected in the students of Class X MIPA of SMA Negeri 1 Tempilang. Sampling in this study using cluster sampling that was chosen randomly. Acquisition of class X MIPA 1 students as the implementation class (experimental) that was given treatment and class X MIPA 2 as a control class that was not given treatment. The implementation class was 36 students and the control class was 34 students. The research design used is the pretest posttest control group design.

After being given the initial test the implementation class gets the treatment of applying android-based physics learning media with PBL learning and the control class is not given treatment (using conventional learning). Data collection methods used are test methods using critical thinking skills tests. Critical thinking ability test in the form of material description of Newton's Law aims to obtain an increase in students' critical thinking skills.

Data analysis uses pretest and posttest to see the students' critical thinking abilities in physics. Initial and final test results were analyzed to find out the N-gain of students' critical thinking skills. The gain value is obtained by calculating the posttest score minus the pretest score then comparing it with the maximum score minus the pertest score. The value of the gain is then in the category whether the score is high, medium, and low.

The pretest-posttest values in the implementation class using learning media will then be analyzed using the Paired Sample t-Test. The Paired Sample t-Test is used to see whether or not there is an average difference between pretest and posttest critical thinking skills in the implementation class that uses Android-based physics learning media with PBL learning.

3. MATH AND EQUATIONS RESULTS AND DISCUSSION

3.1. Increased Critical Thinking Skills

The results of this study were the application of Android-based physics learning media with PBL learning to improve students' critical thinking skills. Physics learning media is used to contain content, one of which contains PBL learning content which is made according to indicators of critical thinking. Instrument statements are prepared based on indicators of critical thinking. Critical thinking skills in this study contain several indicators, namely analyzing facts,

formulating the main problems, clarifying, making conclusions, and evaluating. The application of Android-based physics learning media in PBL learning can be seen in one of the media content presented in Figure 1 and Figure 2.

Figure 1. Android Based Learning Media

Figure 2. Problem Critical Thinking

Figure 1 shows the PBL content section on Android-based learning media consisting of Newton's Law material, Real PBL which contains animations or videos related to Newton's Law material that connects to real problems, PBL activities that contain PBL learning syntax, and critical testing. which contains exercises for critical thinking. Figure 2 shows the content of PBL activities consisting of several phases that are able to direct students to think critically because in each phase there are indicators of critical thinking.

The value of students' critical thinking abilities in physics is obtained through the results of the test description in the implementation class and the control class. Both classes were given 8 critical thinking skills test questions. Initial tests of critical thinking skills will be given before learning and the final test after learning is given. Each class is given a different treatment. The implementation class uses the Android-based physics learning media with PBL learning and the control class uses conventional learning that is commonly used at the school.

The results of the critical thinking skill test are done by looking at the increase in the students' critical thinking physics abilities in the implementation class and the control class can be obtained by comparing the mean gain scores for the dependent variable. The gain value is obtained from the pretest and posttest values which are then disputed. The assessment is carried out for each class both the class given treatment and the class not given treatment. After calculating the gain value it will be known whether there is an increase between the experimental class and the control class.

The results of assessing students' critical thinking abilities in physics can be seen in Figure 3.

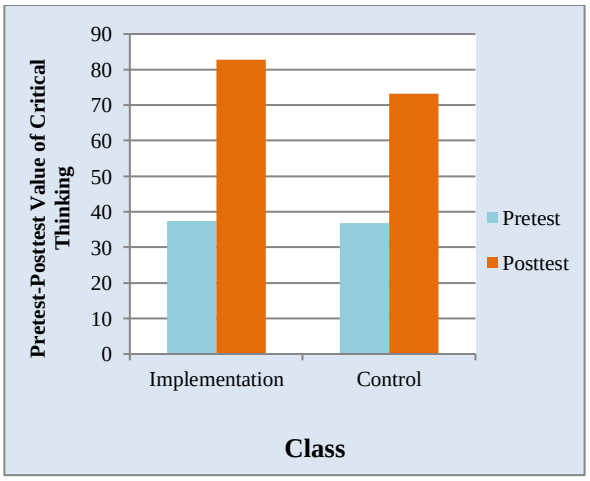

Figure 3. Graph of Increased Critical Thinking Skill

Figure 3 shows that the respective pretest and posttest scores for the implementation class using Android-based physics learning media using PBL learning are 37.29 and 82.70. Meanwhile, the pretest and posttest scores for the control class were 36.84 and 73.16 respectively. The pretest-posttest score of critical thinking skills in the experimental class increased greater than the control class. After the

pretest-posttest value is obtained, then calculate the gain value for critical thinking skills.

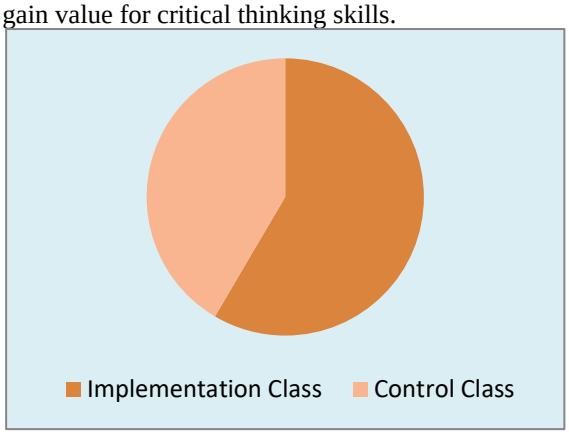

Figure 4. Data diagram comparing N-gain scores

Figure 4 shows the results of the analysis of the gain value of students' critical thinking skills in both classes. The gain value of the critical thinking ability of the experimental class is 0.76 with the high category and the control class with a value of 0.54 with the moderate category. It can be seen that the gain value of the critical thinking skill test in the implementation class (using Android-based physics learning media with PBL learning) is higher and is in the high category. The conclusion obtained is that Android-based physics learning media with PBL learning can improve students' critical thinking skills.

The value of critical thinking skills in the pretest-posttest implementation class can be analyzed using paired sample t-test. The decision criteria determine the differences in the improvement of critical thinking skills in the implementation class, namely:

H_0: There is no significant difference in the mean score between the pretest-posttest critical thinking skills in the implementation class.

H_a: There is a significant difference in the average score between the pretest-posttest critical thinking skills in the implementation class.

The results of the paired sample t-test analysis can be seen in Table 1.

Table 1. Paired sample test t-Test critical thinking skill

Class		Sig. 2 tailed
Implementation	Pretest	0.000
	Posttest	0.000

The result of the analysis shows that the critical thinking ability variable is t_{count} = -50.202 <t_{table} = -2.030 with a significance (2 tailed) in the implementation class <0.05, it is said that Ha is accepted. So it can be concluded that there is a significant difference on average between pretest and posttest critical thinking skills, which means that there is an effect of using Android-based physics learning media with PBL learning in improving students' critical thinking skills.

3.2. Discussion

The progress of a country is marked by improving the quality of people's lives such as the quality of human resources in utilizing and developing appropriate technology and overcoming its impacts. Competition in information and technology has a tendency to change rapidly which requires a fast and effective response to 21st century education [35]. Utilization of technology is very useful in learning. Learning by utilizing cell phones is very useful for connecting students with peers who have an impact on their thinking such as to solve problems and think critically [36]. Mobile learning provides a variety of application programs that can be accessed by students, for example, Android programs [27]. Android cellular learning can improve teaching and learning by emphasizing the acquisition of learners' knowledge. Smartpone like Android is very interesting for students to learn [37]. So learning that utilizes Android-based media is very important to be used in physics learning activities. This is according to Marhadini, Akhlis, & Sumpono's research [32] which states that Android-based learning media has a category that is suitable for use by high school students. Because the use of technology is the goal of 21st century learning [38].

Learning that combines technology that helps improve students' critical thinking using PBL learning. Teachers need to understand the current state of their students and to determine effective teaching strategies for improving problem solving [39]. Learning activities in the classroom must utilize learning that is able to foster students' critical thinking by using PBL learning.Yuliati, Fauziah, &Hidayat's research showed that using PBL there was a positive change in students' critical thinking skills with an average N-Gain test of 0.59 and a measure of test effectiveness of 3.73. Critical thinking skills students need to be trained to use more intensively authentic problems in everyday life. PBL is learning that supports authentic learning [40]. Authentic learning deals with real life problems. Students need to have critical thinking skills to be able to apply knowledge to solve existing problems in everyday life. Students' critical thinking

skills need to be trained to use more intensive authentic problems in everyday life.

The use of android-based learning media by using PBL learning motivates students to be actively involved in learning. Students in class are able to learn with their own initiative, more confident and able to work together between groups because the media used contains good components for learning that can support students involved in learning activities in class. One component of learning contains a Newton Law learning material that involves real problems, there is a learning video or animation that contains an explanation of the learning material. Android media also has PBL learning activities that are adjusted to PBL learning steps. this learning phase consists of the students' orientation to the problem; organize students to learn; conduct an investigation; analyze and evaluate the problem solving process; and reflecting. In the Android-based learning media there are also examples of questions related to the ability to think critically with a view to practicing students' critical thinking skills. This has an effect on learning, utilizing Android-based media with PBL learning can improve students' ability to think critically.

4. CONCLUSIONS

This article has presented the application of android-based physics learning media with PBL learning to improve students' critical thinking skills. The results of this study can be concluded that the adoption of physics media based on android learning with PBL learning can improve the critical thinking skills of students of class X MIPA SMAN 1 Tempilang. The use of physics learning media based on Android using PBL learning (implementation class) can improve students' critical thinking skills seen from the pretest value of 37.29 and the posttest value of 82.70 with a gain value of 0.73 which is a high category. This increase in ability was obtained from the students' pretest and posttest scores and the t-test scores in classes using Android-based learning media. Further research measures other 21st century skills in addition to students' critical thinking skills. Time management is given more attention so that it does not hamper when research activities take place.

AUTHORS' CONTRIBUTIONS

Authors who contributed to the writing of this article were Reni Tania as the first author of UNY students and Jumadi as the second author of UNY lecturers.

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REFERENCES

[1] A.A. Hussin, Education 4.0 made simple: ideas for teaching, international, Journal of Education & Literacy Studies, 2018, vol. 6, pp. 92-98. DOI: https://doi.org/10.7575/aiac.ijels.v.6n.3p.92

[2] A.A. Shahroom, N. Hussin, Industrial revolution 4.0 and education, International Journal of Academic Research in Business and Social Sciences, 2018, vol. 8, pp. 314-319. DOI: https://doi.org/10.6007/IJARBSS/v8-i9/4593

[3] S.K.W. Chu, R.B. Reynolds, N.J. Tavares, M. Notari, C.W.Y. Lee, Twenty-first century skills and global education roadmaps, 21st century skills development through inquiry-based learning from theory to practice, Springer Science, 2017, pp. 17-32. DOI: https://doi.org/10.1007/978-981-10-2481-8_2

[4] A.R. Saavedra, V.D. Opfer, Learning 21st-century skills requires 21st-century teaching, Phi Delta Kappan, 2012, vol. 94, pp. 8-13. DOI: https://doi.org/10.1177/003172171209400203

[5] A.N. Rahma, Pengembangan perangkat pembelajaran model inkuiri berpendekatan sets materi kelarutan dan hasilkali kelarutan untuk menumbuhkan keterampilan berpikir kritis dan empati siswa terhadap lingkungan, Journal of Educational Research and Evaluation, 2012, vol. 1, pp. 134-138.

[6] R. Mulyani, Saminan, Sulastri, Peningkatan kemampuan berpikir kritis peserta didik melalui implementasi lembar kerja peserta didik berbasis predict observe explain, Indonesian Journal of Science Education, 2017, vol. 5, pp. 19-24 DOI: http://doi.org/10.24815/jpsi.v5i2.9810

[7] A. Riyanti, A. Widiyatmoko, I.U. Wusqo, Pengaruh model pembelajaran kooperatif tipe team assisted individualization berbantuan peta konsep terhadap hasil belajar dan keterampilan berpikir kritis siswa smp tema kalor, Unnes Science Education Journal, 2016, vol. 5, pp. 1280-1287.

[8] B. Jatmiko, N. Erlina, Z. Supardi, P. Pandiangan, The comparison of oripa teaching model and problem based learning model effectiveness to improve critical thinking skills of pre-service physics teachers, Journal of Baltic Science Education, 2018, vol. 17, pp. 300-319.

[9] P. Thaiposri, P. Wannapiroon, Enhanching students' critical thinking skills through teaching and learning by inquiry-based learning activities using social network and cloud computing, Procedia Social and Behavioral Sciences, Elsevier, 2015, vol. 174, pp. 2137-2144. DOI: http://doi.org/10.1016/j.sbspro.2015.02.013

[10] Khaeruddin, M. Nur, Wasis, critical thinking skills profile of high school students in learning science-physics, Proceedings of the 3rd International Conference on Research, Implementation and Education of Mathematics And Science (3rd ICRIEMS), *IOP Conf. Series: Journal of Physics*, 2016, pp. 16–17.

[11] I. Puspita, I. Kaniawati, I.R. Suwarma, Analysis of critical thinking skills on the topic of static fluid, Proceedings of the *International Conference on Mathematics and Science Education (ICMScE)*, *IOP Conf. Series: Journal of Physics*, 2017, vol. 895, pp. 1-4. DOI: http://doi.org/10.1088/1742-6596/895/1/012100

[12] D.I. Yuliati, D. Yulianti, S. Khanafiyah, Pembelajaran fisika berbasis hands on activities untuk menumbuhkan kemampuan berpikir kritis dan meningkatkan hasil belajar siswa SMP, Jurnal Pendidikan Fisika Indonesia, 2011, vol. 7, pp. 23-27. DOI: https://doi.org/10.15294/jpfi.v7i1.1064

[13] P.I. Wijayanti, N. Hindarto, Eksplorasi kesulitan belajar siswa pada pokok bahasan cahaya dan upaya peningkatan hasil belajar melalui pembelajaran inkuiri terbimbing, Jurnal Pendidikan Fisika Indonesia, 2016, vol. 6, pp. . DOI: https://doi.org/10.15294/jpfi.v6i1.1093

[14] E. Delima, Warsono, Supahar, Jumadi, The importance of multimedia learning modules (mlms) based on local wisdom as an instructional media of 21st century physics learning, Proceedings of the 5th International Conference on Research, Implementation and Education of Mathematics and Science (5th ICRIEMS), *IOP Conf. Series: Journal of Physics*, 2018, vol. 1097, pp. 1-10. DOI: http://doi.org/10.1088/1742-6596/1097/1/012018

[15] V. Serevina, I.J. Sari, Development of e-module based on problem based learning (PBL) on heat and temperature to improve student's science process skill the turkish online, Journal of Educational Technology, 2018, vol. 17, pp. 26–36. http://www.tojet.net/articles/v17i3/1733.pdf

[16] Shabrina, H. Kuswanto, Android-assisted mobile physics learning through indonesian batik culture: improving students' creative thinking and problem solving, International Journal of Instruction, 2018, vol. 11, pp. 287–302. DOI: https://doi.org/10.12973/iji.2018.11419a

[17] R. Phungsuk, C. Viriyavejakul, T. Ratanaolarn, Development of a problem-based learning model via a virtual learning environment, Kasetsart Journal of Social Sciences, Elsevier, 2017, vol. 30, pp. 301-310. DOI: https://doi.org/10.1016/j.kjss.2017.01.001

[18] E.H.J. Yew, K. Goh, Problem-based learning : an overview of its process and impact on learning, Health Professions Education, 2016, vol. 2, pp. 75-79. DOI: https://doi.org/10.1016/j.hpe.2016.01.004

[19] B.N. Nirbita, S. Joyoatmojo, Sudiyanto, ICT media assisted problem based learning for critical thinking ability, International Journal of Multicultural and Multireligious Understanding, 2018, vol. 5, pp. 341-348 DOI: http://doi.org/10.18415/ijmmu.v5i4.295

[20] I.M. Dwi, H. Arif, K. Sentot, Pengaruh strategi problem based learning berbasis ict terhadap pemahaman konsep dan kemampuan pemecahan masalah fisika, Jurnal Pendidikan Fisika Indonesia, 2013, vol. 9, pp. 8-17. DOI: https://doi.org/10.15294/jpfi.v9i1.2575

[21] R.M. Williams, Image, Text, and Story: Comics and Graphic Novels in the Classroom, Routledge Taylor & Francis Group, 2015, vol. 61, pp. 13-19. DOI: https://doi.org/10.1080/00043125.2008.11652072

[22] I.A.D. Astuti, R.A. Sumarni, D.L. Saraswati, Pengembangan media pembelajaran fisika

mobile learning berbasis android, Jurnal Penelitian & Pengembangan Pendidikan Fisika, 2017, vol. 3, pp. 57–62. DOI: https://doi.org/https://doi.org/10.21009/1.03108

[23] F. Adnan, B. Prasetyo, Usability testing analysis on the bana game as education, Jurnal Pendidikan IPA Indonesia, 2017, vol. 6, pp. 88–94. DOI: https://doi.org/10.15294/jpii.v6i1.9597

[24] S.D. Fatmaryanti, Suparmi, Sarwanto, Ashadi, Implementation of guided inquiry in physics learning at purworejo's senior high school, Conference of the International Conference on Mathematics, Science, and Education, 2015, vol. 2, pp. 12-15.

[25] F.J. Garcia-Penalvo, M.A. Conde, The impact of a mobile personal learning environment in different educational contexts, Universal Access in the Information Society, 2015, vol. 14, pp. 375-387. DOI: https://doi.org/10.1007/s10209-014-0366-z

[26] G. Fulantelli, D. Taibi, M. Arrigo, A framework to support educational decision making in mobile learning, Computers In Human Behavior, Elsevier, 2014, vol. 30, pp. 1-10. DOI: https://doi.org/10.1016/j.chb.2014.05.045

[27] G.M. Abildinova, A.K. Alzhanov, N. Ospanova, Z. Taybaldieva, D.S. Baigojanova, N.O. Pashovkin, Developing a mobile application "educational process remote management system" on the android operating, International Journal of Environmental & Science Education, 2016, vol. 11, pp. 5128-5145.

[28] J.A.N.N.V. Calimag, P.A.G. Miguel, R.S. Conde, L.B. Aquino, Ubiquitous learning environment using android mobile application, International Journal of Research in Engineering & Technology, 2014, vol. 2, pp. 119–128.

[29] N. Mardiana, H. Kuswanto, Android-assisted physics mobile learning to improve senior high school students' divergent thinking skills and physics HOTS, Conference of the 4th International Conference on Research, Implementation, and Education of Mathematics and Science (4th ICRIEMS), AIP Conference Proceedings, vol. 1868, 2017, pp. 1–12. DOI: http://doi: 10.1063/1.4995181

[30] B. Ligi, B.W.D. Raja, Mobile learning in higher education, International Journal of Research-GRANTHAALAYAH, 2017, vol. 5, pp. 1-6. DOI: https://doi.org/10.5281/zenodo.569363

[31] S. Suyoso, S. Nurohman, Pengembangan modul elektronik berbasis web sebagai media pembelajaran fisika, Jurnal Kependidikan Penelitian Inovasi Pembelajaran, 2014, vol. 44, pp. 73-82. DOI: https://doi.org/10.21831/jk.v44i1.2193

[32] S.A.K. Marhadini, I. Akhlis, I. Sumpono, Pengembangan media pembelajaran berbasis android pada materi gerak parabola untuk siswa SMA, Unnes Physics Education Journal, 2017, vol. 6, pp. 38-43. DOI: https://doi.org/10.15294/upej.v6i3.19315

[33] K. Agustina, W.H Kristiyanto, D. Noviandini, Learning design of problem based learning model based on recommendations of sintax study and contents issues on physics impulse materials with experimentals activities, International Journal of Active Learning, 2017, vol. 2, pp. 68-81. DOI: https://doi.org/10.15294/ijal.v2i2.10802

[34] D.S. Indah, Prabowo, Pengembangan alat peraga sederhana gerak parabola untuk memotivasi siswa pada pembelajaran fisika pokok bahasan gerak parabola, Jurnal Inovasi Pendidikan Fisika, 2014, vol. 3, pp. 89–94.

[35] Triyuni, The influence of science learning set using scientific approach and problem solving model on learning outcomes of junior high school students in the subject of heat and temperature, Jurnal Inovasi Pendidikan IPA, 2016, vol. 5, pp. 177–85. DOI: https://doi.org/10.15294/jpii.v5i2.7679

[36] G.J. Hwang, P.H. Wu, H.R. Ke, An interactive concept map approach to supporting mobile learning activities for natural science courses, Computers & Education, 2011, vol. 57, pp. 2272–2280.

[37] N.P. Adi, R.A. Yulianto, M. Irwan, W.M. Endris, Android for the 21st century learning media and its impact on students, Conference of the 2nd International Seminar on Science Education (2nd ISSE), 2016, vol. 2, pp. 2-6.

[38] S.A. Garba, Y. Byabazaire, A.H. Busthami, Toward the use of 21st century teaching- learning approaches: the trend of development in malaysian schools within the context of asia pacific, International Journal of Emerging

Technologies in Learning, 2015, vol. 10, pp. 72–79. DOI: https://doi.org/10.3991/ijet.v10i4.4717

[39] W.K. Adams, C.E. Wieman, Analyzing the many skills involved in solving complex physics problems, American Journal of Physics, 2015, vol. 83, pp. 459–467. DOI: https://doi.org/10.1119/1.4913923

[40] L. Yuliati, R. Fauziah, A. Hidayat, Student's critical thinking skills in authentic problem based learning, Proceedings of the 4th International Seminar of Mathematics, Science and Computer Science Education, IOP Conf. Series: Journal of Physics, 2018, vol. 1013, pp. 1-6. DOI: http://doi.org/10.1088/1742-6596/1013/1/012025