

RE-KLARIFIKASI
BUKTI KORESPONDENSI ARTIKEL
PADA JURNAL INTERNASIONAL BERREPUTASI
(Jurnal Pendidikan IPA Indonesia: JPPI)



PENGUSUL
Dr. Wivi Isnaeni, M.S. / NIDN 0002085807

UNIVERSITAS NEGERI SEMARANG
TAHUN 2022

Bersama surat ini, saya bermaksud menyertakan bukti bukti korespondensi proses review artikel pada Jurnal Internasional berreputasi dengan judul: “**Analysis of The Role of Android-Based Learning Media in Learning Critical Thinking Skills and Scientific Attitude**”, yang dimuat pada Jurnal Pendidikan IPA Indonesia (JPII), edisi Vol. 10, No. 4, publikasi tanggal 31 Desember 2021, halaman: 607-617, dengan p-ISSN: 2339-1286, e-ISSN: 2089-4392, Penerbit: UNNES Journals Indonesia.

Kronologi bukti korespondensi terdiri dari 19 aktivitas, disajikan pada tabel berikut ini.

No	Tanggal	Uraian Aktivitas	Hlm
1	07-12-2020	Submit manuskrip pada jurnal melalui online.....	1
2	07-12-2020	Menerima ucapan terima kasih atas submisi artikel yang saya lakukan. Memperoleh pemberitahuan bahwa kemajuan artikel jurnal dapat diikuti melalui OJS (the online journal management system). Memperoleh URL Manuskrip dan User name. Manuscript URL: https://journal.unnes.ac.id/nju/index.php/jpii/author/submission/27597 Username: wiwi-isnaeni..... Artikel yang di submit.....	1 2
3	22-10-2021	Memperoleh pesan bahwa artikel dalam proses review; Tim JPII mengirimkan blangko Letter of Statement yang harus di tanda tangani.....	10
4	23-10-2021	Author menanda tangani surat pernyataan dan mengirimkan Letter of Statement yang sdh di tandatangani ke Tim Jurnal.....	11
5	25-10-2021	Penerima pesan untuk mengirimkan naskah artikel berbahasa Indonesia kepada (Chief Editor/Tim Jurnal), paling lambat tanggal 27 Oktober 2021.	12
6	26-10-2021	Mengirimkan artikel berbahasa Indonesia via Email dalam format MS Word (oleh Penulis Utama) dan Letter of Statement yang telah di tanda tangani.	12
7	26-10-2021	Mengirimkan artikel berbahasa Indonesia format pdf dan Letter of Statement yang telah ditanda tangani.	13
8	02-11-2021	Menerima pemberitahuan hasil review pertama telah diunggah di OJS; Author diminta merevisi artikel, dan mensubmit hasil revisi paling lambat 5 November 2021; Submit artikel hasil revisi pertama pada tanggal 5-11- 2021. Hasil revisi pertama disubmit dalam dua versi, yaitu versi Bahasa Indonesia dan Bahasa inggris.	13
9	10-11-2021	Pemberitahuan hasil evaluasi terhadap artikel hasil revisi pertama; Artikel diterima dan akan dipublikasikan pada edisi Desember 2021.....	16
10	1-12-2021	Menerima pesan untuk merevisi artikel dengan cara memeriksanya di OJS, dan mensubmit artikel hasil revisi (revisi kedua) di OJS paling lambat 5 -12-2021; mensubmit artikel hasil revisi kedua pada tanggal 6-12-2021.....	16
11	08-12-2021	Menerima pesan untuk merevisi artikel dengan cara memeriksa-	

		nya di OJS, dan mensubmit artikel hasil revisi (revisi ketiga) di OJS paling lambat 14 Desember 2021. Artikel yang dikirim hanya menggunakan bahasa Inggris.	17
12	15 -12-2021	Menerima pemberitahuan tentang penerimaan artikel paska revisi ketiga , rencana jadwal publikasi, dan perlunya proofreading artikel pada lembaga professional, serta memeriksa similarity (cek Turnitin) terhadap artikel ini. Hal di atas harus disubmit tanggal 19-12-2021.	19
13	21-12-2021	Tim jurnal menginformasikan bahwa ada beberapa kutipan yang sumbernya tidak disebutkan di bagian referensi, dan ada beberapa sumber dalam referensi yang tidak disebutkan dalam artikel. Perlu memperhatikan tabel dan urutan gambar. 1. Setiap gambar/tabel didahului dengan pengenalan deskripsi, dan setelah gambar/tabel diberikan deskripsi hasil yang ditampilkan. 2. Gambar/tabel tidak boleh berurutan. Hasil revisi (revisi keempat) disubmit paling lambat 23-12- 2021. Mensubmit hasil revisi keempat pada tanggal 23-12-2021.	21
14	23-12-2021	Menerima pesan untuk: 1. memeriksa pernyataan keaslian dan surat pernyataan, menanda tangani surat-surat tersebut, dan mengunggah pada akun OJS sebagai berkas pelengkap; 2. Unggah laporan Turnitin di akun OJS melengkapi juga semua nama penulis Anda di metadata OJS.....	21
15	24-12-2021	Menerima kiriman LoA dari Tim JPPII.....	22
16	30-12-2021	Menerima pesan untuk memeriksa keadaan artikel setelah proses lay out oleh Tim JPPII (pengecekan akhir sebelum publish / revisi kelima)	22
17	31-12-2021	Submit artikel final kepada Tim JPPII via OJS.....	23
18	10-01-2022	Menerima pemberitahuan dari Tim JPPII bahwa artikel telah Publish di Web, dan author diminta melakukan pemeriksaan terakhir secara online terhadap keadaan artikel (revisi keenam)...	23
19	12-01-2022	Author mengirimkan hasil pemeriksaan terakhir kepada Tim JPPII.....	24

Demikian, data ini kami susun dengan sebenar-benarnya, agar dapat digunakan sebagaimana mestinya. Terimakasih.

Lampiran:

1. Article Clarification dari Tim JPPII
2. Sepuluh artikel, terdiri dari satu artikel submit, artikel review dan hasil revisi pertama hingga keempat (8 artikel), dan satu artikel publish

Semarang, 8 September 2022

Hormat saya,

Dr. Wiwi Isnaeni, M.S.

**KRONOLOGI KORESPONDENSI PUBLIKASI ARTIKEL PADA JURNAL INTERNASIONAL
BEREPUTASI DAN BERFAKTOR DAMPAK (JPII)**

No.	Tanggal	Uraian Kegiatan
1	07 Des 2020	Submit manuskrip pada jurnal melalui online Manuskrip yang di submit disajikan pada halaman 6 – 13 pada berkas ini.
2	07 Des 2020	<p>Menerima ucapan terima kasih atas submisi artikel yang saya lakukan. Memperoleh pemberitahuan dari Chief of Editor bahwa kemajuan/progress artikel jurnal dapat diikuti melalui OJS (the online journal management system). Memperoleh URL Manuskrip dan User name. URL Manuscript: https://journal.unnes.ac.id/nju/index.php/jpii/author/submission/27597 Username: wiwi-isnaeni</p>



Parmin <journal@mail.unnes.ac.id>
to me ▾

Dec 7, 2020, 8:31 AM

Wiwi **Isnaeni**:

Thank you for submitting the manuscript, "ANDROID-BASED LEARNING MEDIA POTENTIAL ANALYSIS AS A MEANS TO TRAIN CRITICAL THINKING SKILLS AND SCIENTIFIC ATTITUDES" to Jurnal Pendidikan IPA Indonesia. With the online journal management system that we are using, you will be able to track its progress through the editorial process by logging in to the journal web site:

Manuscript URL:

<https://journal.unnes.ac.id/nju/index.php/jpii/author/submission/27597>

Username: **wiwi-isnaeni**

If you have any questions, please contact me. Thank you for considering this journal as a venue for your work.

Parmin
Jurnal Pendidikan IPA Indonesia

Jurnal Pendidikan IPA Indonesia
<http://journal.unnes.ac.id/index.php/jpii>



POTENTIAL ANALYSIS OF THE ANDROID-BASED LEARNING MEDIA AS A MEANS TO TRAIN CRITICAL THINKING SKILLS AND SCIENTIFIC ATTITUDES

W. Isnaeni*¹, Y. A. Sujatmiko², S. Ridlo³, S. Saptono⁴, Pujiasih⁵

^{1,2,3,4,5}Natural Science Education Study Program Concertation in Biology,
Faculty of Postgraduate, Universitas Negeri Semarang, Indonesia

DOI:

Accepted: Approved: Published: ...

ABSTRACT

This study aimed to analyze and describe the potential of Android-based learning media to train students' critical thinking skills and scientific attitudes. The learning media were Andro-Webcomic (called Androwebic) and E-Booklet of plant diversity in Banjarnegara (abbreviated as E-Bokartumban). This research was a pre-experimental research, the type of One Group Pretest-Posttest Design. The research subjects included 196 students of grade X from three high schools in Banjarnegara and 105 students of grade XI from three high schools in Jepara. The sample was determined using purposive sampling technique. The data collected included critical thinking skills, students' scientific attitudes, and teacher and student responses. The instruments used were test & non-test sheets, interview sheets, observation sheets for students' scientific attitudes and environmental care, and student and teacher response questionnaires. Data was analyzed using qualitative descriptive statistics and quantitative (n-gain test). The results showed that: (1) E-Bokartumban media had supporting component in facilitating competence of analytical thinking and caring for the environment. Androwebic media was able to train 92.38% analytical thinking skills, and scientific attitude of 85.66%. (2) Student and teacher responses to Androwebic were 89.59% & 87.36%. Conclusion: Android-based media in form of Androwebic and E-Bokartumban has the potential to train critical thinking skills, environmental care, analytical thinking skills, and scientific attitudes.

© 20xx Science Education Study Program FMIPA UNNES Semarang

Keywords: androwebic; e-bokartumban; critical thinking skills; scientific attitude

INTRODUCTION

Biology learning involves skills and reasoning (Amoah & Emmanuel, 2018). In developing reasoning power and skills, learning is needed that can emphasize the aspects of application, analysis, synthesis, and evaluation, not only emphasizing aspects of understanding and knowledge. For this reason, a learning process is needed that can improve cognitive, affective, psychomotor competencies, as well as learning methods that can motivate students to be creative, confident, and think critically (Pujiasih et al., 2020). Basically, students have the ability to think critically in learning, but this

ability sometimes does not develop properly. Therefore, it is necessary to use methods that are able to develop students' critical thinking skills. Students who have critical thinking skills will find it easy to analyze, evaluate, and be able to relate to evidence or arguments, before deciding or assessing information (Mutakinati et al., 2018). In learning process, students' critical thinking skills play an important role in achieving learning achievement, formal reasoning, and creativity (Puspita et al., 2017).

Biology learning in schools is still dominated by textbooks and modules with a few pictures, and learning is still teacher-centered. This causes the students' mindset to

*Correspondence Address
E-mail: wiwiisna@mail.unnes.ac.id

be limited, and the students' understanding of biology concepts weakens, so that their critical thinking skills and scientific attitudes are still weak. This statement was strengthened by the results of interviews by several teachers of SMA/MA in Banjarnegara and Jepara. The information obtained from the interviews included: (1) The learning had not made optimal use of student-centered media; (2) Students were allowed to bring smartphones but it had not been well utilized; (3) Teachers had not used technology (smartphones) as a tool or media that could support learning; (4) limited learning time.

Based on the results of interviews with the teacher, it could be concluded that these problems could be minimized by utilizing technology owned by students, and making maximum use of student-centered learning in the learning process. In this case, there were subject matter that needs to be taught using learning media, including material on the circulatory system and material on biodiversity systems. The choice of circulatory system material was because it had a complicated concept, so it needed to be presented in an attractive manner. Then, the selection of material on biodiversity systems was very necessary to optimize electronic media that could make it easier for students to present diversity in the classroom.

The availability of learning media will facilitate interaction between teachers and students so that learning activities will be more effective and efficient (Puspitasari et al., 2018). The existence of learning media can facilitate ease of learning, foster interest in learning, and facilitate independent learning for students so that the learning process will be more effective (Surjanti et al., 2018). The use of android media can make students more interested in learning. Students are also more interested in using pictorial technology as opposed to using textbooks. Taking this into account, it is clear that there is an urgent need to optimize modern technology to be used as a learning media.

Based on the existing problems, it is clear that current research is needed to optimize learning media that can visualize learning material appropriately. The media should have a simple structure that focuses on one goal. Learning media that are

expected to be useful (good) to overcome the learning problems mentioned before is media that is easy to carry and use anywhere. One of these media is android based media. The android-based media referred to in this article is presented in form of an e-booklet about the diversity of plants in Banjarnegara (named E-Bokartumban), and the circulatory system webcomic (named Androwebic). The media is expected to improve students' critical thinking skills and scientific attitudes.

Based on the problems above, the following questions can be formulated:

- How to improve students' critical thinking skills and scientific attitudes in biology learning using Android-based learning media?
- How do students and teachers respond to biology learning using Android-based learning media?

METHOD

Types of research

The type of research used in this research was pre-experimental, with a one group pretest-posttest design (Sugiyono, 2015).

Research Samples

The samples (subjects) of this study were 196 students of grade X from three high schools in Banjarnegara and 105 students of grade XI students from three high schools in Jepara. The sample/research subject was selected by using purposive sampling technique.

Research Data and Instruments

The data collected included data on critical thinking skills, student scientific attitudes, and teacher and student responses about Android-based media used in biology learning. The research instruments used included test and non-test sheets; interview sheet; observation sheet for students' scientific attitudes and environmental care; as well as student and teacher response questionnaire sheets. Test sheets (pretest and posttest) were used to measure the improvement of students' critical thinking skills and analytical thinking skills. The non-test sheet in form of an observation sheet is used to determine the scientific attitude and environmental care attitudes of students.

Data analysis

The data analysis technique in this study used descriptive qualitative and quantitative statistical methods. The data

analysis techniques were (1) n-gain test to analyze data on students' critical thinking skills and analytical thinking skills; (2) qualitative analysis techniques were used to analyze data on scientific attitudes, environmental care for students, as well as data on the implementation of the learning process, and the responses of teachers and students regarding Android-based media used in Biology learning.

RESULTS AND DISCUSSION

Students' Critical Thinking Skills and

Scientific Attitudes

Androwebic's role in learning Biology

Data on students' critical thinking skills and scientific attitudes in learning using Android-based media (Androwebic and E-Bokartumban) were obtained from test results (pretest and posttest) and non-test. Student learning outcomes in learning using Android-based media (Androwebic and E-Bokartumban) are presented in Table 1, Table 2, Table 3, Table 4, Table 5, Table 6, and Table 7.

Table 1. Students' Pretest and Posttest Score in Biology Learning Using Androwebic Media

Information	Pretest Score (n=105)	Posttest Score (n=105)
Highest score	93.33	100
Lowest score	13.33	60
Average value	53.65	88.83
Number of students completed	11	97
Number of students is not complete	94	8
Classical completeness%	10.48	92.38

Table 1 shows that there is a significant difference between the pretest and posttest scores obtained by students. The pretest results shows an average value of 53.65. This score is still less than the KKM, which has not reached the score of 75. The posttest score achieved by students averaged 88.83 (having exceeded the KKM by 75).

The improvement of students' analytical thinking skills was obtained from the results of the n-gain test on the pretest and posttest scores achieved by students. The results of the n-gain test are presented in Table 2

Table 2. The Results of N-Gain Test for Students' Analytical Abilities after Learning Process Using Androwebic Media

N	Percentage Category N-Gain(%)		
	High	Moderate	Low
105	72	24	4

From Table 2 it is known that most students achieved a high category increase. From these data it can also be stated that almost all students achieve an increase in critical thinking skills in the moderate to high category. The results of the analysis indicate that Biology learning using Androwebic media is effective in improving students' analytical abilities.

Androwebic media has such potential

because it is equipped with various discussion questions that contain problems in the context of everyday life. This can stimulate students' curiosity and encourage students to practice solving problems. Both activities require analytical thinking skills, so that students' abilities in this matter are properly trained. This is in accordance with the research of Prawita et al. (2019) and Sari et al. (2019) which stated that the use of learning media that presents problems can improve learning outcomes and analytical thinking skills in students.

During the discussion stage in learning using Androwebic media, students are directed to discuss with each other and exchange ideas about problem solutions systematically and logically. Thus students become trained to think analytically. This is in accordance with the statement of Sari et al. (2019) which proved that learning by actively involving students to solve problems can improve analytical thinking skills and student learning outcomes.

Information about students' scientific attitudes in learning using Androwebic media was obtained from the observation process using student scientific attitude observation sheets. Androwebic media was created specifically, in such a way that it had a number of useful facilities for practicing 6 aspects of a

scientific attitude (see Table 3). The results of observations of students' scientific attitudes

during the learning process using Androwebic media are presented in Table 3.

Table 3. Scores of Students' Scientific Attitudes During The Learning Process Using Androwebic Media

Indicator	Σ Score	Max Score	Score (%)	Criteria
Attention to every new thing	1086	1260	86.19	Very good
Appreciate and draw conclusions according to facts	1056	1260	83.81	Very good
Not always fell right, changing opinion after considering the evidence	1035	1260	82.14	Very good
Ask questions and give opinions	1124	1260	89.21	Very good
Participate in groups	1107	1260	87.86	Very good
Record complete observations	1068	1260	84.76	Very good
Average of each aspect			85.66	Very good

In Table 3, it can be seen that the average scientific attitude of students is in very good category. This happens because since the beginning of the learning process, students were always motivated to learn and seek information independently, so that during the learning process in the classroom students showed a more attentive, respectful attitude, drawn conclusions according to facts. During the learning process, students were also accustomed not to feel always right, dared to ask questions, dared to express opinions, be active in groups, and recorded complete

observations. In the learning process students must solve discussion questions that contain contextual problems. Every activity carried out during the discussion process made a positive contribution to the formation of a scientific attitude. This is what can encourage students to think analytically in solving problems. This is in accordance with the statement of Dwianto et al. (2017) that the application of learning media that presents contextual problems through discussion can make a positive contribution to the formation of scientific attitudes in student.

The role of E-Bokartumban in Biology learning

E-Bokartumban media hada components that could support in faciliating

the competence of critical thinking skills and environmental care attitudes presented in Table 4.

Table 4. E- Bokartumban Media Components that facilitate critical thinking skills competencies

No.	Aspects and Indicators	Media Components
	Critical thinking skills	
1	Give a simple explanation	Evaluation questions onthe media, students discussion sheets
2	Build basic skills	Evaluation questions onthe media, students discussion sheets
3	Conclude	Evaluation questions onthe media, students discussion sheets
4	Identify terms and consider a definition	Evaluation questions onthe media, students discussion sheets
5	Set strategy and tactics	Evaluation questions onthe media, students discussion sheets

Table 4 shows the media E-Bokartumban has a component that has a function for each competency that exist in the research of this research. According to Ennis in Goal for A Critical Thinking Curriculum is presented in journal Kartimi and Liliarsari (2012), there are five stages of thinking with

each indicator, that are Giving simple explanation, Building basic skills, Summing up, Identifying terms and considering a definition, Setting strategies and tactics. This indicators of thinking can be measured when the students do the worksheets discussion and evaluation questions that exist in the

media. Wiguna et al. (2019) and Damopolil & Kurniadi (2019) which explains about the case of improving student learning outcomes after following the process of learning that implement Android-based media. Arista & Kuswanto (2018) stated that media that can

be operated using a smartphone can increase enthusiasm, interest, and motivation in learning activities. All things that can enhance independence and understanding of concepts in students .

Table 5. E- Bokartumban Media Components that facilitate the competence of Environmental care attitudes

No.	Aspects and Indicators	Media Components
	Environmental Care Attitude	
1	have thought that plants and animals have rights were equal to humans	Introduction to the material
2	have feelings / emotions about human actions that cause disaster	Introduction to the material
3	have thinking that the environment is very fragile and easily disturbed balance	Student discussion sheets, material on the media
4	have feelings and tendencies of behavior that the tendency of human beings there is a limit in controlling nature	Student discussion sheets, material on the media
5	have a tendency of behavior to take advantage of the source power of nature that has been used	Student discussion sheets, material on the media
6	have a tendency of behavior not to be arbitrary towards the environment	Student discussion sheets, material on the media
7	have thoughts and attracted in environmental issues	Student discussion sheets, material on the media
8	have emotional feelings about actions that can cause environmental damage	Student discussion sheets, material on the media

From Table 5 can be known the indicators of environmental care attitudes that used scale that was adapted from NEPS case of aspects, 1) have thought that plants and animals have rights were equal to humans , 2) have the feeling / emotional against the actions of man that cause disasters , 3) have thinking that the environment is very fragile and easily disturbed balance, 4) have feelings and the tendencies of behavior that the tendency of human beings there is a limit in controlling nature, 5) have a tendency of behavior to take advantage of the source power of nature that has been used , 6) have a tendency of behavior for not arbitrarily towards the environment, 7) has thoughts and attracted in environmental issues , and 8) have emotional feelings about actions that can cause environmental damage, can be measured as long as students using the media to read the material and when the process of discussion groups take place in learning process.

Learning with media E-Bokartumban can make a positive contribution in improving students' attitudes environmental care. Environmental care is an attitude and actions that always try to prevent damage to the surrounding natural environment and develop efforts to repair natural damage (Yaumi, 2014). An attitude of caring for the environment can be demonstrated

by attitudes and actions that always try to prevent environmental damage and seek to repair natural damage that has occurred (Mardikaningtyas, 2016).

Based on the description in the paragraph above, can be stated that the use of media android-based learning is very effective to enhance students' understanding. This is in accordance with the opinion of Sudarsana et al. (2019) which stated that the use of technology-based learning media can improve student learning outcomes. Junaedi et al. (2018) and Damopolil & Kurniadi (2019) find that learning by applying android-based media can improve students' learning outcomes . Learning process that using technology can increase student interest and learning outcomes (Sudarsana et al., 2019). Wiguna et al. (2019) and Damopolil & Kurniadi (2019) reported the case of improving student learning outcomes after follow learning that implement Android-based media. This statement is also accordance with the explanation of Jenou et al. (2017), that stated the process of learning that uses Android-based media can improve student learning outcomes.

Results of Student and Teacher Responses to Learning Using Android-Based Biology Learning Media

Student and teacher responses to the learning process using Androwebic media

Student responses to learning using Androwebic media were obtained from student response questionnaires given at the end of the

lesson. Information about students' positive responses to Androwebic media is presented in Table 6.

Table 6. Results of Student Responses to Androwebic Media

Indicators	Score Obtained	Max. Score	Percentage (%)	Criteria
Affective consideration	755	840	89.88	Very good
Learning	1116	1260	88.57	Very good
Multimedia display	2308	2520	91.59	Very good
Navigation	1487	1680	88.51	Very good
Robustness	1507	1680	89.40	Very good
Average			89.59	Very good

The data in Table 6 shows that the average of each aspect/indicator shows very good criteria. In some aspects, the student's response rate shows the maximum score. This showed that students were interested and motivated to learn with comics in the media. Apart from being interested and motivated by comics, students also admitted that the material equipped with pictures on Androwebic media was very helpful and made it easier for students to learn, because it was summarized in a structured manner. The problems presented in Androwebic media are also problem-able to provide the right visualization. This makes it easier for students to understand abstract about the circulatory system. The use of appropriate learning media and in accordance with the character of students in learning, can help students to find concepts in context. The media in question must be interesting, contain extensive learning resources, contain information that is presented with visual images. The use of a problem-based learning approach that is complemented by the use of learning media is proven to be able to

based learning oriented which can increase student activity in learning activities. In the learning process, students not only listened, but also tried, found, and concluded. Therefore, students' understanding, analytical thinking skills, and scientific attitudes will be higher.

In terms of appearance, Androwebic media received high points, with very good criteria. This showed that students were very interested in the appearance of Androwebic media. Androwebic media is equipped with images on every detail of the material, so that it is circulatory material. Androwebic media can also help students understand and discover concepts foster student interest and motivation to be more active in learning so as to create enjoyable learning, understanding the circulatory system material will increase (Maulana & Sulistyoningrum, 2018; Lee et al., 2015).

The level of positive response from the teacher to the implementation of the learning process using Androwebic media, obtained from the teacher's responses are presented in Table 7.

Table 7. Levels of Teacher's Positive Response to Androwebic Media

Indicators/aspects	Score Obtained	Max. Score	Percentage (%)	Criteria
Affective consideration	22	24	91.67	Very good
Learning	30	36	83.33	Very good
Multimedia display	64	72	88.89	Very good
Navigation	41	48	85.42	Very good
Robustness	42	48	87.50	Very good
Average			87.36	Very good

From the data in Table 7, it is known that the average score for each aspect is 87.36%, with the very good category. The teacher said that Androwebic media was very good, easy to use, up to date, the material presented was equipped with attractive visuals, could be used anytime and anywhere with the condition of using an android device.

This confirmed by Sung et al. (2016) which stated that the use of Android devices such as smartphones in learning is better and more effective than conventional learning. Students are more enthusiastic because the learning process is student-centered, while the teacher only directs and guides. This is in accordance with the findings of Ali (2019) which proved

that student-centered learning will improve students' ability to understand the material being studied and the ability to solve problems. In such circumstances, the teacher is sufficient to direct and guide as needed.

Student and Teacher Responses to The Learning Process Using E-Bokartumban Media

Media E-Bokartumban was used in this study is able to assist students in building material concept of biodiversity. Teachers also gave feedback positively on the activities of students in learning, because it made students becoming very enthusiastic when they hold discussions. The teacher said that the E-Bokartumban media was attractive, contemporary, easy to use, easy to carry, and the material presented was very clear.

Based on the results of data analysis, obtained information that the media Androwebic can train analytical thinking skills in students by 92.68% and scientific attitudes of 85.66%. Android-based media taken as positive by students and teachers. Levels of positive responses from students and teachers to the media media Androwebic of 89.59% and 87.36%. Based on that it can be concluded that the media Androwebic and E-Bokartumban were used in Biology learning was very potential to train critical thinking skills and scientific attitudes of students.

CONCLUSION

Two types of media based on Android, namely Androwebic and E-Bokartumban, which were used in biology learning had proven potential to train high school students' critical thinking skills and scientific attitudes.

The authors would like to thanks Prof. Dr. Enni Suwarsi Rahayu, M.Si., and Prof. Dr. Retno Sri Iswari, S.U., as the material expert validator, Dr. Budi Naini Mindayarto, M.App.Sc., and Mohammad Fikri, S.Sn (Pusdatin Kemendikbud) as media expert validators who have provided very useful suggestions for improving this research. This research was supported by the Lembaga Penelitian dan Pengabdian Masyarakat Universitas Negeri Semarang, which has funded this research.

REFERENCES

Ali, S. S. (2019). Problem based learning: a student-centered approach. *English*

- Language Teaching*, 12(5), 73-78.
- Amoah A. C., & Emmanuel E. (2018). Assessing the reasoning skills of biology students in selected senior high schools in the central region of Ghana. *International Journal of Scientific Research and Management (IJSRM)*, 6(4), 299-304.
- Arista, F. S., & Kuswanto, H. (2018). Virtual physics laboratory application based on the android smartphone to improve learning independence and conceptual understanding. *International Journal of Instruction*, 11(1), 1-16.
- Damopolil, I., & Kurniadi, B. (2019). The development of android-based mobile learning supported by problem-based learning strategy for students' learning success. *International Journal of Scientific and Technology research*, 8(7), 190-193.
- Dwianto, A., Wilujeng, I., Prasetyo, Z. K., & Suryadarma, I. G. P. (2017). The development of science domain based learning tool which is integrated with local wisdom to improve science process skill and scientific attitude. *Jurnal Pendidikan IPA Indonesia*, 6(1), 23-31.
- Jeno, L. M., Grytnes, J. A., & Vandvik, V. (2017). The effect of a mobile-application tool on biology students' motivation and achievement in species identification: A Self-Determination Theory perspective. *Computer & Education*, 107, 1-12.
- Junaedi, J., Irviani, R., Muslihudin, M., Hidayat, S., Maselena, A., Gumanti, M., & Fauzi, A. N. (2018). Application program learning based on android for students experiences. *International Journal of Engineering and Technology (UAE)*, 7(2.27), 194-198.
- Kartimi, & Liliarsari. (2012). Pengembangan Alat Ukur Berpikir Kritis pada Konsep Termokimia untuk Siswa SMA Berperingkat Atas dan Menengah. *Jurnal Pendidikan IPA Indonesia*, 1(1), 21-26.
- Lee, S., Kang, E., & Kim, H. B. (2015). Exploring impact of students' learning approach on collaborative group modeling of blood circulation. *Journal of Science Education and Technology*, 24(2), 234-255.
- Mardikaningtyas, A. D. (2016). Pengembangan Pembelajaran Pencemaran Lingkungan berbasis Penelitian Fitoremediasi untuk Menunjang Keterampilan Ilmiah, Sikap Peduli Lingkungan, dan Motivasi pada Matakuliah Dasar-dasar Ilmu Lingkungan. *Jurnal Pendidikan: Teori, Penelitian, dan Pengembangan*, 1(3), 499-506.
- Maulana, H., & Sulistyoningrum. (2018). Implementation Mirror Technique 3D

- Objects for Interactive Learning Media “Circulatory System” Virtual Reality-Based. *Journal of Physics: Conference Series*, 1364 012036.
- Mutakinati, L., Anwari, I., & Yoshisuke, K. (2018). Analysis of students’ critical thinking skill of middle school through STEM education project-based learning. *Jurnal Pendidikan IPA Indonesia*, 7(1), 54-65.
- Prawita, W., Prayitno, B. A., & Sugiyarto. (2019). Effectiveness of generative learning-based biology module to improve the analytical thinking skills of the students with high and low reading motivation. *International Journal of Instruction*, 12(1), 1459-1476.
- Pujiasih, P., Wiwi I., & Saiful R. (2020). Android-based e-booklet development to train students’ critical thinking and attitude of caring for environment. *Journal of Innovative Science Education*, 10(1), 95-101.
- Puspita, I., Kaniawati, I., & Suwarma, R. (2017). Analysis of critical thinking skills on the topic static fluid. *Journal of Physics: Conference Series*, 895 012100.
- Puspitasari, E. D. T., Surjono, H. D., & Minghat, A. D. (2018). Utilizing web based learning as 21st century learning media for vocational education. *International Journal of Engineering & Technology*, 7(4.33), 157-160.
- Sari, R., Perdana, R., Riwayani, Jumadi, Wilujeng, I., & Kuswanto, H. (2019) The implementation of problem-based learning model with online simulation to enhance the student’s analytical thinking skill in learning physics. *Journal of Physics: Conference Series*, 1233012030.
- Sudarsana, I. K., Nakayanti, A. R., Sapta, S., Haimah, Satria, E., Saddhono, K., GS, D. A., Putut, E., Helda, T., & Mursalin, M. (2019). Technology application in education and learning process. *Journal of Physics: Conference Series*, 1363 012061.
- Sugiyono. (2015). *Metode penelitian pendidikan*. Bandung: Alfabeta.
- Sung, H. Y., Hwang, G. J., Chen, C. Y., & Liu, W. X. (2019). A contextual learning model for developing interactive e-books to improve students’ performances of learning the analects of confucius. *Interactive Learning Environments*, 1-14.
- Surjanti, J., Seno, D. N., Hadi, H. K., Maroah, S., Siswanti, Y., Muafi., & Isfianadewi, D. (2018). The role of m-learning on effective learning media in higher education. *International Journal of Civil Engineering and Technology*, 9(4), 77-85.
- Wiguna, D., Irwansyah, F. S., Windayani, N., Aulawi, H., & Ramdhani, M. A. (2019). Development of android-based chemistry learning media oriented towards generic science skills. *Journal of Physics: Conference Series*, 1157 042047.
- Yaumi, M. (2014). *Pendidikan karakter: landasan, pilar, dan implementasi*. Jakarta: Kencana.

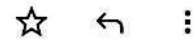
3

22 Okt 2021

Memperoleh pesan bahwa artikel dalam proses review; Tim JPPII mengirimkan blangko Letter of Statement yang harus di tanda tangani.



Jurnal Pendidikan IPA Indonesia ... Oct 22, 2021, 9:17 AM
to me ▼



Dear Author,

We hope you are doing well. We would like to inform you that your article is considered to be in the review process of our journal. In order that the review process runs accordingly, we ask you to carefully read the letter of statement that we sent (check the attachment part), then sign and send it back by replying to this email. If you still have any questions, please contact us by this email. Thank you in advance.

Best Regards,
JPPII Team

Jurnal Pendidikan IPA Indonesia

Nationally Accredited based on the Decree of the Minister of Research, Technology and Higher Education, Number 2/E/KPT/2015

Jurnal Pendidikan IPA Indonesia (Indonesian Journal of Science Education) [p-ISSN 2339-1286 | e-ISSN 2089-4392] published a scientific paper on the results of the study and review of the literature in the sphere of natural science education in primary education, secondary education and higher education. This journal in collaborate with *Perkumpulan Pendidik IPA Indonesia (PPII) / Indonesian Society for Science Educators*

This journal has been indexed in [Google Scholar](#), [DOAJ](#), [EBSCO](#), [SCOPUS](#)

Principal Contact

Parmin

Editor-in-Chief

Science Education Studies Program , Faculty of Mathematics and Natural Sciences, Semarang State University (UNNES)

D7 Building , 3rd Floor, Sekaran Campus, Gunungpati, Semarang, Indonesia 50229

Phone: 024-70805795

Fax: 024-8508005

Email: jpii@mail.unnes.ac.id

Support Contact

Parmin

Phone: +628164258038

Email: parmin@mail.unnes.ac.id





Ministry of Education, Culture, Research and Technology
 UNIVERSITAS NEGERI SEMARANG
 FACULTY OF MATHEMATICS AND NATURAL SCIENCES
 DEPARTMENT OF INTEGRATED SCIENCES
 IN COLLABORATION WITH PERKUMPULAN PENDIDIK IPA INDONESIA
JURNAL PENDIDIKAN IPA INDONESIA



p-ISSN: 2339-1288; e-ISSN: 2088-4382
 Nationally Accredited Decree of The Minister of Education, Culture, Research and Technology No. 2/E/KPT/2016
 SCOPUS INDEXED AND Q2 SCIMAGOJR
 Sekretariat: D6 Building, First Floor, UNNES Campus in Sekaran ~~Group~~ Semarang, Indonesia, Postal Code 50229.
 Phone (+6224) 70605795, Fax: (+6224) 8506005, E-mail: ipii@mail.unnes.ac.id, Website: <http://journal.unnes.ac.id/ju/index.php/pii>

LETTER OF STATEMENT JURNAL PENDIDIKAN IPA INDONESIA

I, as Author,

Name : Wiwi Isnaeni

WhatsApp number : +628122883070

Article entitled : ANDROID-BASED LEARNING MEDIA POTENTIAL ANALYSIS AS A
 MEANS TO TRAIN CRITICAL THINKING SKILLS AND SCIENTIFIC ATTITUDES
 or (an alternative title)

POTENCIAL ANALYSIS OF THE ANDROID-BASED LEARNING MEDIA AS A
 MEANS TO TRAIN CRITICAL THINKING SKILLS AND SCIENTIFIC ATTITUDES

Declaring that we are willing to fulfill the following article administration requirements:

1. revise the article according to the set time limit;
2. proofread the article from an official, reliable, and professional institution after the review process is completed, and provided an official letter or certificate of the proofread;
3. pay the publication fee amounting to Rp 4.000.000 after receiving the bill from us, and complete the payment within 2 weeks since the bill is received. If the article could not be accepted for a reason, then the fee will be fully refunded;
4. submit articles in 2 languages (English and Indonesian) specifically for the domestic author (Indonesia). Send both the English and Indonesian versions of your manuscript to this email.

If the requirements from points 1-4 are not fulfilled, then I am willing that the article will not be processed.

Thus this statement is made for the article publication process.

The first author,

WIWI ISNAENI

Note: sent this letter of statement by email to ipii@mail.unnes.ac.id

5	25-10-2021	Penerima permintaan mengirimkan naskah artikel berbahasa Indonesia kepada (Chief Editor/Tim Jurnal), paling lambat 27 Okt.
---	------------	---



Jurnal Pendidikan IPA Indonesia <jpii... Oct 25, 2021, 8:40 AM ☆ ↩ ⋮
to me ▾

Dear Author,

Thank you very much for your great cooperation. Authors from Indonesia or domestic are asked to submit articles in the Indonesian version (as stated in the 4th point in the Letter of Statement) to be translated by parties who have been trusted by us so that the quality of the language in the articles to be published is even. Please submit the Indonesian version of the article to this email. If there is something unclear please reach us through this email. We are waiting for your response as soon as possible. We will wait for your Indonesian version until October 27, 2021. Thank you in advance.

Regards,
JPPI Team

Jurnal Pendidikan IPA Indonesia

6	26-10-2021	Mengirimkan artikel berbahasa Indonesia via Email dalam format MS Word (oleh Penulis Utama) dan Letter of Statement yang telah di tanda tangani.
---	------------	---



Wiwi Isnaeni <wiwiisna@mail.unnes.... Oct 26, 2021, 11:43 AM ☆ ↩ ⋮
to Jurnal ▾

In response to an email from the Journal team dated Oct 25, 2021, 8:40 AM asking me to submit an article in the Indonesian version (as stated in point 4 of the Statement Letter), we will send our article in Indonesian to this email. We apologize for only being able to submit the article today. We hope that this article that we submit can facilitate the process of publishing our articles by JPPI. Thank you very much.



7	26-10-2021	Mengirimkan artikel berbahasa Indonesia format pdf (atas inisiatif sendiri) dan Letter of Statement yang telah ditanda tangani.
---	------------	---



8	02-11-2021	Menerima pemberitahuan hasil review pertama telah diunggah di OJS; Author diminta merevisi artikel, dan mensubmit hasil revisi paling lambat tanggal 5 November 2021; Submit artikel hasil revisi pertama pada tanggal 5-11- 2021. Hasil revisi pertama disubmit dalam dua versi, yaitu versi Bahasa Indonesia dan Bahasa Inggris.
---	------------	--

Author submit artikel hasil revisi pertama pada tanggal 5 – 11 – 2021, tetapi ternyata ada kekeliruan pada artikel, sehingga artikel yang dikirim tanggal 5 November saya delete. Selanjutnya artikel hasil revisi pertama saya submit ulang pada tanggal 6 – 11 – 2021.

Pada hasil review yang pertama terdapat beberapa hal mendasar pada artikel yang harus diperbaiki. Catatan tentang bagian yang di revisi dan hasil revisinya, disajikan pada Tabel 1: Daftar catatan reviewer. Tabel 2 merupakan daftar cek/checklist Penilaian artikel



Tabel 1. Tabel Daftar Catatan dari Reviewer Pertama & revisi pertama yang dilakukan author

No.	Catatan Reviewer	Tindakan Revisi
1	<p>INTRODUCTION should:</p> <ul style="list-style-type: none">• contain urgency (importance) to research• contain a carrying capacity in the form of supporting data and facts• contain a preliminary study as a basis for the importance of the research conducted• contain a GAP ANALYSIS Departing from the preliminary study, analysis of published articles formulated in the Gap analysis GAP ANALYSIS refers to articles published in various internationally reputable journals to emphasize the novelty of research.• clear limitation of research objectives	<p>Dilakukan revisi menyeluruh, sesuai masukan/koreksi Reviewer, dengan lebih menegaskan tentang urgensi masalah ini untuk diteliti, menambahkan hasil studi terdahulu, menegaskan tentang anaalisis gap mengacu kepada berbagai artikel yang memadai.</p> <p>Menegaskan tentang novelty</p> <p>Memerjelas tentang pembatasan masalah</p>
2	<p>METHODS should</p> <ul style="list-style-type: none">• contain detailed research stages• Each stage is explained and analyzed by what method• Data analysis must be with clear references• The research instruments used were elaborated to the data analysis technique <p>• It is hoped that there will be a modification in the stages of research from sources referred by the researcher</p>	<p>Sudah diperbaiki sesuai saran/koreksi dari reviewer</p>
3	<p>RESULTS AND DISCUSSION</p> <ul style="list-style-type: none">• Tables or graphs (one selected) must represent different results• The results of data analysis must be strong in answering the analysis gap• Display of results other than those narrated in table-graph-image-modeling• The research novelty has not been clear enough• It is recommended not to repeat the references in the introduction, using previous research findings.• References used should be taken from reputable journals. <p>It is necessary to explain the specifications of the findings in this study that show</p>	<p>Sudah diperbaiki sesuai saran/koreksi dari reviewer</p>
4	<p>Make it in the Acknowledgement part. Include the contract number of the funding letter.</p>	<p>Sudah diperbaiki sesuai saran/koreksi dari reviewer.</p>
5	<ol style="list-style-type: none">1. Please provide at least 30 references which 80% of them are taken from the last 10 years (>2011) articles of no-predatory journals, written in accordance with the APA Standard. You may go to Google Scholar and find the right format for APA Style provided.2. For books, please refer to the original/primary book reference no matter the date.3. All of the listed references must be cited in the body of the article, and vice versa.	<p>Sudah diperbaiki sesuai saran/koreksi dari reviewer</p>

Tabel 2: Check List Penilaian artikel untuk paper / artikel berjudul:

Paper title: POTENTIAL ANALYSIS OF THE ANDROID-BASED LEARNING MEDIA AS A MEANS TO TRAIN CRITICAL THINKING SKILLS AND SCIENTIFIC ATTITUDES

Parts of review	Guidelines	Yes	Partly	No	Reviewer's note for improvement	Author's responds (highlight of revision)
Title	• Does the subject matter fit within the scope of journal?	/				
	• Does the title clearly and sufficiently reflect its contents?	/				
Abstract	• Does the abstract contain informative, including Background, Methods, Results and Conclusion?	/				
Back-ground	• Is the background informative and sufficient (include the background problem and objectives)?		/			
	• Is research question of the study clear and understandable?		/			
	• Does the rationale of the study clearly explained using relevant literature?		/			
	• Is the "aim" of the manuscript clear and understandable?	/				
Methods	• Is the methodology chosen suitable to the nature of the topic studied?		/			
	• Is the methodology of the research described clearly?(including study design, location, subjects, data collection, data analysis)		/			
	• Is there adequate information about the data collection tools used? (only for empirical studies)		/			
	• Are the validity and reliability of data collection tools established? (only for empirical studies)	/				
	• Are the data collection tools suitable for the methodology of the study? (only for empirical studies)		/			
Results & Discussion	• Are the tables, graphs and pictures understandable, well presented and numbered consecutively?		/			
	• Do the data analysis and the interpretation appropriate to the problem and answer the objectives?		/			
	• Does the "discussion" section of the manuscript adequately relate to the current and relevant literature?		/			
	• Are the findings discussed adequately considering the research question(s), sub-question(s) or hypothesis?		/			
Conclusion	• Is the conclusion clear and in the form of a narration instead of pointers?		/			
	• Isn't the conclusion a summary and consistent between problems, objectives and conclusion?		/			
References	• Do the references and citations match?		/			
	• Are the writing of references correct?		/		Add the latest sources from reputable journals.	
Quality Criteria	• Do the title, problem, objectives, methods and conclusion are in line? Is it well organized?		/			
	• The quality of the language is satisfactory		/			
	• The work relevant and novel		/			
	• Are there strong consistencies among the parts of the manuscript? (introduction, methods, results and discussion, and conclusion)		/			

9	10-11-2021	Pemberitahuan hasil evaluasi terhadap artikel hasil revisi pertama; Artikel diterima dan akan dipublikasikan pada edisi Desember 2021;
---	------------	---



Jurnal Pendidikan IPA Indonesia... Wed, Nov 10, 2021, 4:43 PM ☆ ↶ ⋮
to me ▾

Dear Author,

Congratulations. Your article has been chosen to publish in JPII December 2021 Issue. Now that our publication payment is done before the final review process, so we would like to inform you about the publication fee. **The next reviews process will still be going on.** When the review has been done by the reviewers we would inform you afterward.

10	1-12-2021	Menerima pesan untuk merevisi artikel (revisi kedua) dengan cara memeriksanya di OJS, dan mensubmit artikel hasil revisi kedua di OJS paling lambat 5 -12-2021;
----	-----------	--



Jurnal Pendidikan IPA Indonesia ... Wed, Dec 1, 2021, 8:54 AM ☆ ↶
to me ▾

Dear Authors,

We are pleased to inform you that the reviewer has uploaded the review results of your article.
Please check your OJS account for the newest review results.
We are looking forward to your revision **no later** than December 03, 2021.
Thank you.

Best regards,
JPII Team

Proses revisi kedua membawa perubahan mendasar terhadap artikel ini, yang membawa kepada perubahan Judul dan metode penelitian. Hal sangat penting pada revisi kedua ini disajikan pada Tabel 3 (**Daftar Catatan dari Reviewer kedua**)

Tabel 3: Daftar Catatan dari Reviewer Kedua dan revisi kedua yang dilakukan author

No.	Catatan Reviewer	Tindakan Revisi
1	The Title: Use the other term instead of potential analysis. A means means tools?	Change the title of the article to Analysis of The Role of Android-Based Learning Media in Learning Critical Thinking Skills and Scientific Attitude
2	General: Pre-experimental research is a kind of beginner research whose validity and reliability cannot be justified, unless it is coupled with development research or combined with in-depth qualitative research. Therefore, this article can be considered if accompanied by research on media development or with in-depth descriptive research, and it should be analyzed /discussed in depth and comprehensively.	Revise the rethe research methods, with improved it to an in-depth descriptive study, which was analyzed/discussed in depth and comprehensively.

11	08-12-2021	Menerima pesan untuk merevisi artikel (revisi ketiga) dengan cara memeriksanya di OJS, dan mensubmit artikel hasil revisi (revisi ketiga) di OJS paling lambat 14 Desember 2021 . Artikel yang dikirim hanya menggunakan bahasa Inggris . Daftar Catatan dari Reviewer Ketiga dan Revisi Ketiga yang dilakukan author disajikan pada Tabel 4.
----	------------	--



Jurnal Pendidikan IPA Indonesia... Wed, Dec 8, 2021, 10:39 AM



to me ▾

Dear Authors,

We are pleased to inform you that the reviewer has uploaded the review results of your article.

Please check your OJS account for the newest review results.

We are looking forward to your revision **no later** than December 14, 2021. You may submit your revision using English only.

Thank you.

Best regards,
JPPI Team

Tabel 4: Daftar Catatan dari Reviewer Ketiga dan Revisi Ketiga yang dilakukan author

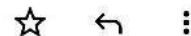
No.	Catatan Reviewer	Tindakan Revisi
1	<p>Bagian INTRODUCTION This section must cover the background, gap analysis, research objective, research status, research urgency, research novelty supported by the data of previous research.</p> <p>NOTE: Research status is the point of this study towards other studies, whether it supports, debates, or corrects, and this section lacks of it. In addition, the research novelty and urgency have not also been stated clearly.</p>	Memperbaiki bagian Introduction sesuai koreksi/catatan reviewer
2	<p>Bagian: Data Analysis Need more information of the data analysis used in this study.</p>	Memperbaiki bagian analisis data sesuai koreksi/catatan reviewer
3	Why using purposive random sampling? And what are the considerations choosing this sample?	Menjelaskan alasan menggunakan purposive random sampling.
4	<p>Data research & n instrument What is the type of test? Multiple choice test or open ended questions?</p>	Menjelaskan jenis tes yang digunakan.
5	<p>KKM What is KKM? Significant difference need to prove by statistical analysis.</p>	Menjelaskan/mendeskripsikan tentang KKM. Pada bagian ini tidak dilakukan analisis statistic, karena hasil pre dan post test tidak dimaksudkan untuk melihat beda di antara keduanya, tetapi kedua hasil tersebut digunakan untuk menentukan besarnya peningkatan hasil belajar antara sebelum dan sesudah belajar menggunakan media.
6	<p>RESULT & DISCUSSION You need to explain the learning media used in this study Androwebic and E-Bokartumban. Probably, you can explain the part of these learning media.</p>	Memperbaiki bagian ini sesuai koreksi/ catatan reviewer
7	<p>Very good: From where this criteria are coming from? Why all criteria are very good</p>	Memberi penjelasan tentang hal ini.
8	<p>Table 5. Competency indicators of environmental care attitudes in students and components of the E-Bokartumban media that facilitate the emergence of these attitude indicators. You need to put figure of each part of media component</p>	Memperbaiki artikel sesuai saran/koreksi reviewer, dan menambahkan beberapa gambar yang sesuai.
	<p>Komentar terhadap paragraph ini <i>The availability of various menus on Androwebic media (see Fig 1 and Table 2) stimulates students' curiosity and encourages students to practice problem solving. Both activities require analytical thinking skills, so that students' abilities in that regard are well trained.</i> Could you explain more of this statement?</p>	Memperbaiki / mejelaskan bagian ini dengan nmemberikan contoh-contoh masalah yang diajukan dalam menu diskusi yang terkait dengan peristiwa keseharian antara lain ialah tentang kerja jantung, keadaan darah yang normal dan tidak, tentang golongan daran. Itu senua adalah hal-hal keseharian yang sangat seruing dialami siswa.
	<p><i>"It happened because since the beginning of the learning process using androwebic media students are always motivated to learn and seek information independently. During the learning process assisted by Androwebic media students show a more caring attitude, respect, and draw conclusions according to facts."</i> Is this statement related to learning media used in this study?</p>	Menjelaskan keterkaitan antara pernyataan itu dengan penggunaan media pembelajaran pada penelitian ini

	This study is lack of discussions. The discussion chapter is where you delve into the meaning, importance and relevance of your results. It should focus on explaining and evaluating what you found, showing how it relates to your literature review and research questions, and making an argument in support of your overall conclusion.	Menambahkan diskusi sesuai koreksi reviewer
	Put in the acknowledgement	Menambahkan acknowledgment
	Reference Add more the latest sources from reputable or international journals. Taken from the last 10 years (>2011)	Menambahkan referensi sesuai catatan reviewer

12	15 -12-2021	Menerima pemberitahuan tentang penerimaan artikel (Article Acceptance) paska revisi ketiga , dan tentang rencana jadwal publikasi ; Perlu melakukan proofreading artikel pada lembaga professional, dan melakukan pemeriksaan similarity (cek Turnitin) terhadap artikel ini. Hal di atas harus disubmit tanggal 19-12-2021 .
----	-------------	--



Jurnal Pendidikan IPA Indonesi... Wed, Dec 15, 2021, 10:01 AM
to me ▾



Dear Author;

We are pleased to announce that your article is going to be published in the further edition. At this stage, there are two aspects required from you:

1) You should make sure you do proofreading effectively in order to produce a quality publication in JPII. Proofread must be from an official, reliable, and professional institution. When the proofread is done please send us the article that has been proofread and the official letter or certificate from the proofread institution. If you have any difficulty in finding an institution in a short time, we have a recommendation. You may directly contact this phone number at (+6285700952423 / +6285877370020).

2) We encourage you to upload the similarity report of your article on your OJS account as a supplementary file. We are going to accept the article having a $\leq 20\%$ similarity rate. Please be aware of using trusted plagiarism/similarity checker applications such as Grammarly, Turnitin Premium, or others. Please avoid using the free application to make the results accountable.

We are waiting for your proofreading and similarity result until Monday, 19 December 2021. Thank you for submitting your manuscript to Jurnal Pendidikan IPA Indonesia. The Editors of the JPII are looking forward to your continued contributions to the Journal.

Best Regards,
JPII Team

Jurnal Pendidikan IPA Indonesia

Aktivitas author ialah **melakukan Proofreading**, dan **uji kemiripan dengan Turnitin** (bukti / sertifikat proofreading dan hasil uji kemiripan (16%) disajikan berikut ini.



**ANALYSIS OF THE ROLE OF ANDROID-BASED LEARNING MEDIA
IN CRITICAL THINKING SKILLS AND SCIENTIFIC ATTITUDE**

ORIGINALITY REPORT

16% SIMILARITY INDEX
11% INTERNET SOURCES
7% PUBLICATIONS
1% STUDENT PAPERS

PRIMARY SOURCES

- 1** journal.unnes.ac.id
Internet Source 9%
- 2** Y A Sujatmiko, W Isnaeni, S Ridlo, S Saptono. "The development of andro-webcomic media based on problem-based learning to improve analytical thinking ability and scientific attitude", Journal of Physics: Conference Series, 2021
Publication 3%
- 3** Submitted to Universitas Jember
Student Paper 1%
- 4** Vita Ria Mustikasari, Hadi Suwono, Kholida Farhania. "Improving students' science learning outcomes through joyful-inquiry interactive demonstration assisted by game android", AIP Publishing, 2020
Publication 1%
- 5** Luluk Ifadah. "The method of strengthening character education values for students in industrial revolution 4.0 era",
1%

ATTARBIYAH: Journal of Islamic Culture and Education, 2019

Publication

- 6** repository.lppm.unila.ac.id
Internet Source 1%
- 7** H Rezeki, J Rokhmat, Gunawan, M Makhrus, Wahyudi. "Implementation of causalitic-learning devices to improve creative thinking ability and problem-solving of students in physics", Journal of Physics: Conference Series, 2021
Publication <1%
- 8** Yetri, Koderi, Amirudin, S Latifah, M D Apriliana. "The Effectiveness of Physics Demonstration Kit: The Effect on The Science Process Skills Through Students' Critical Thinking", Journal of Physics: Conference Series, 2019
Publication <1%
- 9** mafiadoc.com
Internet Source <1%
- 10** Sulasih, A Suparmi, Sarwanto. "Profile of student critical thinking ability on static fluid concept", Journal of Physics: Conference Series, 2017
Publication <1%
- 11** jppipa.unram.ac.id
Internet Source

<1%

Exclude quotes On
Exclude bibliography On

Exclude matches 15 words

13	21-12-2021	<p>Tim jurnal menginformasikan bahwa ada beberapa kutipan yang sumbernya tidak disebutkan di bagian referensi, dan ada beberapa sumber dalam referensi yang tidak disebutkan dalam artikel. Perlu memperhatikan tabel dan urutan gambar.</p> <ol style="list-style-type: none"> 1. Setiap gambar/tabel didahului dengan pengenalan deskripsi, dan setelah gambar/tabel diberikan deskripsi hasil yang ditampilkan. 2. Gambar/tabel tidak boleh berurutan. <p>Hasil revisi (revisi keempat) disubmit paling lambat 23-12-2021.</p>
----	------------	---

Sesuai pesan dari Tim Jurnal, author melakukan **Revisi Keempat**, dan mensubmit **hasil revisi keempat** pada tanggal 23-12-2021.



Jurnal Pendidikan IPA Indon... Tue, Dec 21, 2021, 11:03 AM
to me ▾

Dear Author,

We would like to inform you that there are several citations that the sources have not been mentioned in the references section, and there are several sources in the references that are not cited in the article. Please also pay attention to the tables and figure order: 1. Each picture/table is preceded by an introduction to the description, and after the picture/table is given a description of the results shown.
2. The pictures/tables must not be consecutive. Please check the attachment file below. We will wait for your revision until Thursday, December 23, 2021. Thank you very much.

Sincerely,
JPPI Team

Jurnal Pendidikan IPA Indonesia

14	23-12-2021	<p>Menerima pesan untuk:</p> <ol style="list-style-type: none"> 3. Memeriksa pernyataan keaslian dan surat pernyataan, menandatangani surat-surat tersebut, dan mengunggah pada akun OJS sebagai berkas pelengkap; 4. Unggah laporan Turnitin di akun OJS melengkapinya juga semua nama penulis Anda di metadata OJS.
----	------------	---



Jurnal Pendidikan IPA Indonesia <jpii... Dec 23, 2021, 10:16 AM
to me ▾






Dear Author,

We hope you are doing fine. We are waiting for your revision today. Thank you.

Sincerely,
JPPI Team

Jurnal Pendidikan IPA Indonesia

15	24-12-2021	Menerima kiriman LoA dari Tim JPPII
----	------------	-------------------------------------

 Jurnal Pendidikan IPA Indone...  Fri, Dec 24, 2021, 1:39 PM   

to bcc: me ▾

Dear Author,

Since the publication time is getting closer, we encourage you to:

- 1). Read carefully the declaration of originality and letter of statement, sign the letters, and upload it on your OJS account as the supplementary file;
- 2). Upload the Turnitin report on your OJS account as the supplementary file.
- 3). Complete all your authors' names in the metadata OJS as well.

We are waiting for your response and congratulations once more.

Thank you for your cooperation.

All the best,

JPPII Team

16	30-12-2021	Menerima pesan untuk memeriksa keadaan artikel setelah proses lay out oleh Tim JPPII (pengecekan akhir sebelum publish / revisi kelima)
----	------------	---

 Jurnal Pendidikan IPA Indon...  Thu, Dec 30, 2021, 11:30 AM   

to me ▾

Dear Author,

Congratulations. Your article has been chosen to publish in JPPII December 2021 Issue. We hereby attach your latest article.

We encourage you to read carefully the latest article that has been through our final review, if there is any correction, this is the last chance to fix it, **make a note on the pdf file** and send it back to us if you have any corrections.

We are waiting for your response and congratulations once more.

Thank you for your cooperation.

All the best,

JPPII Team

Jurnal Pendidikan IPA Indonesia

17	31-12-2021	Submit artikel final kepada Tim JPPII via OJS
----	------------	---



Wiwi Isnaeni <wiwiisna@mail.unnes.a...> Dec 31, 2021, 2:32 PM ☆ ↩ ⋮
to Jurnal ▼

Dear JPPII Team

Thank you very much for your informasion.
Here we send the revised PDF file, the same file as the file that the JPPII Journal Team sent to me, but I have added a note of improvement to the file I sent. My repair notes are marked in yellow.
Thank you for the kindness of the JPPII Team



18	10-01-2022	Menerima pemberitahuan dari Tim JPPII bahwa artikel telah Publish di Web, dan meminta author melakukan pemeriksaan terakhir terhadap keadaan artikel (revisi keenam).
----	------------	--



Jurnal Pendidikan IPA Indonesia <jpii@...> Mon, Jan 10, 9:41 AM ☆ ↩ ⋮
to bcc: me ▼

Dear Author,

Congratulations. We would like to inform you that your article has been published on the Web. Please check it for the last time. We will wait until Tuesday, 11 January 2022. After passing tomorrow, it cannot be edited again. If there is any correction, make a note on the pdf file in the website and send it back to us.

Thank you for your attention. We would like to hear from you soon. Congratulations!

Sincerely,
JPPII Team

19	12-01-2022	Author mengirimkan hasil pemeriksaan terakhir kepada Tim JPII
----	------------	---



Wiwi Isnaeni <wiiisna@mail.unnes.a...> Jan 12, 2022, 5:22 AM ☆ ↶ ⋮
to Jurnal ▾

Assalamualaikum wr wb.
Dear JPII Team, sorry, I was late to find out and read the email from the JPII Team, so I just edited it this morning (adding what is still missing).
In my article, I found a lack of one word in the title, less than 1 source of reference in the reference, and there was an error in writing the year in one of the reference sources.
The results of editing / adding my notes are in the attached article.
Sorry for my delay, and thank you.

...



Jurnal Pendidikan IPA Indonesia <jpii...> Jan 12, 2022, 9:31 AM ☆ ↶ ⋮
to me ▾

Dear Author,

We will edit it. Thank you.

Regards,
JPII Team

\$

LAMPIRAN 1
ARTICLE CLARIFICATION



ARTICLE CLARIFICATION

Xo: 97/JPII/R.A./2022

Article Title : Analysis of the Role of Android-Based Learning Media in Learning Critical Thinking Skills and Scientific Attitude
Authors W. Isnaeni, Y. A. Sujatmiko, P. Pujasih
Publish . JPII Volume 10 Nomor 4 (2021)

The article above has been reviewed very strictly through the stages:

1. After submission, the article goes through the initial selection process by the editor team to ensure the article fits the focus & scope of the journal and meets substance quality standards.
2. After the article is declared according to the focus & scope of the journal and meets the quality standards of substance, the article is continued with the first review process by the reviewer.
3. After the first phase of the article has been reviewed, revised and resubmitted by the author, the journal editor informs that the article will be published in the December 2021 issue after completing all the article review stages.

Semarang, 2nd September 2022

Editor-in-Chief of JPII,

thin, M.Pd.

NIP 197901232006041003

LAMPIRAN 2.1
ARTICLE SUBMIT

ada
3/12-2020



JPPI x (x) (20xx) xxx-xxx

Jurnal Pendidikan IPA Indonesia

<http://journal.unnes.ac.id/index.php/jpii>



ANDROID-BASED LEARNING MEDIA POTENTIAL ANALYSIS AS A MEANS TO TRAIN CRITICAL THINKING SKILLS AND SCIENTIFIC ATTITUDES

W. Isnaeni*¹, Y. A. Sujatmiko², S. Ridlo³, S. Saptono⁴, Pujiasih⁵

^{1,2,3,4,5}Natural Science Education Study Program Concertation in Biology,
Faculty of Postgraduate, Universitas Negeri Semarang, Indonesia

DOI:

Accepted: Approved: Published: ...

ABSTRACT

This study aimed to analyze and describe the potential of Android-based learning media to train students' critical thinking skills and scientific attitudes. The learning media were Andro-Webcomic (called Androwebic) and E-Booklet of plant diversity in Banjarnegara (abbreviated as E-Bokartumban). This research was a pre-experimental research, the type of One Group Pretest-Posttest Design. The research subjects included 196 students of grade X from three high schools in Banjarnegara and 105 students of grade XI from three high schools in Jepara. The sample was determined using purposive sampling technique. The data collected included critical thinking skills, students' scientific attitudes, and teacher and student responses. The instruments used were test & non-test sheets, interview sheets, observation sheets for students' scientific attitudes and environmental care, and student and teacher response questionnaires. Data was analyzed using qualitative descriptive statistics and quantitative (n-gain test). The results showed that: (1) E-Bokartumban media had supporting component in facilitating competence of analytical thinking and caring for the environment. Androwebic media was able to train 92.38% analytical thinking skills, and scientific attitude of 85.66%. (2) Student and teacher responses to Androwebic were 89.59% & 87.36%. Conclusion: Android-based media in form of Androwebic and E-Bokartumban has the potential to train critical thinking skills, environmental care, analytical thinking skills, and scientific attitudes.

© 20xx Science Education Study Program FMIPA UNNES Semarang

Keywords: androwebic; e-bokartumban; critical thinking skills; scientific attitude

INTRODUCTION

Biology learning involves skills and reasoning (Amoah & Emmanuel, 2018). In developing reasoning power and skills, learning is needed that can emphasize the aspects of application, analysis, synthesis, and evaluation, not only emphasizing aspects of understanding and knowledge. For this reason, a learning process is needed that can improve cognitive, affective, psychomotor competencies, as well as learning methods that can motivate students to be creative, confident, and think critically (Pujiasih et al., 2020). Basically, students have the ability to think critically in learning, but this

ability sometimes does not develop properly. Therefore, it is necessary to use methods that are able to develop students' critical thinking skills. Students who have critical thinking skills will find it easy to analyze, evaluate, and be able to relate to evidence or arguments, before deciding or assessing information (Mutakinati et al., 2018). In learning process, students' critical thinking skills play an important role in achieving learning achievement, formal reasoning, and creativity (Puspita et al., 2017).

Biology learning in schools is still dominated by textbooks and modules with a few pictures, and learning is still teacher-centered. This causes the students' mindset to be limited, and the students' understanding of biology

*Correspondence Address
E-mail: wiiisna@mail.unnes.ac.id

concepts weakens, so that their critical thinking skills and scientific attitudes are still weak. This statement was strengthened by the results of interviews by several teachers of SMA/MA in Banjarnegara and Jepara. The information obtained from the interviews included: (1) The learning had not made optimal use of student-centered media; (2) Students were allowed to bring smartphones but it had not been well utilized; (3) Teachers had not used technology (smartphones) as a tool or media that could support learning; (4) limited learning time.

Based on the results of interviews with the teacher, it could be concluded that these problems could be minimized by utilizing technology owned by students, and making maximum use of student-centered learning in the learning process. In this case, there were subject matter that needs to be taught using learning media, including material on the circulatory system and material on biodiversity systems. The choice of circulatory system material was because it had a complicated concept, so it needed to be presented in an attractive manner. Then, the selection of material on biodiversity systems was very necessary to optimize electronic media that could make it easier for students to present diversity in the classroom.

The availability of learning media will facilitate interaction between teachers and students so that learning activities will be more effective and efficient (Puspitasari et al., 2018). The existence of learning media can facilitate ease of learning, foster interest in learning, and facilitate independent learning for students so that the learning process will be more effective (Surjanti et al., 2018). The use of android media can make students more interested in learning. Students are also more interested in using pictorial technology as opposed to using textbooks. Taking this into account, it is clear that there is an urgent need to optimize modern technology to be used as a learning media.

Based on the existing problems, it is clear that current research is needed to optimize learning media that can visualize learning material appropriately. The media should have a simple structure that focuses on one goal. Learning media that are expected to be useful (good) to overcome the learning problems mentioned before is media that is easy to carry and use anywhere. One of these media is android based media. The android-based media referred to in this article is presented in form of an e-booklet about the diversity of plants in Banjarnegara (named E-Bokartumban), and the circulatory system webcomic (named Androwebic). The media is expected to improve students' critical thinking skills and scientific attitudes.

Based on the problems above, the following questions can be formulated:

- How to improve students' critical thinking skills and scientific attitudes in biology learning using Android-based learning media?
- How do students and teachers respond to biology learning using Android-based learning media?

METHOD

Types of research

The type of research used in this research was pre-experimental, with a one group pretest-posttest design (Sugiyono, 2015).

Research Samples

The samples (subjects) of this study were 196 students of grade X from three high schools in Banjarnegara and 105 students of grade XI students from three high schools in Jepara. The sample/research subject was selected by using purposive sampling technique.

Research Data and Instruments

The data collected included data on critical thinking skills, student scientific attitudes, and teacher and student responses about Android-based media used in biology learning. The research instruments used included test and non-test sheets; interview sheet; observation sheet for students' scientific attitudes and environmental care; as well as student and teacher response questionnaire sheets. Test sheets (pretest and posttest) were used to measure the improvement of students' critical thinking skills and analytical thinking skills. The non-test sheet in form of an observation sheet is used to determine the scientific attitude and environmental care attitudes of students.

Data analysis

The data analysis technique in this study used descriptive qualitative and quantitative statistical methods. The data analysis techniques were (1) n-gain test to analyze data on students' critical thinking skills and analytical thinking skills; (2) qualitative analysis techniques were used to analyze data on scientific attitudes, environmental care for students, as well as data on the implementation of the learning process, and the responses of teachers and students regarding Android-based media used in Biology learning.

RESULTS AND DISCUSSION

Students' Critical Thinking Skills and Scientific Attitudes

Androwebic's role in learning Biology

Data on students' critical thinking skills and scientific attitudes in learning using Android-

based media (Androwebic and E-Bokartumban) were obtained from test results (pretest and posttest) and non-test. Student learning outcomes in learning using Android-based media

(Androwebic and E-Bokartumban) are presented in Table 1, Table 2, Table 3, Table 4, Table 5, Table 6, and Table 7.

Table 1. Students' Pretest and Posttest Score in Biology Learning Using Androwebic Media

Information	Pretest Score (n=105)	Posttest Score (n=105)
Highest score	93.33	100
Lowest score	13.33	60
Average value	53.65	88.83
Number of students completed	11	97
Number of students is not complete	94	8
Classical completeness%	10.48	92.38

Table 1 shows that there is a significant difference between the pretest and posttest scores obtained by students. The pretest results shows an average value of 53.65. This score is still less than the KKM, which has not reached the score of 75. The posttest score achieved by students averaged 88.83 (having exceeded the KKM by 75).

The improvement of students' analytical thinking skills was obtained from the results of the n-gain test on the pretest and posttest scores achieved by students. The results of the n-gain test are presented in Table 2

Table 2. The Results of N-Gain Test for Students' Analytical Abilities after Learning Process Using Androwebic Media

N	Percentage Category N-Gain (%)		
	High	Moderate	Low
105	72	24	4

From Table 2 it is known that most students achieved a high category increase. From these data it can also be stated that almost all students achieve an increase in critical thinking skills in the moderate to high category. The results of the analysis indicate that Biology learning using Androwebic media is effective in improving students' analytical abilities.

Androwebic media has such potential because it is equipped with various discussion questions that contain problems in the context of everyday life. This can stimulate students'

curiosity and encourage students to practice solving problems. Both activities require analytical thinking skills, so that students' abilities in this matter are properly trained. This is in accordance with the research of Prawita et al. (2019) and Sari et al. (2019) which stated that the use of learning media that presents problems can improve learning outcomes and analytical thinking skills in students.

During the discussion stage in learning using Androwebic media, students are directed to discuss with each other and exchange ideas about problem solutions systematically and logically. Thus students become trained to think analytically. This is in accordance with the statement of Sari et al. (2019) which proved that learning by actively involving students to solve problems can improve analytical thinking skills and student learning outcomes.

Information about students' scientific attitudes in learning using Androwebic media was obtained from the observation process using student scientific attitude observation sheets. Androwebic media was created specifically, in such a way that it had a number of useful facilities for practicing 6 aspects of a scientific attitude (see Table 3). The results of observations of students' scientific attitudes during the learning process using Androwebic media are presented in Table 3.

Table 3. Scores of Students' Scientific Attitudes During The Learning Process Using Androwebic Media

Indicator	Σ Score	Max Score	Score (%)	Criteria
Attention to every new thing	1086	1260	86.19	Very good
Appreciate and draw conclusions according to facts	1056	1260	83.81	Very good
Not always fell right, changing opinion after considering the evidence	1035	1260	82.14	Very good
Ask questions and give opinions	1124	1260	89.21	Very good
Participate in groups	1107	1260	87.86	Very good
Record complete observations	1068	1260	84.76	Very good
Average of each aspect			85.66	Very good

In Table 3, it can be seen that the average scientific attitude of students is in very good always motivated to learn and seek information independently, so that during the learning process in the classroom students showed a more right, dared to ask questions, dared to express opinions, be active in groups, and recorded complete observations. In the learning process students must solve discussion questions that contain contextual problems. Every activity carried out during the discussion process made a positive contribution to the formation of a scientific attitude. This is what can encourage

category. This happens because since the beginning of the learning process, students were attentive, respectful attitude, drawn conclusions according to facts. During the learning process, students were also accustomed not to feel always students to think analytically in solving problems. This is in accordance with the statement of Dwianto et al. (2017) that the application of learning media that presents contextual problems through discussion can make a positive contribution to the formation of scientific attitudes in student.

The role of E-Bokartumban in Biology learning

E-Bokartumban media hada components that could support in faciliating the competence of

critical thinking skills and evironmental care attitudes presented in Table 4.

Table 4. E- Bokartumban Media Components that facilitate critical thinking skills competencies

No.	Aspects and Indicators	Media Components
Critical thinking skills		
1	Give a simple explanation	Evaluation questions onthe media, students discussion sheets
2	Build basic skills	Evaluation questions onthe media, students discussion sheets
3	Conclude	Evaluation questions onthe media, students discussion sheets
4	Identify terms and consider a definition	Evaluation questions onthe media, students discussion sheets
5	Set strategy and tactics	Evaluation questions onthe media, students discussion sheets

Table 4 shows the media E- Bokartumban has a component that has a function for each competency that exist in the research of this research. According to Ennis in Goal for A Critical Thinking Curriculum is presented in journal Kartimi and Liliyasi (2012), there are five stages of thinking with each indicator, that are Giving simple explanation, Building basic skills, Summing up, Identifying terms and considering a definition, Setting strategies and tactics. This indicators of thinking can be measured when the students do the worksheets discussion and

evaluation questions that exist in the media. Wiguna et al. (2019) and Damopolil & Kurniadi (2019) which explains about the case of improving student learning outcomes after following the process of learning that implement Android-based media. Arista & Kuswanto (2018) stated that media that can be operated using a smartphone can increase enthusiasm, interest, and motivation in learning activities. All things that can enhance independence and understanding of concepts in students.

Table 5. E- Bokartumban Media Components that facilitate the competence of environmental care attitudes

No.	Aspects and Indicators	Media Components
Environmental Care Attitude		
1	have thought that plants and animals have rights were equal to hu mans	Introduction to the material
2	have feelings / emotions about human actions that cause disaster	Introduction to the material
3	have thinking that the environment is very fragile and easily disturbed balance	Student discussion sheets, material on the media
4	have feelings and tendencies of behavior that the tendency of human beings there is a limit in controlling nature	Student discussion sheets, material on the media
5	have a tendency of behavior to take advantage of the source power of nature that has been used	Student discussion sheets, material on the media
6	have a tendency of behavior not to be arbitrary towards the environment	Student discussion sheets, material on the media
7	havethoughts and attracted in environmental issues	Student discussion sheets, material on the media
8	have emotional feelings about actions that can cause	environmental damage

From Table 5 can be known the indicators of environmental care attitudes that used scale that was adapted from NEPS case of aspects, 1) have thought that plants and animals have rights were equal to humans, 2) have the feeling / emotional against the actions of man that cause disasters, 3) have thinking that the environment is very fragile and easily disturbed balance, 4) have feelings and the tendencies of behavior that the tendency of human beings there is a limit in controlling nature, 5) have a tendency of behavior to take advantage of the source power of nature that has been used, 6) have a tendency of behavior for not arbitrarily towards the environment, 7) has thoughts and attracted in environmental issues, and 8) have emotional feelings about actions that can cause environmental damage, can be measured as long as students using the media to read the material and when the process of discussion groups take place in learning process.

Learning with media E-Bokartumban can make a positive contribution in improving students' attitudes environmental care. Environmental care is an attitude and actions that always try to prevent damage to the surrounding natural environment and develop efforts to repair natural damage (Yaumi, 2014). An attitude of caring for the environment can be demonstrated by attitudes and actions that always try to prevent environmental damage and seek to repair natural damage that has occurred (Mardikaningtyas, 2016).

Based on the description in the paragraph above, can be stated that the use of media android-based learning is very effective to enhance students' understanding. This is in accordance with the opinion of Sudarsana et al. (2019) which stated that the use of technology-based learning media can improve student learning outcomes. Junaedi et al. (2018) and Damopolil & Kurniadi (2019) find that learning by applying android-based media can improve students' learning outcomes. Learning process that using technology can increase student interest and learning outcomes (Sudarsana et al., 2019). Wiguna et al. (2019) and Damopolil & Kurniadi (2019) reported the case of improving student learning outcomes after follow learning that implement Android-based media. This statement is also accordance with the explanation of Jeno et al. (2017), that stated the process of learning that uses Android-based media can improve student learning outcomes.

Results of Student and Teacher Responses to Learning Using Android-Based Biology Learning Media

Student and teacher responses to the learning process using Androwebic media

Student responses to learning using Androwebic media were obtained from student response questionnaires given at the end of the lesson. Information about students' positive responses to Androwebic media is presented in Table 6.

Table 6. Results of Student Responses to Androwebic Media

Indicators	Score Obtained	Max. Score	Percentage (%)	Criteria
Affective consideration	755	840	89.88	Very good
Learning	1116	1260	88.57	Very good
Multimedia display	2308	2520	91.59	Very good
Navigation	1487	1680	88.51	Very good
Robustness	1507	1680	89.40	Very good
Average			89.59	Very good

The data in Table 6 shows that the average of each aspect/indicator shows very good criteria. In some aspects, the student's response rate shows the maximum score. This showed that students were interested and motivated to learn with comics in the media. Apart from being interested and motivated by comics, students also admitted that the material equipped with pictures on Androwebic media was very helpful and made it easier for students to learn, because it was summarized in a structured manner. The problems presented in Androwebic media are also able to provide the right visualization. This makes it easier for students to understand abstract about the circulatory system. The use of appropriate learning media and in accordance

problem-based learning oriented which can increase student activity in learning activities. In the learning process, students not only listened, but also tried, found, and concluded. Therefore, students' understanding, analytical thinking skills, and scientific attitudes will be higher.

In terms of appearance, Androwebic media received high points, with very good criteria. This showed that students were very interested in the appearance of Androwebic media. Androwebic media is equipped with images on every detail of the material, so that it is circulatory material. Androwebic media can also help students understand and discover concepts with the character of students in learning, can help students to find concepts in context. The

media in question must be interesting, contain extensive learning resources, contain information that is presented with visual images. The use of a problem-based learning approach that is complemented by the use of learning media is proven to be able to foster student interest and motivation to be more active in learning so as to create enjoyable learning, understanding the

circulatory system material will increase (Maulana & Sulistyoningrum, 2018; Lee et al., 2015).

The level of positive response from the teacher to the implementation of the learning process using Androwebic media, obtained from the teacher's responses are presented in Table 7.

Table 7. Levels of Teacher's Positive Response to Androwebic Media

Indicators/aspects	Score Obtained	Max. Score	Percentage(%)	Criteria
Affective consideration	22	24	91.67	Very good
Learning	30	36	83.33	Very good
Multimedia display	64	72	88.89	Very good
Navigation	41	48	85.42	Very good
Robustness	42	48	87.50	Very good
Average			87.36	Very good

From the data in Table 7, it is known that the average score for each aspect is 87.36%, with the very good category. The teacher said that Androwebic media was very good, easy to use, up to date, the material presented was equipped with attractive visuals, could be used anytime and anywhere with the condition of using an android device. This confirmed by Sung et al. (2016) which stated that the use of Android devices such as smartphones in learning is better and more effective than conventional learning. Students are more enthusiastic because the learning process is student-centered, while the teacher only directs and guides. This is in accordance with the findings of Ali (2019) which proved that student-centered learning will improve students' ability to understand the material being studied and the ability to solve problems. In such circumstances, the teacher is sufficient to direct and guide as needed.

Student and Teacher Responses to The Learning Process Using E-Bokartumban Media

Media E-Bokartumban was used in this study is able to assist students in building material concept of biodiversity. Teachers also gave feedback positively on the activities of students in learning, because it made students becoming very enthusiastic when they hold discussions. The teacher said that the E-Bokartumban media was attractive, contemporary, easy to use, easy to carry, and the material presented was very clear.

Based on the results of data analysis, obtained information that the media Androwebic can train analytical thinking skills in students by 92.68% and scientific attitudes of 85.66%. Android-based media taken as positive by students and teachers. Levels of positive responses from students and teachers to the media media Androwebic of 89.59% and 87.36%. Based on that it can be concluded that the media Androwebic and E-Bokartumban were used in

Biologylearning was very potential to train critical thinking skills and scientific attitudes of students.

CONCLUSION

Two types of media based on Android, namely Androwebic and E-Bokartumban, which were used in biology learning had proven potential to train high school students' critical thinking skills and scientific attitudes.

The authors would like to thanks Prof. Dr. Enni Suwarsi Rahayu, M.Si., and Prof. Dr. Retno Sri Iswari, S.U., as the material expert validator, Dr. Budi Naini Mindayarto, M.App.Sc., and Mohammad Fikri, S.Sn (Pusdatin Kemendikbud) as media expert validators who have provided very useful suggestions for improving this research. This research was supported by the Lembaga Penelitian dan Pengabdian Masyarakat Universitas Negeri Semarang, which has funded this research.

REFERENCES

- Ali, S. S. (2019). Problem based learning: a student-centered approach. *English Language Teaching, 12*(5), 73-78.
- Amoah A. C., & Emmanuel E. (2018). Assessing the reasoning skills of biology students in selected senior high schools in the central region of Ghana. *International Journal of Scientific Research and Management (IJSRM), 6*(4), 299-304.
- Arista, F. S., & Kuswanto, H. (2018). Virtual physics laboratory application based on the android smartphone to improve learning independence and conceptual understanding. *International Journal of Instruction, 11*(1), 1-16.

- Damopolil, I., & Kurniadi, B. (2019). The development of android-based mobile learning supported by problem-based learning strategy for students' learning success. *International Journal of Scientific and Technology research*, 8(7), 190-193.
- Dwianto, A., Wilujeng, I., Prasetyo, Z. K., & Suryadarma, I. G. P. (2017). The development of science domain based learning tool which is integrated with local wisdom to improve science process skill and scientific attitude. *Jurnal Pendidikan IPA Indonesia*, 6(1), 23-31.
- Jeno, L. M., Grytnes, J. A., & Vandvik, V. (2017). The effect of a mobile-application tool on biology students' motivation and achievement in species identification: A Self-Determination Theory perspective. *Computer & Education*, 107, 1-12.
- Junaedi, J., Irviani, R., Muslihudin, M., Hidayat, S., Maselena, A., Gumanti, M., & Fauzi, A. N. (2018). Application program learning based on android for students experiences. *International Journal of Engineering and Technology (UAE)*, 7(2.27), 194-198.
- Kartimi, & Liliarsari. (2012). Pengembangan Alat Ukur Berpikir Kritis pada Konsep Termokimia untuk Siswa SMA Berperingkat Atas dan Menengah. *Jurnal Pendidikan IPA Indonesia*, 1(1), 21-26.
- Lee, S., Kang, E., & Kim, H. B. (2015). Exploring impact of students' learning approach on collaborative group modeling of blood circulation. *Journal of Science Education and Technology*, 24(2), 234-255.
- Mardikaningtyas, A. D. (2016). Pengembangan Pembelajaran Pencemaran Lingkungan berbasis Penelitian Fitoremediasi untuk Menunjang Keterampilan Ilmiah, Sikap Peduli Lingkungan, dan Motivasi pada Matakuliah Dasar-dasar Ilmu Lingkungan. *Jurnal Pendidikan: Teori, Penelitian, dan Pengembangan*, 1(3), 499-506.
- Maulana, H., & Sulistyoningrum. (2018). Implementation Mirror Technique 3D Objects for Interactive Learning Media "Circulatory System" Virtual Reality-Based. *Journal of Physics: Conference Series*, 1364 012036.
- Mutakinati, L., Anwari, I., & Yoshisuke, K. (2018). Analysis of students' critical thinking skill of middle school through STEM education project-based learning. *Jurnal Pendidikan IPA Indonesia*, 7(1), 54-65.
- Prawita, W., Prayitno, B. A., & Sugiyarto. (2019). Effectiveness of generative learning-based biology module to improve the analytical thinking skills of the students with high and low reading motivation. *International Journal of Instruction*, 12(1), 1459-1476.
- Pujiasih, P., Wiwi I., & Saiful R. (2020). Android-based e-booklet development to train students' critical thinking and attitude of caring for environment. *Journal of Innovative Science Education*, 10(1), 95-101.
- Puspita, I., Kaniawati, I., & Suwarma, R. (2017). Analysis of critical thinking skills on the topic static fluid. *Journal of Physics: Conference Series*, 895 012100.
- Puspitasari, E. D. T., Surjono, H. D., & Minghat, A. D. (2018). Utilizing web based learning as 21st century learning media for vocational education. *International Journal of Engineering & Technology*, 7(4.33), 157-160.
- Sari, R., Perdana, R., Riwayani, Jumadi, Wilujeng, I., & Kuswanto, H. (2019) The implementation of problem-based learning model with online simulation to enhance the student's analytical thinking skill in learning physics. *Journal of Physics: Conference Series*, 1233012030.
- Sudarsana, I. K., Nakayanti, A. R., Saptia, S., Haimah, Satria, E., Saddhono, K., GS, D. A., Putut, E., Helda, T., & Mursalin, M. (2019). Technology application in education and learning process. *Journal of Physics: Conference Series*, 1363 012061.
- Sugiyono. (2015). *Metode penelitian pendidikan*. Bandung: Alfabeta.
- Sung, H. Y., Hwang, G. J., Chen, C. Y., & Liu, W. X. (2019). A contextual learning model for developing interactive e-books to improve students' performances of learning the analects of confucius. *Interactive Learning Environments*, 1-14.
- Surjanti, J., Seno, D. N., Hadi, H. K., Maroah, S., Siswanti, Y., Muafi., & Isfianadewi, D. (2018). The role of m-learning on effective learning media in higher education. *International Journal of Civil Engineering and Technology*, 9(4), 77-85.
- Wiguna, D., Irwansyah, F. S., Windayani, N., Aulawi, H., & Ramdhani, M. A. (2019). Development of android-based chemistry learning media oriented towards generic

science skills. *Journal of Physics: Conference Series*, 1157 042047.

Yaumi, M. (2014). *Pendidikan karakter: landasan, pilar, dan implementasi*. Jakarta: Kencana.

LAMPIRAN 2.2
PROSES REVIEW KE-1



POTENTIAL ANALYSIS OF THE ANDROID-BASED LEARNING MEDIA AS A MEANS TO TRAIN CRITICAL THINKING SKILLS AND SCIENTIFIC ATTITUDES

DOI:

Accepted: Approved: Published: ...

ABSTRACT

This study aims to analyze and describe the potential of Android-based learning media to train students' critical thinking skills and scientific attitudes. The learning media were Andro-Webcomic (called Androwebic) and E-Booklet of plant diversity in Banjarnegara (abbreviated as E-Bokartumban). This research was pre-experimental, the type of One Group Pretest-Posttest Design. The research subjects were 196 tenth-grade students from three high schools in Banjarnegara and 105 eleventh-grade students from three high schools in Jepara. The sample was determined using the purposive sampling technique. The data collected included critical thinking skills, students' scientific attitudes, and teacher and student responses. The instruments used were test and non-test sheets, interview sheets, observation sheets for students' scientific attitudes and environmental care, and student and teacher response questionnaires. Data were analyzed using qualitative descriptive statistics and quantitative (n-gain test). The results showed that: (1) E-Bokartumban media had a supporting component in facilitating competence of analytical thinking and caring for the environment. Androwebic media was able to train 92.38% analytical thinking skills and a scientific attitude of 85.66%. (2) Student and teacher responses to Androwebic were 89.59% and 87.36%. Conclusion: Android-based media in the form of Androwebic and E-Bokartumban has the potential to train critical thinking skills, environmental care, analytical thinking skills, and scientific attitudes.

© 20xx Science Education Study Program FMIPA UNNES Semarang

Keywords: androwebic; e-bokartumban; critical thinking skills; scientific attitude

INTRODUCTION

Biology learning involves skills and

Students who have critical thinking skills will find

reasoning (Amoah & Emmanuel, 2018). In developing reasoning power and skills, learning can emphasize the aspects of the application, analysis, synthesis, and evaluation, not only emphasizing aspects of understanding and knowledge. For this reason, a learning process is needed that can improve cognitive, affective, psychomotor competencies, as well as learning methods that can motivate students to be creative, confident, and think critically (Pujiasih et al., 2020). Students can think critically in learning, but this ability sometimes does not develop properly. Therefore, it is necessary to use methods that can develop students' critical thinking skills.

it easy to analyze, evaluate, and relate to evidence or arguments before deciding or assessing information (Mutakinati et al., 2018). Students' critical thinking skills play an essential role in achieving learning achievement, formal reasoning, and creativity (Puspita et al., 2017).

Textbooks and modules still dominate biology learning in schools with a few pictures, and learning is still teacher-centered. It causes the students' mindset to be limited, and their understanding of biology concepts weakens, so their critical thinking skills and scientific attitudes are still weak. This statement was strengthened by the results of interviews by several teachers of

- Commented [U1]:** INTRODUCTION should:
- contain urgency (importance) to research
 - contain a carrying capacity in the form of supporting data and facts
 - contain a preliminary study as a basis for the importance of the research conducted
 - contain a GAP ANALYSIS Departing from the preliminary study, analysis of published articles formulated in the Gap analysis
 - GAPANALYSIS refers to articles published in various internationally reputable journals to emphasize the novelty of research.
 - clear limitation of research objectives

SMA/MA in Banjarnegara and Jepara. The information obtained from the interviews included: (1) The learning had not made optimal use of student-centered media; (2) Students were allowed to bring smartphones, but it had not been well utilized; (3) Teachers had not used technology (smartphones) as a tool or media that could support learning; (4) limited learning time.

Based on the results of interviews with the teacher, it could be concluded that these problems could be minimized by utilizing technology owned by students and making maximum use of student-centered learning in the learning process. In this case, a subject matter needs to be taught using learning media, including material on the circulatory system and material on biodiversity systems. The choice of circulatory system material was because it had a complicated concept, so it needed to be presented attractively. Then, the selection of material on biodiversity systems was necessary to optimize electronic media to make it easier for students to present diversity in the classroom.

The availability of learning media will facilitate interaction between teachers and students so that learning activities will be more effective and efficient (Puspitasari et al., 2018). Learning media can facilitate ease of learning, foster interest in learning, and facilitate independent learning for students so that the learning process will be more effective (Surjanti et al., 2018). The use of android media can make students more interested in learning. Students are also more interested in using pictorial technology as opposed to using textbooks. Considering this, it is clear that there is an urgent need to optimize modern technology to be used as a learning medium.

Based on the existing problems, it is clear that current research is needed to optimize learning media that can visualize learning material appropriately. The media should have a simple structure that focuses on one goal. Learning media that are expected to be useful (good) to overcome the learning problems mentioned before is easy to carry and use anywhere. One of these media is Android-based media. The android-based media referred to in this article is presented in an e-booklet about the diversity of plants in Banjarnegara (named E-Bokartumban) and the circulatory system webcomic (named Androwebic). The media is expected to improve students' critical thinking skills and scientific attitudes.

Based on the problems above, the following questions can be formulated:

- How to improve students' critical thinking skills and scientific attitudes in biology learning using Android-based learning media?

- How do students and teachers respond to biology learning using Android-based learning media?

METHOD

Types of research

The type of research used was pre-experimental, with a one-group pretest-posttest design (Sugiyono, 2015).

Research Samples

This study's samples (subjects) were 196 tenth-grade students from three high schools in Banjarnegara and 105 eleventh-grade students from three high schools in Jepara. The sample/research subject was selected by using the purposive sampling technique.

Research Data and Instruments

The data collected included critical thinking skills, student scientific attitudes, and teacher and student responses about Android-based media used in biology learning. The research instruments used included test and non-test sheets, interview sheets, observation sheets for students' scientific attitudes and environmental care, and student and teacher response questionnaire sheets. Test sheets (pretest and posttest) were used to measure the improvement of students' critical thinking skills and analytical thinking skills. The non-test sheet in the form of an observation sheet is used to determine students' scientific and environmental care attitudes.

Data analysis

The data analysis technique in this study used descriptive qualitative and quantitative statistical methods. The data analysis techniques were (1) n-gain test to analyze data on students' critical thinking skills and analytical thinking skills; (2) qualitative analysis techniques were used to analyze data on scientific attitudes, environmental care for students, as well as data on the implementation of the learning process, and the responses of teachers and students regarding Android-based media used in Biology learning.

RESULTS AND DISCUSSION

Students' Critical Thinking Skills and Scientific Attitudes

Androwebic's role in learning Biology

Data on students' critical thinking skills and scientific attitudes in learning using Android-based media (Androwebic and E-Bokartumban) were obtained from test results (pretest and posttest) and non-test. Student learning outcomes in learning using Android-based media (Androwebic and E-Bokartumban) are presented in Table 1, Table 2, Table 3, Table 4, Table 5, Table 6, and Table 7.

Commented [U2]: METHODS should

- contain detailed research stages
- Each stage is explained and analyzed by what method
- Data analysis must be with clear references
- The research instruments used were elaborated to the data analysis technique
- It is hoped that there will be a modification in the stages of research from sources referred by the researcher

Commented [U3]: RESULTS AND DISCUSSION

- Tables or graphs (one selected) must represent different results
 - The results of data analysis must be strong in answering the analysis gap
 - Display of results other than those narrated in table-graph-image-modeling
 - The research novelty has not been clear enough
 - It is recommended not to repeat the references in the introduction, using previous research findings.
 - References used should be taken from reputable journals.
- It is necessary to explain the specifications of the findings in this study that show

Table 1. Students' Pretest and posttest Score in Biology Learning Using Androwebic Media

Information	Pretest Score (n=105)	Posttest Score (n=105)
Highest score	93.33	100
Lowest score	13.33	60
Average value	53.65	88.83
Number of students completed	11	97
The number of students is not complete	94	8
Classical completeness%	10.48	92.38

Table 1 shows that there is a significant difference between the pretest and posttest scores obtained by students. The pretest results show an average score of 53.65. This score is still less than the KKM, which has not reached the score of 75. The posttest score is achieved by students averaged 88.83 (having exceeded the KKM by 75).

The improvement of students' analytical thinking skills was obtained from the results of the n-gain test on the pretest and posttest scores achieved by students. The results of the n-gain test are presented in Table 2

Table 2. The Results of N-Gain Test for Students' Analytical Abilities after Learning Process Using Androwebic Media

N	Percentage Category N-Gain (%)		
	High	Moderate	Low
105	72	24	4

From Table 2, it is known that most students achieved a high category increase. From these data, it can also be stated that almost all students increase critical thinking skills in the moderate to high category. The analysis results indicate that Biology learning using Androwebic media is effective in improving students' analytical abilities.

Androwebic media has such potential because it is equipped with various discussion

questions that contain problems in everyday life. This can stimulate students' curiosity and encourage students to practice solving problems. Both activities require analytical thinking skills so that students' abilities in this matter are correctly trained. This is under the research of Prawita et al. (2019) and Sari et al. (2019), which state that learning media that presents problems can improve students' learning outcomes and analytical thinking skills.

During the discussion stage in learning using Androwebic media, students are directed to discuss and exchange ideas about problem solutions systematically and logically. Thus, students become trained to think analytically. This is per Sari et al. (2019) statement, which proves that learning by actively involving students to solve problems can improve analytical thinking skills and student learning outcomes.

Information about students' scientific attitudes in learning using Androwebic media was obtained from the observation process using student scientific attitude observation sheets. Androwebic media was explicitly created to have several proper facilities for practicing six aspects of a scientific attitude (see Table 3). The results of observations of students' scientific attitudes during the learning process using Androwebic media are presented in Table 3.

Table 3. Scores of Students' Scientific Attitudes During The Learning Process Using Androwebic Media

Indicator	Σ Score	Max Score	Score (%)	Criteria
Attention to every new thing	1086	1260	86.19	Very good
Appreciate and conclude according to facts	1056	1260	83.81	Very good
Not always fell right, changing opinion after considering the evidence	1035	1260	82.14	Very good
Ask questions and give opinions	1124	1260	89.21	Very good
Participate in groups	1107	1260	87.86	Very good
Record complete observations	1068	1260	84.76	Very good
Average of each aspect			85.66	Very good

In Table 3, it can be seen that students' average scientific attitude is in a very good category. This happens because, since the beginning of the learning process, students were always motivated to learn and seek information independently, so that during the learning process

in the classroom, students showed a more attentive, respectful attitude, drew conclusions according to facts. Students were also accustomed not to feeling always right, dared to ask questions, express opinions, be active in groups, and record complete observations during the learning process.

In the learning process, students must solve problems. This is by the statement of Dwianto et al. (2017) that the application of learning media problems. Every activity carried out during the that presents contextual problems through discussion process positively contributed to the discussion can positively contribute to students' formation of a scientific attitude. This is what can formation of scientific attitudes. encourage students to think analytically in solving

The role of E-Bokartumban in Biology learning

E-Bokartumban media had components thinking skills and environmental care attitudes that could facilitate the competence of critical presented in Table 4.

Table 4. E- Bokartumban Media Components that facilitate critical thinking skills competencies

No.	Aspects and Indicators	Media Components
Critical thinking skills		
1	Give a simple explanation	Evaluation questions on the media, students discussion sheets
2	Build basic skills	Evaluation questions on the media, students discussion sheets
3	Conclude	Evaluation questions on the media, students discussion sheets
4	Identify terms and consider a definition	Evaluation questions on the media, students discussion sheets
5	Set strategy and tactics	Evaluation questions on the media, students discussion sheets

Table 4 shows the media E- Bokartumban the discussion worksheet and evaluation questions has a component that has a function for each in the media. Wiguna et al. (2019) and Damopolil competency that exists in this research. According and Kurniadi (2019) explain the case of improving to Ennis in Goal for A Critical Thinking student learning outcomes after following the Curriculum is presented in journal Kartimi and process of learning that implement Android-based Liliarsari (2012), there are five stages of thinking media. Arista and Kuswanto (2018) state that with each indicator, that are Giving simple smartphone-based media can increase enthusiasm, explanation, Building basic skills, Summing up, interest, and motivation in learning activities. All Identifying terms, and considering a definition, things can enhance independence and Setting strategies and tactics. These thinking understanding of concepts in students. indicators can be measured when the students do

Table 5. E- Bokartumban Media Components that facilitate the competence of environmental care attitudes

No.	Aspects and Indicators	Media Components
Environmental Care Attitude		
1	have thought that plants and animals have rights were equal to hu mans	Introduction to the materials
2	have feelings/emotions about human actions that cause disaster	Introduction to the materials
3	have thought that the environment is very fragile and easily disturbed balance	Student discussion sheets, materials on the media
4	have feelings and tendencies of behavior that the tendency of human beings there is a limit in controlling nature	Student discussion sheets, materials on the media
5	tend to take advantage of the source power of nature that has been used	Student discussion sheets, materials on the media
6	tend not to be arbitrary towards the environment	Student discussion sheets, materials on the media
7	have thoughts and attracted to environmental issues	Student discussion sheets, materials on the media
8	have emotional feelings about actions that can cause environmental damage	Student discussion sheets, materials on the media

From Table 5 can be known the indicators and easily disturbed balance, 4) have feelings and of environmental care attitudes that used a scale that the tendencies of behavior that the tendency of was adapted from NEPS case of aspects, 1) have human beings there is a limit in controlling nature, thought that plants and animals have rights were 5) have a tendency of behavior to take advantage equal to humans, 2) have the feeling / emotional of the source power of nature that has been used, against the actions of man that cause disasters, 3) 6) have a tendency of behavior for not arbitrarily have thought that the environment is very fragile towards the environment, 7) has thoughts and

attracted in environmental issues, and 8) have emotional feelings about actions that can cause environmental damage, can be measured as long as students using the media to read the material and when the process of discussion groups take place in the learning process.

Learning with media E-Bokartumban can make a positive contribution in improving students' attitudes to environmental care. Environmental care is an attitude and action that always try to prevent damage to the surrounding natural environment and develop efforts to repair natural damage (Yaumi, 2014). An attitude of caring for the environment can be demonstrated by attitudes and actions that always try to prevent environmental damage and seek to repair natural damage (Mardikaningtyas, 2016).

Based on the description in the paragraph above, it can be stated that the use of media android-based learning is very effective to enhance students' understanding. This is under Sudarsana et al. (2019), which state that technology-based learning media can improve student learning outcomes. Junaedi et al. (2018) and Damopolil

and Kurniadi (2019) find that applying android-based media can improve students' learning outcomes. The learning process using technology can increase student interest and learning outcomes (Sudarsana et al., 2019). Wiguna et al. (2019) and Damopolil and Kurniadi (2019) reported the case of improving student learning outcomes after learning with Android-based media. This statement is also by the explanation of Jeno et al. (2017), which states that learning using Android-based media can improve student learning outcomes.

Results of Student and Teacher Responses to Learning Using Android-Based Biology Learning Media

Student and teacher responses to the learning process using Androwebic media

Student responses to learning using Androwebic media were obtained from student response questionnaires given at the end of the lesson. Information about students' positive responses to Androwebic media is presented in Table 6.

Table 6. Results of Student Responses to Androwebic Media

Indicators	Score Obtained	Max. Score	Percentage (%)	Criteria
Affective consideration	755	840	89.88	Very good
Learning	1116	1260	88.57	Very good
Multimedia display	2308	2520	91.59	Very good
Navigation	1487	1680	88.51	Very good
Robustness	1507	1680	89.40	Very good
Average			89.59	Very good

The data in Table 6 shows that the average of each aspect/indicator shows very good criteria. In some aspects, the student's response rate shows the maximum score. This showed that students were interested and motivated to learn with comics in the media. Apart from being interested and motivated by comics, students also admitted that the material equipped with pictures on Androwebic media was beneficial and made it easier for students to learn because it was summarized in a structured manner. The problems presented in Androwebic media are also problem-based learning-oriented, increasing student activity in learning activities. In the learning process, students not only listened but also tried, found, and concluded. Therefore, students' understanding, analytical thinking skills, and scientific attitudes will be higher.

In terms of appearance, Androwebic media received high points, with very good criteria. This showed that students were very interested in the appearance of Androwebic media. Androwebic media is equipped with images on

every detail of the material to provide the correct visualization. This makes it easier for students to understand abstract circulatory material. Androwebic media can also help students understand and discover concepts about the circulatory system. The use of appropriate learning media and following students' character in learning can help students find concepts in context. The media in question must be interesting, contain extensive learning resources, and contain information presented with visual images. The use of a problem-based learning approach that is complemented by the use of learning media is proven to be able to foster student interest and motivation to be more active in learning to create enjoyable learning, understanding the circulatory system material will increase (Maulana & Sulistyoningrum, 2018; Lee et al., 2015).

The level of positive response from the teacher to the implementation of the learning process using Androwebic media obtained from the teachers' responses is presented in Table 7.

Table 7. Levels of Teacher's Positive Response to Androwebic Media

Indicators/aspect s	Score Obtained	Max. Score	Percentage (%)	Criteria
Affective consideration	22	24	91.67	Very good
Learning	30	36	83.33	Very good
Multimedia display	64	72	88.89	Very good
Navigation	41	48	85.42	Very good
Robustness	42	48	87.50	Very good
Average			87.36	Very good

From the data in Table 7, it is known that the average score for each aspect is 87.36%, with the very good category. The teacher said that Androwebic media was very good, easy to use, up to date. The material presented was equipped with attractive visuals, could be used anytime and anywhere with the condition of using an android device. This is confirmed by Sung et al. (2016), which stated that Android devices such as smartphones are better and more effective than conventional learning. Students are enthusiastic because the learning process is student-centered, while the teacher only directs and guides. This is following the findings of Ali (2019), which prove that student-centered learning will improve

students' ability to understand the material being studied and problem-solving skills. In such circumstances, the teacher is sufficient to direct and guide as needed.

Student and Teacher Responses to The Learning Process Using E-Bokartumban Media

Media E-Bokartumban was used in this study can assist students in building the material concept of biodiversity. Teachers also gave feedback positively on the activities of students in learning because it made students very enthusiastic when they held discussions. The teacher said that the E-Bokartumban media was attractive,

contemporary, easy to use, easy to carry, and the material presented was evident.

Based on the results of data analysis, obtained information that the media Androwebic can train analytical thinking skills in students by 92.68% and scientific attitudes of 85.66%. Android-based media is taken as positive by students and teachers. Levels of positive responses from students and teachers to the media Androwebic were 89.59% and 87.36%. Based on that, it can be concluded that the media Androwebic and E-Bokartumban were used in Biology learning was very potential to train students' critical thinking skills and scientific attitudes.

CONCLUSION

Two types of media based on Android, namely Androwebic and E-Bokartumban, which were used in biology learning, had proven

potential to train high school students' critical thinking skills and scientific attitudes.

The authors would like to thanks Prof. Dr. Enni Suwarsi Rahayu, M.Si., and Prof. Dr. Retno Sri Iswari, S.U., as the material expert validator, Dr. Budi Naini Mindayarto, M.App.Sc., and Mohammad Fikri, S.Sn (Pusdatin Kemendikbud) as media expert validators who have provided very useful suggestions for improving this research. This research was supported by the Lembaga Penelitian dan Pengabdian Masyarakat Universitas Negeri Semarang, which has funded this research.

REFERENCES

- Ali, S. S. (2019). Problem-based learning: a student-centered approach. *English Language Teaching*, 12(5), 73-78.
- Amoah A. C., & Emmanuel E. (2018). Assessing the reasoning skills of biology students in selected senior high schools in the central region of Ghana. *International Journal of Scientific Research and Management (IJSRM)*, 6(4), 299-304.
- Arista, F. S., & Kuswanto, H. (2018). Virtual physics laboratory application based on the android smartphone to improve learning independence and conceptual understanding. *International Journal of Instruction*, 11(1), 1-16.
- Damopolil, I., & Kurniadi, B. (2019). The development of android-based mobile learning supported by problem-based learning strategy for students' learning success. *International Journal of Scientific and Technology Research*, 8(7), 190-193.
- Dwianto, A., Wilujeng, I., Prasetyo, Z. K., & Suryadarma, I. G. P. (2017). The development of science domain based learning tool which is integrated with local wisdom to improve science process skill and scientific attitude. *Jurnal Pendidikan IPA Indonesia*, 6(1), 23-31.
- Jeno, L. M., Grytnes, J. A., & Vandvik, V. (2017). The effect of a mobile-application tool on biology students' motivation and achievement in species identification: A

Commented [U4]: The conclusion part should be answer the research questions. Make it concise and clear into one main paragraph.

Commented [U5]: Make it in the Acknowledgement part. Include the contract number of the funding letter.

Commented [U6]: 1. Please provide at least **30 references** which 80% of them are taken from **the last 10 years (>2011)** articles of no-predatory journals, written in accordance with the APA Standard. You may go to Google Scholar and find the right format for APA Style provided.

2. For books, please refer to the original/primary book reference no matter the date.

3. All of the listed references must be cited in the body of the article, and vice versa.

- Self-Determination Theory perspective. *Computer & Education*, 107, 1-12.
- Junaedi, J., Irviani, R., Muslihudin, M., Hidayat, S., Maselena, A., Gumanti, M., & Fauzi, A. N. (2018). Application program learning based on Android for students experiences. *International Journal of Engineering and Technology (UAE)*, 7(2.27), 194-198.
- Kartimi, & Liliasari. (2012). Pengembangan Alat Ukur Berpikir Kritis pada Konsep Termokimia untuk Siswa SMA Berperingkat Atas dan Menengah. *Jurnal Pendidikan IPA Indonesia*, 1(1), 21-26.
- Lee, S., Kang, E., & Kim, H. B. (2015). Exploring impact of students' learning approach on collaborative group modeling of blood circulation. *Journal of Science Education and Technology*, 24(2), 234-255.
- Mardikaningtyas, A. D. (2016). Pengembangan Pembelajaran Pencemaran Lingkungan berbasis Penelitian Fitoremediasi untuk Menunjang Keterampilan Ilmiah, Sikap Peduli Lingkungan, dan Motivasi pada Matakuliah Dasar-dasar Ilmu Lingkungan. *Jurnal Pendidikan: Teori, Penelitian, dan Pengembangan*, 1(3), 499-506.
- Maulana, H., & Sulistyoningrum. (2018). Implementation Mirror Technique 3D Objects for Interactive Learning Media "Circulatory System" Virtual Reality-Based. *Journal of Physics: Conference Series*, 1364 012036.
- Mutakinati, L., Anwari, I., & Yoshisuke, K. (2018). Analysis of students' critical thinking skill of middle school through STEM education project-based learning. *Jurnal Pendidikan IPA Indonesia*, 7(1), 54-65.
- Prawita, W., Prayitno, B. A., & Sugiyarto. (2019). Effectiveness of generative learning-based biology module to improve the analytical thinking skills of the students with high and low reading motivation. *International Journal of Instruction*, 12(1), 1459-1476.
- Pujiasih, P., Wiwi I., & Saiful R. (2020). Android-based e-booklet development to train students' critical thinking and attitude of caring for environment. *Journal of Innovative Science Education*, 10(1), 95-101.
- Puspita, I., Kaniawati, I., & Suwarma, R. (2017). Analysis of critical thinking skills on the topic static fluid. *Journal of Physics: Conference Series*, 895 012100.
- Puspitasari, E. D. T., Surjono, H. D., & Minghat, A. D. (2018). Utilizing web based learning as 21st century learning media for vocational education. *International Journal of Engineering & Technology*, 7(4.33), 157-160.
- Sari, R., Perdana, R., Riwayani, Jumadi, Wilujeng, I., & Kuswanto, H. (2019) The implementation of problem-based learning model with online simulation to enhance the student's analytical thinking skill in learning physics. *Journal of Physics: Conference Series*, 1233012030.
- Sudarsana, I. K., Nakayanti, A. R., Sapta, S., Haimah, Satria, E., Saddhono, K., GS, D. A., Putut, E., Helda, T., & Mursalin, M. (2019). Technology application in education and learning process. *Journal of Physics: Conference Series*, 1363 012061.
- Sugiyono. (2015). *Metode penelitian pendidikan*. Bandung: Alfabeta.
- Sung, H. Y., Hwang, G. J., Chen, C. Y., & Liu, W. X. (2019). A contextual learning model for developing interactive e-books to improve students' performances of learning the analects of confucius. *Interactive Learning Environments*, 1-14.
- Surjanti, J., Seno, D. N., Hadi, H. K., Maroah, S., Siswanti, Y., Muafi., & Isfianadewi, D. (2018). The role of m-learning on effective learning media in higher education. *International Journal of Civil Engineering and Technology*, 9(4), 77-85.
- Wiguna, D., Irwansyah, F. S., Windayani, N., Aulawi, H., & Ramdhani, M. A. (2019). Development of android-based chemistry learning media oriented towards generic science skills. *Journal of Physics: Conference Series*, 1157 042047.
- Yaumi, M. (2014). *Pendidikan karakter: landasan, pilar, dan implementasi*. Jakarta: Kencana.

Paper title: POTENTIAL ANALYSIS OF THE ANDROID-BASED LEARNING MEDIA AS A MEANS TO TRAIN CRITICAL THINKING SKILLS AND SCIENTIFIC ATTITUDES.

Parts of review	Guidelines	Yes	Partly		Reviewer's note for improvement	Author's responds (highlight of revision)
			ly	No		
Title	• Does the subject matter fit within the scope of journal?	/				
	• Does the title clearly and sufficiently reflect its contents?	/				
Abstract	• Does the abstract contain informative, including Background, Methods, Results and Conclusion?	/				
Back-ground	• Is the background informative and sufficient (include the background problem and objectives)?		/			
	• Is research question of the study clear and understandable?		/			
	• Does the rationale of the study clearly explained using relevant literature?		/			
	• Is the "aim" of the manuscript clear and understandable?	/				
Methods	• Is the methodology chosen suitable to the nature of the topic studied?		/			
	• Is the methodology of the research described clearly?(including study design, location, subjects, data collection, data analysis)		/			
	• Is there adequate information about the data collection tools used? (only for empirical studies)		/			
	• Are the validity and reliability of data collection tools established? (only for empirical studies)	/				
Results & Discussion	• Are the data collection tools suitable for the methodology of the study? (only for empirical studies)		/			
	• Are the tables, graphs and pictures understandable, well presented and numbered consecutively?		/			
	• Do the data analysis and the interpretation appropriate to the problem and answer the objectives?		/			
	• Does the "discussion" section of the manuscript adequately relate to the current and relevant literature?		/			
Conclusion	• Are the findings discussed adequately considering the research question(s), sub-question(s) or hypothesis?		/			
	• Is the conclusion clear and in the form of a narration instead of pointers?		/			
References	• Isn't the conclusion a summary and consistent between problems, objectives and conclusion?		/			
	• Do the references and citations match?		/		Add the latest sources from reputable journals.	
Quality Criteria	• Are the writing of references correct?		/			
	• Do the title, problem, objectives, methods and conclusion are in line? Is it well organized?		/			
	• The quality of the language is satisfactory		/			
	• The work relevant and novel		/			
	• Are there strong consistencies among the parts of the manuscript? (introduction, methods, results and discussion, and conclusion)		/			

LAMPIRAN 2.3
PROSES REVISI KE-1



POTENTIAL ANALYSIS OF THE ANDROID-BASED LEARNING MEDIA AS A MEANS TO TRAIN CRITICAL THINKING SKILLS AND SCIENTIFIC ATTITUDES

W. Isnaeni*¹, Y. A. Sujatmiko², S. Ridlo³, Pujiasih⁴

^{1,2,3,4}Natural Science Education Study Program Concertation in Biology, Faculty of Postgraduate, Universitas Negeri Semarang, Indonesia

DOI:

Accepted: Approved: Published: ...

ABSTRACT

This study aims to analyze and describe the potential of Android-based learning media to train students' critical thinking skills and scientific attitudes. The learning media were Andro-Webcomic (called Androwebic) and E-Booklet of plant diversity in Banjarnegara (abbreviated as E-Bokartumban). This research was pre-experimental, the type of One Group Pretest-Posttest Design. The research subjects were 196 tenth-grade students from three high schools in Banjarnegara and 105 eleventh-grade students from three high schools in Jepara. The sample was determined using the purposive sampling technique. The data collected included critical thinking skills, students' scientific attitudes and environment care attitudes, and teacher and student responses. The instruments used were test and non-test sheets, interview sheets, observation sheets for students' scientific attitudes and environmental care, and student and teacher response questionnaires. Data were analyzed using qualitative descriptive statistics and quantitative (n-gain test). The results showed that: (1) E-Bokartumban media had a supporting component in facilitating competence of analytical thinking and caring for the environment. Androwebic media was able to train 92.38% analytical thinking skills and a scientific attitude of 85.66%. (2) Student and teacher responses to Androwebic were 89.59% and 87.36%. Conclusion: Android-based media in the form of Androwebic and E-Bokartumban has the potential to train critical thinking skills, environmental care, and scientific attitudes.

© 20xx Science Education Study Program FMIPA UNNES Semarang

Keywords: androwebic; e-bokartumban; critical thinking skills; scientific attitude

INTRODUCTION

Biology learning involves skills and

reasoning (Amoah & Emmanuel, 2018). In developing reasoning power and skills, learning can emphasize the aspects of the application, analysis, synthesis, and evaluation, not only emphasizing aspects of understanding and knowledge. For this reason, a learning process is needed that can improve cognitive, affective, psychomotor competencies, as well as learning methods that can motivate students to be creative, confident, and think critically (Pujiasih et al., 2020). Critical thinking skills are needed to assess information, explain reasons and solve problems

(Thomas, 2011). Teaching critical thinking and

problem solving skills can be done with problem-based learning/PBL (Yew & Goh, 2016). Students can think critically in learning, but this ability sometimes does not develop properly. Therefore, it is necessary to use methods that can develop students' critical thinking skills. Students who have critical thinking skills will find it easy to analyze, evaluate, and relate to evidence or arguments before deciding or assessing information (Mutakinati et al., 2018). Students' critical thinking skills play an essential role in achieving learning achievement, formal

Commented [U1]: INTRODUCTION should:

- contain urgency (importance) to research
 - contain a carrying capacity in the form of supporting data and facts
 - contain a preliminary study as a basis for the importance of the research conducted
 - contain a GAP ANALYSIS Departing from the preliminary study, analysis of published articles formulated in the Gap analysis
- GAP ANALYSIS refers to articles published in various internationally reputable journals to emphasize the novelty of research.
- clear limitation of research objectives

reasoning, and creativity (Puspita et al., 2017). Learning that facilitates critical thinking skills can be realized if there is cooperation and participation from all parties, ranging from policy makers, teacher universities, local education departments, schools, and families (Nhat et al, 2018). The results of research by Seventika et al (2018) show that students' critical thinking skills (in vocational schools/vocational schools) are still low.

Textbooks and modules still dominate biology learning in schools with a few pictures, and learning is still teacher-centered. It causes the students' mindset to be limited, and their understanding of biology concepts weakens, so their critical thinking skills and scientific attitudes are still weak. This statement was strengthened by the results of interviews by several teachers of SMA/MA in Banjarnegara and Jepara. The information obtained from the interviews included: (1) The learning had not made optimal use of student-centered media; (2) Students were allowed to bring smartphones, but it had not been well utilized; (3) technology (smartphone) as a tool or media that does not support learning, (4) limited learning time.

Based on the results of interviews with teachers, it can be concluded that these problems can be minimized by utilizing the technology owned by students, and utilizing student-centered learning strategies to the fullest. Examples of biological materials that need to be taught using media are the circulatory system and biodiversity. The material of the circulatory system needs to be studied with the media because it contains complex concepts, so that it can be presented in a more interesting way. Biodiversity material (especially plant diversity) also really needs to be taught by optimizing electronic media, to present a plant diversity environment in the classroom.

The availability of learning media will facilitate interaction between teachers and students, so that learning activities will be more effective and efficient (Puspitasari et al., 2018). The existence of learning media facilitates ease of learning, fosters interest in learning, and makes it easier for students to learn independently so that the learning process will be more effective (Surjanti et al., 2018). The use of android-based media can make students more interested in learning. The use of pictorial technology media is also more attractive to students when compared to the use of textbooks. Paying attention to this, it is clear that optimizing the use of modern technology-based media in learning is an urgent matter, especially during a pandemic like now. In learning during the Covid-19 pandemic, the use of media and technology must be able to make a real contribution to knowledge and the emergence of educational practices with online and digital education formats (Williamson et al, 2020).

Based on the existing problems, it is clear that currently optimizing learning media that are useful for visualizing learning materials appropriately. The media should have a simple structure that focuses on one goal. Learning media that are expected to be useful (good) to overcome the learning problems mentioned earlier are media that are easy to carry and use anywhere. Sukenda et al (2019) stated that multimedia-based learning media can be packaged into software that is able to present material.

One of these media is android-based media. The android-based media referred to in this article are presented in the form of an e-booklet about plant diversity in Banjarnegara (named E-Bokartumban), and a webcomic of the circulatory system (named Androwebic). The media is expected to improve critical thinking skills and scientific attitudes in students. Modules based on critical thinking skills on respiratory system material are useful for practicing critical thinking skills (Khasanah et al. (2017). Referring to these results, it can be expected that the E-Bokartumban media is useful for practicing critical thinking skills in students.

E-bokartumban media is expected to be useful for bringing the surrounding environment into the classroom. This is important considering that the environment is a process to equip students with a conscious mind and care for the environment, for all issues related to the environment (Amini, 2015). The environment is also important to instill knowledge, skills, attitudes, behavior, motivation, and commitment to work together in solving environmental problems, as well as an attitude of caring for the environment. On the other hand, science comics media (science comics based on guided inquiry) can also improve critical thinking skills and scientific attitudes (Putri & Prodjosantoso, 2020). Scientific attitude is an attitude that encourages students to solve problems (Hasanah et al, 2020).

Based on the problems above, the following questions can be formulated:

- How is the level of critical thinking skills, scientific attitudes, and environmental care attitudes of students in learning biology using android-based media?
- How do students and teachers respond to learning biology using android-based media?
- Does android-based learning media have the potential to train students' critical thinking skills, scientific attitudes and environmental care attitudes?

METHOD

Types of research

The type of research used was pre-experimental, with a one-group pretest-posttest design (Sugiyono, 2015).

Commented [U2]: METHODS should

- contain detailed research stages
- Each stage is explained and analyzed by what method
- Data analysis must be with clear references
- The research instruments used were elaborated to the data analysis technique
- It is hoped that there will be a modification in the stages of research from sources referred by the researcher

Research Samples

This study's samples (subjects) were 196 tenth-grade students from three high schools in Banjarnegara and 105 eleventh-grade students from three high schools in Jepara. The sample/research subject was selected by using the purposive sampling technique.

Research Data and Instruments

The data collected includes data on critical thinking skills, students' scientific attitudes, environmental care attitudes, as well as student and teacher responses to the biology learning process using android-based media.

The data collected included critical thinking skills, student scientific attitudes, and teacher and student responses about Android-based media used in biology learning. The research instruments used included test and non-test sheets, interview sheets, observation sheets for students' scientific attitudes and environmental care, and student and teacher response questionnaire sheets. Test sheets (pretest and posttest) were used to measure the improvement of students' critical thinking skills and analytical thinking skills. The non-test sheet in the form of an observation sheet is used to determine students' scientific and environmental care attitudes.

Data analysis

The data analysis technique in this study used descriptive qualitative and quantitative statistical methods. The data analysis techniques were (1) n-gain test to analyze data on students' critical thinking skills and students' scientific attitudes, (2) qualitative analysis techniques were used to analyze data on scientific attitudes, environmental care for students, as well as data on the implementation of the learning process, and the responses of teachers and students regarding Android-based media used in Biology learning.

RESULTS AND DISCUSSION

Students' Critical Thinking Skills and Scientific Attitudes

Androwebic's role in learning Biology

Data on students' critical thinking skills and scientific attitudes in learning using android-based media (Androwebic and E-Bokarmban) were obtained from test results (pretest and posttest) and non-test. Student learning outcomes in learning using android-based media (Androwebic and E-Bokarmban) are presented in Table 1, Table 2, Table 3, Table 4, Table 5). Teacher and student responses are presented in Table 6 and Table 7.

Table 1. Students' Pretest and posttest Score in Biology Learning Using Androwebic Media

Information	Pretest Score (n=105)	Posttest Score (n=105)
Highest score	93.33	100
Lowest score	13.33	60
Average value	53.65	88.83
Number of students completed	11	97
The number of students is not complete	94	8
Classical completeness%	10.48	92.38

Table 1 shows a significant difference between the pretest and posttest scores obtained by students. The results of the pretest showed an average score of 53.65 (not yet reached the value of 75), while the posttest score achieved by students was an average of 88.83 (beyond the KKM

The improvement of students' analytical thinking skills was obtained from the results of the n-gain test on the pretest and posttest scores achieved by students. The results of the n-gain test are presented in Table 2

Table 2. The Results of N-Gain Test for Students' Analytical Abilities after Learning Process Using Androwebic Media

N	Percentage Category N-Gain (%)		
	High	Moderate	Low
105	72	24	4

From Table 2, it is known that most of the students achieved an increase in critical thinking

skills in the high category. From these data it can also be stated that almost all students experienced an increase in critical thinking skills in the medium to high category. The results of the analysis show that Androwebic media is effectively used to improve students' critical thinking skills, especially in learning Biology (circulation system material).

Androwebic media has such potential because it is equipped with various menus such as discussion questions, which contain problems in the context of everyday life. It can stimulate students' curiosity and encourage students to practice solving problems. Both activities require analytical thinking skills so that students' abilities in this matter are correctly trained. This is under the research of Prawita et al. (2019) and Sari et al. (2019), which state that learning media that presents problems can improve students' learning outcomes and analytical thinking skills.

During the discussion stage in biology learning using Androwebic media, students are students are trained to discuss and exchange ideas

Commented [U3]: RESULTS AND DISCUSSION

- Tables or graphs (one selected) must represent different results
 - The results of data analysis must be strong in answering the analysis gap
 - Display of results other than those narrated in table-graph-image-modeling
 - The research novelty has not been clear enough
 - It is recommended not to repeat the references in the introduction, using previous research findings.
 - References used should be taken from reputable journals.
- It is necessary to explain the specifications of the findings in this study that show

Sudah diperbaiki

about problem solutions systematically and logically. Thus, students become trained to think analytically. This is in accordance with the statement of Sari et al. (2019) which proves that learning by actively involving students to solve problems can improve analytical thinking skills and student learning outcomes. **The ability to think analytically is one component of the ability to think critically (Facione 2015). So, it can be stated that Androwebic media has the potential to train critical thinking skills.**

Information about students' scientific attitudes in learning using Androwebic media was obtained from the observation process using student scientific attitude observation sheets. Androwebic media was explicitly created to have several proper facilities for practicing six aspects of a scientific attitude (see Table 3). The results of observations of students' scientific attitudes during the learning process using Androwebic media are presented in Table 3.

Table 3. Scores of Students' Scientific Attitudes During The Learning Process Using Androwebic Media

Indicator	Σ Score	Max Score	Score (%)	Criteria
Attention to every new thing	1086	1260	86.19	Very good
Appreciate and conclude according to facts	1056	1260	83.81	Very good
Not always fell right, changing opinion after considering the evidence	1035	1260	82.14	Very good
Ask questions and give opinions	1124	1260	89.21	Very good
Participate in groups	1107	1260	87.86	Very good
Record complete observations	1068	1260	84.76	Very good
Average of each aspect			85.66	Very good

In Table 3, it can be seen that students' average scientific attitude is in a very good category. This happens because, from the beginning of the learning process, students were always motivated to learn and seek information independently, so that during the learning process in the classroom, students showed a more attentive, respectful attitude, drew conclusions according to facts. Students were also accustomed not to feeling always right, dared to ask questions, express opinions, be active in groups, and record complete observations during the learning process.

found in Banjarnegara. The information includes the classification of each plant species and a description of its morphology, equipped with colorful pictures that look very attractive. With its characteristics, the E-Bokartumban media is useful for presenting the natural environment (environment) to the classroom. The E-Bokartumban format in the form of an application that can be operated using a smartphone makes it very easy for students to use it.

E-Bokartumban has useful components to facilitate critical thinking skills and an attitude of caring for the environment (see Table 4).

The role of E-Bokartumban in learning

Android-based E-Bokartumban media contains information about the diversity of plants

Table 4. E- Bokartumban Media Components that facilitate critical thinking skills competencies

No.	Aspects and Indicators	Media Components
Critical thinking skills		
1	Give a simple explanation	Evaluation questions on the media, students discussion sheets
2	Build basic skills	Evaluation questions on the media, students discussion sheets
3	Conclude	Evaluation questions on the media, students discussion sheets
4	Identify terms and consider a definition	Evaluation questions on the media, students discussion sheets
5	Set strategy and tactics	Evaluation questions on the media, students discussion sheets

Table 4 shows the media E- Bokartumban has a component that has a function for each competency that exists in this research. According to Ennis in Goal for A Critical Thinking Curriculum is presented in journal Kartimi and Liliyasi (2012), there are five stages of thinking with each indicator, that are Giving simple explanation, Building basic skills, Summing up, Identifying terms, and considering a definition, Setting strategies and tactics. These thinking indicators can be measured when the students do

the discussion worksheet and evaluation questions in the media. Wiguna et al. (2019) and Damopolil and Kurniadi (2019) explain the case of improving student learning outcomes after following the process of learning that implement Android-based media. Arista and Kuswanto (2018) state that smartphone-based media can increase enthusiasm, interest, and motivation in learning activities. All things can enhance independence and understanding of concepts in students.

From Table 5 can be known the indicators of the source power of nature that has been used, of environmental care attitudes that used a scale that 6) have a tendency of behavior for not arbitrarily was adapted from NEPS case of aspects, 1) have towards the environment, 7) has thoughts and thought that plants and animals have rights were attracted in environmental issues, and 8) have equal to humans, 2) have the feeling / emotional emotional feelings about actions that can cause against the actions of man that cause disasters, 3) environmental damage, can be measured as long have thought that the environment is very fragile as students using the media to read the material and easily disturbed balance, 4) have feelings and and when the process of discussion groups take the tendencies of behavior that the tendency of place in the learning process. human beings there is a limit in controlling nature, 5) have a tendency of behavior to take advantage

Table 5. E- Bokartumban Media Components that facilitate the competence of environmental care attitudes

No.	Aspects and Indicators	Media Components
Environmental Care Attitude		
1	Have thought that plants and animals have rights were equal to humans	Introduction to the materials
2	Have feelings/emotions about human actions that cause disaster	Introduction to the materials
3	Have thought that the environment is very fragile and easily disturbed balance	Student discussion sheets, materials on the media
4	Have feelings and tendencies of behavior that the tendency of human beings there is a limit in controlling nature	Student discussion sheets, materials on the media
5	Tend to take advantage of the source power of nature that has been used	Student discussion sheets, materials on the media
6	Tend not to be arbitrary towards the environment	Student discussion sheets, materials on the media
7	Have thoughts and attracted to environmental issues	Student discussion sheets, materials on the media
8	Have emotional feelings about actions that can cause environmental damage	Student discussion sheets, materials on the media

Learning with media E-Bokartumban can reported the case of improving student learning make a positive contribution in improving outcomes after learning with Android-based students' attitudes to environmental care. media. This statement is also by the explanation of Environmental care is an attitude and action that Jenou et al. (2017), which states that learning using always try to prevent damage to the surrounding Android-based media can improve student natural environment and develop efforts to repair learning outcomes. natural damage (Yaumi, 2014).

Based on the description in the paragraph above, it can be stated that the use of media **Student and Teacher Responses to Biology** android-based learning is very effective to enhance **Learning Using Android-Based Media** students' understanding. This is under Sudarsana et al. (2019), which state that technology-based **Student and teacher responses to the biology learning using Androwebic media** learning media can improve student learning outcomes. Junaedi et al. (2018) and Damopolil Student responses to learning using and Kurniadi (2019) find that applying android- Androwebic media were obtained from student based media can improve students' learning response questionnaires given at the end of the outcomes. The learning process using technology lesson. Information about students' positive can increase student interest and learning responses to Androwebic media is presented in outcomes (Sudarsana et al., 2019). Wiguna et al. Table 6. (2019) and Damopolil and Kurniadi (2019)

Table 6. Results of Student Responses to Androwebic Media

Indicators	Score Obtained	Max. Score	Percentage (%)	Criteria
Affective consideration	755	840	89.88	Very good
Learning	1116	1260	88.57	Very good
Multimedia display	2308	2520	91.59	Very good
Navigation	1487	1680	88.51	Very good
Robustness	1507	1680	89.40	Very good
Average			89.59	Very good

The data in Table 6 shows that the average of each aspect/indicator shows very good criteria. In some aspects, the student's response rate shows the maximum score. This showed that students were interested and motivated to learn with comics in the media. Apart from being interested and motivated by comics, students also admitted that the material equipped with pictures on Androwebic media was beneficial and made it easier for students to learn because it was summarized in a structured manner. The problems presented in Androwebic media are also problem-based learning-oriented, increasing student activity in learning activities. In the learning process, students not only listened but also tried, found, and concluded. Therefore, students' understanding, analytical thinking skills, and scientific attitudes will be higher.

In terms of appearance, Androwebic media received high points, with very good criteria. This showed that students were very interested in the appearance of Androwebic media. Androwebic media is equipped with images on

every detail of the material to provide the correct visualization. This makes it easier for students to understand abstract circulatory material. Androwebic media can also help students understand and discover concepts about the circulatory system. The use of appropriate learning media and following students' character in learning can help students find concepts in context. The media in question must be interesting, contain extensive learning resources, and contain information presented with visual images. The use of a problem-based learning approach that is complemented by the use of learning media is proven to be able to foster student interest and motivation to be more active in learning to create enjoyable learning, understanding the circulatory system material will increase (Maulana & Sulistyoningrum, 2018; Lee et al., 2015).

The level of positive response from the teacher to the implementation of the learning process using Androwebic media obtained from the teachers' responses is presented in Table 7.

Table 7. Levels of Teacher's Positive Response to Androwebic Media

Indicators/aspects	Score Obtained	Max. Score	Percentage (%)	Criteria
Affective consideration	22	24	91.67	Very good
Learning	30	36	83.33	Very good
Multimedia display	64	72	88.89	Very good
Navigation	41	48	85.42	Very good
Robustness	42	48	87.50	Very good
Average			87.36	Very good

From the data in Table 7, it is known that the average score for each aspect is 87.36%, with the very good category. The teacher said that Androwebic media was very good, easy to use, up to date. The material presented was equipped with attractive visuals, could be used anytime and anywhere with the condition of using an android device. This is confirmed by Sung et al. (2016), which stated that Android devices such as smartphones are better and more effective than conventional learning. Students are enthusiastic because the learning process is student-centered, while the teacher only directs and guides. This is following the findings of Ali (2019), which prove that student-centered learning will improve students' ability to understand the material being studied and problem-solving skills. In such circumstances, the teacher is sufficient to direct and guide as needed.

feedback positively on the activities of students in learning because it made students very enthusiastic when they held discussions. The teacher said that the E-Bokartumban media was attractive, contemporary, easy to use, easy to carry, and the material presented was evident.

Based on the results of data analysis, obtained information that the media Androwebic can train analytical thinking skills in students by 92.68% and scientific attitudes of 85.66%. Android-based media is taken as positive by students and teachers. Levels of positive responses from students and teachers to the media Androwebic were 89.59% and 87.36%. Based on that, it can be concluded that the media Androwebic and E-Bokartumban were used in Biology learning was very potential to train students' critical thinking skills and scientific attitudes.

CONCLUSION

From the discussion above, the following conclusions can be drawn. 1) Critical thinking skills, scientific attitudes, and environmental care attitudes of students after learning to use android-

Student and Teacher Responses to Biology Learning Using E-Bokartumban Media

Media E-Bokartumban was used in this study can assist students in building the material concept of biodiversity. Teachers also gave

based media increased to become good and very good. 2) Students and teachers give a very good response to the biology learning process using android-based media. Two types of Android-based media - namely Androwebic and E-Bokartuban used in Biology learning have proven to be very potential to train critical thinking skills and scientific attitudes, environmental care attitudes in high school students.

The authors would like to thanks Prof. Dr. Enni Suwarsi Rahayu, M.Si., and Prof. Dr. Retno Sri Iswari, S.U., as the material expert validator, Dr. Budi Naini Mindayarto, M.App.Sc., and Mohammad Fikri, S.Sn (Pusdatin Kemendikbud) as media expert validators who have provided very useful suggestions for improving this research. This research was supported by the Lembaga Penelitian dan Pengabdian Masyarakat Universitas Negeri Semarang, which has funded this research (the contract number of the funding letter: SP DIPA-023.17.2.677507/2020, 27-12-2019, in accordance with the Letter of Assignment of Research Implementation of UNNES DIPA Funds Year 2020 , Number 166.23.4/UN37/PPK.3.1/2020, 23-04-2020

REFERENCES

- Ali, S. S. (2019). Problem based learning: a student-centered approach. *English Language Teaching*, 12(5), 73-78.
- Amini, R. (2015). Outdoor Based Environmental Education Learning and its Effect in Caring Attitude Toward Environment. *Journal Pendidikan IPA Indonesia*, 4(1),43-47.
- Amoah A. C., & Emmanuel E. (2018). Assessing the reasoning skills of biology students in selected senior high schools in the central region of Ghana. *International Journal of Scientific Research and Management (IJSRM)*, 6(4), 299-304.
- Arista, F. S., & Kuswanto, H. (2018). Virtual physics laboratory application based on the android smartphone to improve learning independence and conceptual understanding. *International Journal of Instruction*, 11(1), 1-16.
- Damopolil, I., & Kurniadi, B. (2019). The development of android-based mobile learning supported by problem-based learning strategy for students' learning success. *International Journal of Scientific and Technology research*, 8(7), 190-193.
- Dwianto, A., Wilujeng, I., Prasetyo, Z. K., & Suryadarma, I. G. P. (2017). The development of science domain based learning tool which is integrated with local wisdom to improve science process skill and scientific attitude. *Jurnal Pendidikan IPA Indonesia*, 6(1): 23-31.
- Facione, P. A. (2015). *Critical Thinking : What It Is and Why It Counts*. In Insight assessment (Issue ISBN 13: 978-1-891557-07-1).
- Hasanah, S. I., Mustofa, R. F., & Ardiansyah, R. (2020). Correlation between Generic Science Skills and Scientific Attitudes on Learning Outcomes. *BIOEDUSCIENCE*, 4(2), 124-128.
- Jeno, L. M., Grytnes, J. A., & Vandvik, V. (2017). The effect of a mobile-application tool on biology students' motivation and achievement in species identification: A Self-Determination Theory perspective.
- Junaedi, J., Irviani, R., Mushlihudin, M., Hidayat, S., Maselena, A., Gumanti, M., & Fauzi, A. N. (2018). Application program learning based on android for students experiences. *International Journal of Engineering and Technology (UAE)*, 7(2.27), 194-198.
- Kartimi, & Liliyasi. 2012. Pengembangan Alat Ukur Berpikir Kritis pada Konsep Termokimia untuk Siswa SMA Berperingkat Atas dan Menengah. *Jurnal Pendidikan IPA Indonesia*, 1(1): 21-26.
- Lee, S., Kang, E., & Kim, H. B. (2015). Exploring impact of students' learning approach on collaborative group modeling of blood circulation. *Journal of Science Education and Technology*, 24(2): 234-255.
- Maulana, H., & Sulistyoningrum. (2018). Implementation Mirror Technique 3D Objects for Interactive Learning Media "Circulatory System" Virtual Reality-Based. *Journal of Physics: Conference Series*, 1364 012036.
- Mutakinati, L., Anwari, I., & Yoshisuke, K. (2018). Analysis of students' critical thinking skill of middle school through STEM education project-based learning. *Jurnal Pendidikan IPA Indonesia*, 7(1), 54-65.
- Nhat, H. T., Lien, N. T., Tinh, N. T., Hang, N. V. T., & Trang, N. T. (2018). The Development of Critical Thinking for Students in Vietnamese Schools: From Policies to Practices. *American Journal of Educational Research*, 6(5), 431-435.
- Prawita, W., Prayitno, B. A., & Sugiyarto. (2019). Effectiveness of generative learning-based biology module to improve the analytical thinking skills of the students with high and

Commented [U4]: Make it in the Acknowledgement part. Include the contract number of the funding letter. Sudah saya tambah sumber yang baru, sehingga menjadi 31

Commented [W15]: 1. Please provide at least 30 references which 80% of them are taken from the last 10 years (>2011) articles of no-predatory journals, written in accordance with the APA Standard. You may go to Google Scholar and find the right format for APA Style provided.

2. For books, please refer to the original/primary book reference no matter the date.

3. All of the listed references must be cited in the body of the article, and vice versa.

- low reading motivation. *International Journal of Instruction*, 12(1), 1459-1476.
- Pujasih, P., Wiwi I., & Saiful R. (2020). Android-based e-booklet development to train students' critical thinking and attitude of caring for environment. *Journal of Innovative Science Education*, 10 (1), 95-101.
- Puspita, I., Kaniawati, I., & Suwarma, R. (2017). Analysis of critical thinking skills on the topic static fluid. *Journal of Physics: Conference Series*, 895 012100.
- Puspitasari, E. D. T., Surjono, H. D., & Minghat, A. D. (2018). Utilizing web based learning as 21st century learning media for vocational education. *International Journal of Engineering & Technology*, 7(4.33), 157-160.
- Putri, M. A., & Prodjosantoso, A. K. (2020). Improving Critical Thinking Skills and Scientific Attitudes by Using Comic. *Psychology, Evaluation, and Technology in Educational Research*, 2(2), 69-80.
- Sari, R., Perdana, R., Riwayani, Jumadi, Wilujeng, I., & Kuswanto, H. (2019) The implementation of problem-based learning model with online simulation to enhance the student's analytical thinking skill in learning physics. *Journal of Physics: Conference Series*, 1233 012030.
- Sudarsana, I. K., Nakayanti, A. R., Saptia, S., Haimah, Satria, E., Saddhono, K., GS, D. A., Putut, E., Helda, T., & Mursalin, M. (2019). Technology application in education and learning process. *Journal of Physics: Conference Series*, 1363 012061.
- A., Putut, E., Helda, T., & Mursalin, M. (2019). Technology application in education and learning process. *Journal of Physics: Conference Series*, 1363 012061.
- Sugiyono. (2015). *Metode penelitian pendidikan*. Bandung: Alfabeta.
- Sukenda, Anjani, M., & Yustim, B. (2019). Learning Media for Biology Subject Based on Multimedia in Junior High School Level. *Universal Journal of Educational Research*, 7(4A), 43-51.
- Sung, H. Y., Hwang, G. J., Chen, C. Y., & Liu, W. X. (2019). A contextual learning model for developing interactive e-books to improve students' performances of learning the analects of confucius. *Interactive Learning Environments*, 1-14.
- Surjanti, J., Seno, D. N., Hadi, H. K., Maroah, S., Siswanti, Y., Muafi., & Isfianadewi, D. (2018). The role of m-learning on effective learning media in higher education. *International Journal of Civil Engineering and Technology*, 9(4): 77-85.
- Thomas, T. (2011). Developing First Year Student's Critical Thinking Skills. *Asian Social Science*, 7(4), 26-35
- Wiguna, D., Irwansyah, F. S., Windayani, N., Aulawi, H., & Ramdhani, M. A. (2019). Development of android-based chemistry learning media oriented towards generic science skills. *Journal of Physics: Conference Series*, 1157 042047.
- Williamson, B., Eynon, R., & Potter, J. (2020). Pandemic Politics, Pedagogies and Practices: Digital Technologies and Distance Education during the Coronavirus Emergency. *Learning, Media and Technology*, 45(2), 107-114.
- Yew, E. H. J., & Goh, K. (2016). Problem-Based Learning: An Overview of its Process and Impact on Learning. *Health Professions Education*, 2(2), 75-79.

Paper title: POTENTIAL ANALYSIS OF THE ANDROID-BASED LEARNING MEDIA AS A MEANS TO TRAIN CRITICAL THINKING SKILLS AND SCIENTIFIC ATTITUDES

Parts of review	Guidelines	Yes	Partly	No	Reviewer's note for improvement	Author's responds (highlight of revision)
Title	• Does the subject matter fit within the scope of journal?	/				
	• Does the title clearly and sufficiently reflect its contents?	/				
Abstract	• Does the abstract contain informative, including Background, Methods, Results and Conclusion?	/				
Back-ground	• Is the background informative and sufficient (include the background problem and objectives)?		/			
	• Is research question of the study clear and understandable?		/			
	• Does the rationale of the study clearly explained using relevant literature?		/			
	• Is the "aim" of the manuscript clear and understandable?	/				
Methods	• Is the methodology chosen suitable to the nature of the topic studied?		/			
	• Is the methodology of the research described clearly?(including study design, location, subjects, data collection, data analysis)		/			
	• Is there adequate information about the data collection tools used? (only for empirical studies)		/			
	• Are the validity and reliability of data collection tools established? (only for empirical studies)	/				
	• Are the data collection tools suitable for the methodology of the study? (only for empirical studies)		/			
Results & Discussion	• Are the tables, graphs and pictures understandable, well presented and numbered consecutively?		/			
	• Do the data analysis and the interpretation appropriate to the problem and answer the objectives?		/			
	• Does the "discussion" section of the manuscript adequately relate to the current and relevant literature?		/			
	• Are the findings discussed adequately considering the research question(s), sub-question(s) or hypothesis?		/			
Conclusion	• Is the conclusion clear and in the form of a narration instead of pointers?		/			
	• Isn't the conclusion a summary and consistent between problems, objectives and conclusion?		/			
References	• Do the references and citations match?		/			
	• Are the writing of references correct?		/		Add the latest sources from reputable journals.	
Quality Criteria	• Do the title, problem, objectives, methods and conclusion are in line? Is it well organized?		/			
	• The quality of the language is satisfactory		/			
	• The work relevant and novel		/			
	• Are there strong consistencies among the parts of the manuscript? (introduction, methods, results and discussion, and conclusion)		/			

LAMPIRAN 2.4
PROSES REVIEW KE-2



POTENTIAL ANALYSIS OF THE ANDROID-BASED LEARNING MEDIA AS A MEANS TO TRAIN CRITICAL THINKING SKILLS AND SCIENTIFIC ATTITUDES

Pre-experimental research is a kind of beginner research whose validity and reliability cannot be justified, unless it is coupled with development research or combined with in-depth qualitative research. Therefore, this article can be considered if accompanied by research on media development or with in-depth descriptive research, and it should be analyzed /discussed in depth and comprehensively.

DOI:

Accepted: ... Approved: ... Published: ...

ABSTRACT

This study aims to analyze and describe the potential of Android-based learning media to train students' critical thinking skills and scientific attitudes. The learning media were Andro-Webcomic (called Androwebic) and E- Booklet of plant diversity in Banjarnegara (abbreviated as E-Bokartumban). This research was pre-experimental, the type of One Group Pretest-Posttest Design. The research subjects were 196 tenth-grade students from three high schools in Banjarnegara and 105 eleventh-grade students from three high schools in Jepara. The sample was determined using the purposive sampling technique. The data collected included critical thinking skills, students' scientific attitudes and environment care attitudes, and teacher and student responses. The instruments used were test and non-test sheets, interview sheets, observation sheets for students' scientific attitudes and environmental care, and student and teacher response questionnaires. Data were analyzed using qualitative descriptive statistics and quantitative (n-gain test). The results showed that: (1) E-Bokartumban media had a supporting component in facilitating competence of analytical thinking and caring for the environment. Androwebic media was able to train 92.38% analytical thinking skills and a scientific attitude of 85.66%. (2) Student and teacher responses to Androwebic were 89.59% and 87.36%. Conclusion: Android-based media in the form of Androwebic and E-Bokartumban has the potential to train critical thinking skills, environmental care, and scientific attitudes.

© 20xx Science Education Study Program FMIPA UNNES Semarang

Keywords: androwebic; e-bokartumban; critical thinking skills; scientific attitude

INTRODUCTION

Biology learning involves skills and reasoning (Amoah & Emmanuel, 2018). In developing reasoning power and skills, learning can emphasize the aspects of the application, analysis, synthesis, and evaluation, not only emphasizing aspects of understanding and knowledge. For this reason, a learning process is needed that can improve cognitive, affective, psychomotor competencies, as well as learning methods that can motivate students to be creative, confident, and think critically (Pujiasih et al.,

2020). Critical thinking skills are needed to assess information, explain reasons and solve problems (Thomas, 2011). Teaching critical thinking and problem solving skills can be done with problem-based learning/PBL (Yew & Goh, 2016). Students can think critically in learning, but this ability sometimes does not develop properly. Therefore, it is necessary to use methods that can develop students' critical thinking skills. Students who have critical thinking skills will find it easy to analyze, evaluate, and relate to evidence or

Commented [U1]: Use the other term instead of potential analysis.

Commented [U2]: A means means tools?

arguments before deciding or assessing information (Mutakinati et al., 2018). Students' critical thinking skills play an essential role in achieving learning achievement, formal reasoning, and creativity (Puspita et al., 2017). Learning that facilitates critical thinking skills can be realized if there is cooperation and participation from all parties, ranging from policy makers, teacher universities, local education departments, schools, and families (Nhat et al., 2018). The results of research by Seventika et al (2018) show that students' critical thinking skills (in vocational schools/vocational schools) are still low.

Textbooks and modules still dominate biology learning in schools with a few pictures, and learning is still teacher-centered. It causes the students' mindset to be limited, and their understanding of biology concepts weakens, so their critical thinking skills and scientific attitudes are still weak. This statement was strengthened by the results of interviews by several teachers of SMA/MA in Banjarnegara and Jepara. The information obtained from the interviews included: (1) The learning had not made optimal use of student-centered media; (2) Students were allowed to bring smartphones, but it had not been well utilized; (3) technology (smartphone) as a tool or media that does not support learning, (4) limited learning time.

Based on the results of interviews with teachers, it can be concluded that these problems can be minimized by utilizing the technology owned by students, and utilizing student-centered learning strategies to the fullest. Examples of biological materials that need to be taught using media are the circulatory system and biodiversity. The material of the circulatory system needs to be studied with the media because it contains complex concepts, so that it can be presented in a more interesting way. Biodiversity material (especially plant diversity) also really needs to be taught by optimizing electronic media, to present a plant diversity environment in the classroom.

The availability of learning media will facilitate interaction between teachers and students, so that learning activities will be more effective and efficient (Puspitasari et al., 2018). The existence of learning media facilitates ease of learning, fosters interest in learning, and makes it easier for students to learn independently so that the learning process will be more effective (Surjanti et al., 2018). The use of android-based media can make students more interested in learning. The use of pictorial technology media is also more attractive to students when compared to the use of textbooks. Paying attention to this, it is clear that optimizing the use of modern technology-based media in learning is an urgent matter, especially during a pandemic like now. In learning during the Covid-19 pandemic, the use of media and technology must be able to make a real

contribution to knowledge and the emergence of educational practices with online and digital education formats (Williamson et al, 2020).

Based on the existing problems, it is clear that currently optimizing learning media that are useful for visualizing learning materials appropriately. The media should have a simple structure that focuses on one goal. Learning media that are expected to be useful (good) to overcome the learning problems mentioned earlier are media that are easy to carry and use anywhere. Sukenda et al (2019) stated that multimedia-based learning media can be packaged into software that is able to present material.

One of these media is android-based media. The android-based media referred to in this article are presented in the form of an e-booklet about plant diversity in Banjarnegara (named E-Bokartumban), and a webcomic of the circulatory system (named Androwebic). The media is expected to improve critical thinking skills and scientific attitudes in students. Modules based on critical thinking skills on respiratory system material are useful for practicing critical thinking skills (Khasanah et al. (2017). Referring to these results, it can be expected that the E-Bokartumban media is useful for practicing critical thinking skills in students.

E-bokartumban media is expected to be useful for bringing the surrounding environment into the classroom. This is important considering that the environment is a process to equip students with a conscious mind and care for the environment, for all issues related to the environment (Amini, 2015). The environment is also important to instill knowledge, skills, attitudes, behavior, motivation, and commitment to work together in solving environmental problems, as well as an attitude of caring for the environment. On the other hand, science comics media (science comics based on guided inquiry) can also improve critical thinking skills and scientific attitudes (Putri & Prodjosantoso, 2020). Scientific attitude is an attitude that encourages students to solve problems (Hasanah et al, 2020).

Based on the problems above, the following questions can be formulated:

- How is the level of critical thinking skills, scientific attitudes, and environmental care attitudes of students in learning biology using android-based media?
- How do students and teachers respond to learning biology using android-based media?
- Does android-based learning media have the potential to train students' critical thinking skills, scientific attitudes and environmental care attitudes?

METHOD

Types of research

The type of research used was pre-experimental, with a one-group pretest-posttest design (Sugiyono, 2015).

Research Samples

This study's samples (subjects) were 196 tenth-grade students from three high schools in Banjarnegara and 105 eleventh-grade students from three high schools in Jepara. The sample/research subject was selected by using the purposive sampling technique.

Research Data and Instruments

The data collected includes data on critical thinking skills, students' scientific attitudes, environmental care attitudes, as well as student and teacher responses to the biology learning process using android-based media.

The data collected included critical thinking skills, student scientific attitudes, and teacher and student responses about Android-based media used in biology learning. The research instruments used included test and non-test sheets, interview sheets, observation sheets for students' scientific attitudes and environmental care, and student and teacher response questionnaire sheets. Test sheets (pretest and posttest) were used to measure the improvement of students' critical thinking skills and analytical thinking skills. The non-test sheet in the form of an observation sheet is used to determine students' scientific and environmental care attitudes.

Data analysis

The data analysis technique in this study used descriptive qualitative and quantitative statistical methods. The data analysis techniques were (1) n-gain test to analyze data on students' critical thinking skills and students' scientific attitudes, (2) qualitative analysis techniques were used to analyze data on scientific attitudes, environmental care for students, as well as data on the implementation of the learning process, and the responses of teachers and students regarding Android-based media used in Biology learning.

RESULTS AND DISCUSSION

Students' Critical Thinking Skills and Scientific Attitudes

Androwebic's role in learning Biology

Data on students' critical thinking skills and scientific attitudes in learning using android-based media (Androwebic and E-Bokarmban) were obtained from test results (pretest and posttest) and non-test. Student learning outcomes in learning using android-based media (Androwebic and E-Bokarmban) are presented in Table 1, Table 2, Table 3, Table 4, Table 5). Teacher and student responses are presented in Table 6 and Table 7.

Table 1. Students' Pretest and posttest Score in Biology Learning Using Androwebic Media

Information	Pretest Score (n=105)	Posttest Score (n=105)
Highest score	93.33	100
Lowest score	13.33	60
Average value	53.65	88.83
Number of students completed	11	97
The number of students is not complete	94	8
Classical completeness%	10.48	92.38

Table 1 shows a significant difference between the pretest and posttest scores obtained by students. The results of the pretest showed an average score of 53.65 (not yet reached the value of 75), while the posttest score achieved by students was an average of 88.83 (beyond the KKM

The improvement of students' analytical thinking skills was obtained from the results of the n-gain test on the pretest and posttest scores achieved by students. The results of the n-gain test are presented in Table 2

Table 2. The Results of N-Gain Test for Students' Analytical Abilities after Learning Process Using Androwebic Media

N	Percentage Category N-Gain (%)		
	High	Moderate	Low
105	72	24	4

From Table 2, it is known that most of the students achieved an increase in critical thinking skills in the high category. From these data it can also be stated that almost all students experienced an increase in critical thinking skills in the medium to high category. The results of the analysis show that Androwebic media is effectively used to improve students' critical thinking skills, especially in learning Biology (circulation system material).

Androwebic media has such potential because it is equipped with various menus such as discussion questions, which contain problems in the context of everyday life. It can stimulate students' curiosity and encourage students to practice solving problems. Both activities require analytical thinking skills so that students' abilities in this matter are correctly trained. This is under the research of Prawita et al. (2019) and Sari et al. (2019), which state that learning media that

presents problems can improve students' learning outcomes and analytical thinking skills.

During the discussion stage in biology learning using Androwebic media, students are trained to discuss and exchange ideas about problem solutions systematically and logically. Thus, students become trained to think analytically. This is in accordance with the statement of Sari et al. (2019) which proves that learning by actively involving students to solve problems can improve analytical thinking skills and student learning outcomes. **The ability to think analytically is one component of the ability to**

think critically (Facione 2015). So, it can be stated that Androwebic media has the potential to train critical thinking skills.

Information about students' scientific attitudes in learning using Androwebic media was obtained from the observation process using student scientific attitude observation sheets. Androwebic media was explicitly created to have several proper facilities for practicing six aspects of a scientific attitude (see Table 3). The results of observations of students' scientific attitudes during the learning process using Androwebic media are presented in Table 3.

Table 3. Scores of Students' Scientific Attitudes During The Learning Process Using Androwebic Media

Indicator	Σ Score	Max Score	Score (%)	Criteria
Attention to every new thing	1086	1260	86.19	Very good
Appreciate and conclude according to facts	1056	1260	83.81	Very good
Not always fell right, changing opinion after considering the evidence	1035	1260	82.14	Very good
Ask questions and give opinions	1124	1260	89.21	Very good
Participate in groups	1107	1260	87.86	Very good
Record complete observations	1068	1260	84.76	Very good
Average of each aspect			85.66	Very good

In Table 3, it can be seen that students' average scientific attitude is in a very good category. This happens because, since the beginning of the learning process, students were always motivated to learn and seek information independently, so that during the learning process in the classroom, students showed a more attentive, respectful attitude, drew conclusions according to facts. Students were also accustomed not to feeling always right, dared to ask questions, express opinions, be active in groups, and record complete observations during the learning process.

The role of E-Bokartumban in learning

Android-based E-Bokartumban media contains information about the diversity of plants

found in Banjarnegara. The information includes the classification of each plant species and a description of its morphology, equipped with colorful pictures that look very attractive. With its characteristics, the E-Bokartumban media is useful for presenting the natural environment (environment) to the classroom. The E-Bokartumban format in the form of an application that can be operated using a smartphone makes it very easy for students to use it.

E-Bokartumban has useful components to facilitate critical thinking skills and an attitude of caring for the environment (see Table 4).

Table 4. E- Bokartumban Media Components that facilitate critical thinking skills competencies

No.	Aspects and Indicators	Media Components
	Critical thinking skills	
1	Give a simple explanation	Evaluation questions on the media, students discussion sheets
2	Build basic skills	Evaluation questions on the media, students discussion sheets
3	Conclude	Evaluation questions on the media, students discussion sheets
4	Identify terms and consider a definition	Evaluation questions on the media, students discussion sheets
5	Set strategy and tactics	Evaluation questions on the media, students discussion sheets

Table 4 shows the media E- Bokartumban has a component that has a function for each competency that exists in this research. According to Ennis in Goal for A Critical Thinking Curriculum is presented in journal Kartimi and Liliyasi (2012), there are five stages of thinking with each indicator, that are Giving simple explanation, Building basic skills, Summing up, Identifying terms, and considering a definition,

Setting strategies and tactics. These thinking indicators can be measured when the students do the discussion worksheet and evaluation questions in the media. Wiguna et al. (2019) and Damopolil and Kurniadi (2019) explain the case of improving student learning outcomes after following the process of learning that implement Android-based media. Arista and Kuswanto (2018) state that smartphone-based media can increase enthusiasm,

interest, and motivation in learning activities. All 5) have a tendency of behavior to take advantage things can enhance independence and of the source power of nature that has been used, understanding of concepts in students. 6) have a tendency of behavior for not arbitrarily

From Table 5 can be known the indicators towards the environment, 7) has thoughts and of environmental care attitudes that used a scale that attracted in environmental issues, and 8) have was adapted from NEPS case of aspects, 1) have emotional feelings about actions that can cause thought that plants and animals have rights were environmental damage, can be measured as long equal to humans, 2) have the feeling / emotional as students using the media to read the material against the actions of man that cause disasters, 3) and when the process of discussion groups take have thought that the environment is very fragile place in the learning process.

and easily disturbed balance, 4) have feelings and the tendencies of behavior that the tendency of human beings there is a limit in controlling nature,

Table 5. E- Bokartumban Media Components that facilitate the competence of environmental care attitudes

No.	Aspects and Indicators	Media Components
Environmental Care Attitude		
1	Have thought that plants and animals have rights were equal to humans	Introduction to the materials
2	Have feelings/emotions about human actions that cause disaster	Introduction to the materials
3	Have thought that the environment is very fragile and easily disturbed balance	Student discussion sheets, materials on the media
4	Have feelings and tendencies of behavior that the tendency of human beings there is a limit in controlling nature	Student discussion sheets, materials on the media
5	Tend to take advantage of the source power of nature that has been used	Student discussion sheets, materials on the media
6	Tend not to be arbitrary towards the environment	Student discussion sheets, materials on the media
7	Have thoughts and attracted to environmental issues	Student discussion sheets, materials on the media
8	Have emotional feelings about actions that can cause environmental damage	Student discussion sheets, materials on the media

Learning with media E-Bokartumban can reported the case of improving student learning make a positive contribution in improving outcomes after learning with Android-based students' attitudes to environmental care. media. This statement is also by the explanation of Environmental care is an attitude and action that Jeno et al. (2017), which states that learning using always try to prevent damage to the surrounding Android-based media can improve student natural environment and develop efforts to repair learning outcomes.

natural damage (Yaumi, 2014).

Based on the description in the paragraph

above, it can be stated that the use of media **Student and Teacher Responses to Biology**

android-based learning is very effective to enhance **Learning Using Android-Based Media**

students' understanding. This is under Sudarsana

et al. (2019), which state that technology-based **Student and teacher responses to the biology learning using Androwebic media**

outcomes. Junaedi et al. (2018) and Damopolil Student responses to learning using and

Kurniadi (2019) find that applying android- Androwebic media were obtained from student based

media can improve students' learning response questionnaires given at the end of the outcomes. The

learning process using technology lesson. Information about students' positive

can increase student interest and learning responses to Androwebic media is presented in

outcomes (Sudarsana et al., 2019). Wiguna et al. Table 6.

(2019) and Damopolil and Kurniadi (2019)

Table 6. Results of Student Responses to Androwebic Media

Indicators	Score Obtained	Max. Score	Percentage (%)	Criteria
Affective consideration	755	840	89.88	Very good
Learning	1116	1260	88.57	Very good
Multimedia display	2308	2520	91.59	Very good
Navigation	1487	1680	88.51	Very good
Robustness	1507	1680	89.40	Very good
Average			89.59	Very good

The data in Table 6 shows that the average of each aspect/indicator shows very good criteria. In some aspects, the student's response rate shows the maximum score. This showed that students were interested and motivated to learn with comics in the media. Apart from being interested and motivated by comics, students also admitted that the material equipped with pictures on Androwebic media was beneficial and made it easier for students to learn because it was summarized in a structured manner. The problems presented in Androwebic media are also problem-based learning-oriented, increasing student activity in learning activities. In the learning process, students not only listened but also tried, found, and concluded. Therefore, students' understanding, analytical thinking skills, and scientific attitudes will be higher.

In terms of appearance, Androwebic media received high points, with very good criteria. This showed that students were very interested in the appearance of Androwebic media. Androwebic media is equipped with images on

every detail of the material to provide the correct visualization. This makes it easier for students to understand abstract circulatory material. Androwebic media can also help students understand and discover concepts about the circulatory system. The use of appropriate learning media and following students' character in learning can help students find concepts in context. The media in question must be interesting, contain extensive learning resources, and contain information presented with visual images. The use of a problem-based learning approach that is complemented by the use of learning media is proven to be able to foster student interest and motivation to be more active in learning to create enjoyable learning, understanding the circulatory system material will increase (Maulana & Sulistyoningrum, 2018; Lee et al., 2015).

The level of positive response from the teacher to the implementation of the learning process using Androwebic media obtained from the teachers' responses is presented in Table 7.

Table 7. Levels of Teacher's Positive Response to Androwebic Media

Indicators/aspects	Score Obtained	Max. Score	Percentage (%)	Criteria
Affective consideration	22	24	91.67	Very good
Learning	30	36	83.33	Very good
Multimedia display	64	72	88.89	Very good
Navigation	41	48	85.42	Very good
Robustness	42	48	87.50	Very good
Average			87.36	Very good

From the data in Table 7, it is known that the average score for each aspect is 87.36%, with the very good category. The teacher said that Androwebic media was very good, easy to use, up to date. The material presented was equipped with attractive visuals, could be used anytime and anywhere with the condition of using an android device. This is confirmed by Sung et al. (2016), which stated that Android devices such as smartphones are better and more effective than conventional learning. Students are enthusiastic because the learning process is student-centered, while the teacher only directs and guides. This is following the findings of Ali (2019), which prove that student-centered learning will improve students' ability to understand the material being studied and problem-solving skills. In such circumstances, the teacher is sufficient to direct and guide as needed.

Student and Teacher Responses to Biology Learning Using E-Bokartumban Media

Media E-Bokartumban was used in this study can assist students in building the material concept of biodiversity. Teachers also gave feedback positively on the activities of students in learning because it made students very enthusiastic when they held discussions. The teacher said that the E-Bokartumban media was attractive, contemporary, easy to use, easy to carry, and the material presented was evident.

Based on the results of data analysis, obtained information that the media Androwebic can train analytical thinking skills in students by 92.68% and scientific attitudes of 85.66%. Android-based media is taken as positive by students and teachers. Levels of positive responses from students and teachers to the media Androwebic were 89.59% and 87.36%. Based on that, it can be concluded that the media Androwebic and E-Bokartumban were used in Biology learning was very potential to train students' critical thinking skills and scientific attitudes.

CONCLUSION

From the discussion above, the following conclusions can be drawn. 1) Critical thinking skills, scientific attitudes, and environmental care attitudes of students after learning to use android-based media increased to become good and very good. 2) Students and teachers give a very good response to the biology learning process using android-based media. Two types of Android-based media - namely Androwebic and E-Bokartumban used in Biology learning have proven to be very potential to train critical thinking skills and scientific attitudes, environmental care attitudes in high school students.

The authors would like to thanks Prof. Dr. Enni Suwarsi Rahayu, M.Si., and Prof. Dr. Retno Sri Iswari, S.U., as the material expert validator, Dr. Budi Naini Mindayarto, M.App.Sc., and Mohammad Fikri, S.Sn (Pusdatin Kemendikbud) as media expert validators who have provided very useful suggestions for improving this research. **This research was supported by the Lembaga Penelitian dan Pengabdian Masyarakat Universitas Negeri Semarang, which has funded this research (the contract number of the funding letter: SP DIPA-023.17.2.677507/2020, 27-12-2019, in accordance with the Letter of Assignment of Research Implementation of UNNES DIPA Funds Year 2020 , Number 166.23.4/UN37/PPK.3.1/2020, 23-04-2020**

REFERENCES

- Ali, S. S. (2019). Problem based learning: a student-centered approach. *English Language Teaching*, 12(5), 73-78.
- Amini, R. (2015). Outdoor Based Environmental Education Learning and its Effect in Caring Attitude Toward Environment. *Journal Pendidikan IPA Indonesia*, 4(1), 43-47.
- Amoah A. C., & Emmanuel E. (2018). Assessing the reasoning skills of biology students in selected senior high schools in the central region of Ghana. *International Journal of Scientific Research and Management (IJSRM)*, 6(4), 299-304.
- Arista, F. S., & Kuswanto, H. (2018). Virtual physics laboratory application based on the android smartphone to improve learning independence and conceptual understanding. *International Journal of Instruction*, 11(1), 1-16.
- Damopolil, I., & Kurniadi, B. (2019). The development of android-based mobile learning supported by problem-based learning strategy for students' learning success. *International Journal of Scientific and Technology research*, 8(7), 190-193.
- Dwianto, A., Wilujeng, I., Prasetyo, Z. K., & Suryadarma, I. G. P. (2017). The development of science domain based learning tool which is integrated with local wisdom to improve science process skill and scientific attitude. *Jurnal Pendidikan IPA Indonesia*, 6(1): 23-31.
- Facione, P. A. (2015). *Critical Thinking : What It Is and Why It Counts*. In Insight assessment (Issue ISBN 13: 978-1-891557-07-1.).
- Hasanah, S. I., Mustofa, R. F., & Ardiansyah, R. (2020). Correlation between Generic Science Skills and Scientific Attitudes on Learning Outcomes. *BIOEDUSCIENCE*, 4(2), 124-128.
- Jeno, L. M., Grytnes, J. A., & Vandvik, V. (2017). The effect of a mobile-application tool on biology students' motivation and achievement in species identification: A Self-Determination Theory perspective. *Computer & Education*, 107, 1-12.
- Junaedi, J., Irviani, R., Muslihudin, M., Hidayat, S., Maseleno, A., Gumanti, M., & Fauzi, A. N. (2018). Application program learning based on android for students experiences. *International Journal of Engineering and Technology (UAE)*, 7(2.27), 194-198.
- Kartimi, & Liliasari. 2012. Pengembangan Alat Ukur Berpikir Kritis pada Konsep Termokimia untuk Siswa SMA Berperingkat Atas dan Menengah. *Jurnal Pendidikan IPA Indonesia*, 1(1): 21-26.
- Lee, S., Kang, E., & Kim, H. B. (2015). Exploring impact of students' learning approach on collaborative group modeling of blood circulation. *Journal of Science Education and Technology*, 24(2): 234-255.
- Maulana, H., & Sulistyoningrum. (2018). Implementation Mirror Technique 3D Objects for Interactive Learning Media "Circulatory System" Virtual Reality-Based. *Journal of Physics: Conference Series*, 1364 012036.
- Mutakinati, L., Anwari, I., & Yoshisuke, K. (2018). Analysis of students' critical thinking skill of middle school through STEM education project-based learning. *Jurnal Pendidikan IPA Indonesia*, 7(1), 54-65.
- Nhat, H. T., Lien, N. T., Tinh, N. T., Hang, N. V. T., & Trang, N. T. (2018). The Development of Critical Thinking for Students in Vietnamese Schools: From Policies to Practices. *American Journal of Educational Research*, 6(5), 431-435.

- Prawita, W., Prayitno, B. A., & Sugiyarto. (2019). Effectiveness of generative learning-based biology module to improve the analytical thinking skills of the students with high and low reading motivation. *International Journal of Instruction*, 12(1), 1459-1476.
- Pujiasih, P., Wiwi I., & Saiful R. (2020). Android-based e-booklet development to train students' critical thinking and attitude of caring for environment. *Journal of Innovative Science Education*, 10 (1), 95-101.
- Puspita, I., Kaniawati, I., & Suwarma, R. (2017). Analysis of critical thinking skills on the topic static fluid. *Journal of Physics: Conference Series*, 895 012100.
- Puspitasari, E. D. T., Surjono, H. D., & Minghat, A. D. (2018). Utilizing web based learning as 21st century learning media for vocational education. *International Journal of Engineering & Technology*, 7(4.33), 157-160.
- Putri, M. A., & Prodjosantoso, A. K. (2020). Improving Critical Thinking Skills and Scientific Attitudes by Using Comic. *Psychology, Evaluation, and Technology in Educational Research*, 2(2), 69-80.
- Sari, R., Perdana, R., Riwayani, Jumadi, Wilujeng, I., & Kuswanto, H. (2019) The implementation of problem-based learning model with online simulation to enhance the student's analytical thinking skill in learning physics. *Journal of Physics: Conference Series*, 1233 012030.
- Sudarsana, I. K., Nakayanti, A. R., Saptia, S., Haimah, Satria, E., Saddhono, K., GS, D. A., Putut, E., Helda, T., & Mursalin, M. (2019). Technology application in education and learning process. *Journal of Physics: Conference Series*, 1363 012061.
- A., Putut, E., Helda, T., & Mursalin, M. (2019). Technology application in education and learning process. *Journal of Physics: Conference Series*, 1363 012061.
- Sugiyono. (2015). *Metode penelitian pendidikan*. Bandung: Alfabeta.
- Sukenda, Anjani, M., & Yustim, B. (2019). Learning Media for Biology Subject Based on Multimedia in Junior High School Level. *Universal Journal of Educational Research*, 7(4A), 43-51.
- Sung, H. Y., Hwang, G. J., Chen, C. Y., & Liu, W. X. (2019). A contextual learning model for developing interactive e-books to improve students' performances of learning the analects of confucius. *Interactive Learning Environments*, 1-14.
- Surjanti, J., Seno, D. N., Hadi, H. K., Maroah, S., Siswanti, Y., Muafi., & Isfianadewi, D. (2018). The role of m-learning on effective learning media in higher education. *International Journal of Civil Engineering and Technology*, 9(4): 77-85.
- Thomas, T. (2011). Developing First Year Student's Critical Thinking Skills. *Asian Social Science*, 7(4), 26-35
- Wiguna, D., Irwansyah, F. S., Windayani, N., Aulawi, H., & Ramdhani, M. A. (2019). Development of android-based chemistry learning media oriented towards generic science skills. *Journal of Physics: Conference Series*, 1157 042047.
- Williamson, B., Eynon, R., & Potter, J. (2020). Pandemic Politics, Pedagogies and Practices: Digital Technologies and Distance Education during the Coronavirus Emergency. *Learning, Media and Technology*, 45(2), 107-114.
- Yew, E. H. J., & Goh, K. (2016). Problem-Based Learning: An Overview of its Process and Impact on Learning. *Health Professions Education*, 2(2), 75-79.

Paper title: POTENTIAL ANALYSIS OF THE ANDROID-BASED LEARNING MEDIA AS A MEANS TO TRAIN CRITICAL THINKING SKILLS AND SCIENTIFIC ATTITUDES

Parts of review	Guidelines	Yes	Partly		Reviewer's note for improvement	Author's responds (highlight of revision)
			No			
Title	• Does the subject matter fit within the scope of journal?	/				
	• Does the title clearly and sufficiently reflect its contents?	/				
Abstract	• Does the abstract contain informative, including Background, Methods, Results and Conclusion?	/				
Back-ground	• Is the background informative and sufficient (include the background problem and objectives)?		/			
	• Is research question of the study clear and understandable?		/			
	• Does the rationale of the study clearly explained using relevant literature?		/			
Methods	• Is the "aim" of the manuscript clear and understandable?	/				
	• Is the methodology chosen suitable to the nature of the topic studied?		/			
	• Is the methodology of the research described clearly?(including study design, location, subjects, data collection, data analysis)		/			
	• Is there adequate information about the data collection tools used? (only for empirical studies)		/			
	• Are the validity and reliability of data collection tools established? (only for empirical studies)	/				
Results & Discussion	• Are the data collection tools suitable for the methodology of the study? (only for empirical studies)		/			
	• Are the tables, graphs and pictures understandable, well presented and numbered consecutively?		/			
	• Do the data analysis and the interpretation appropriate to the problem and answer the objectives?		/			
	• Does the "discussion" section of the manuscript adequately relate to the current and relevant literature?		/			
Conclusion	• Are the findings discussed adequately considering the research question(s), sub-question(s) or hypothesis?		/			
	• Is the conclusion clear and in the form of a narration instead of pointers?		/			
	• Isn't the conclusion a summary and consistent between problems, objectives and conclusion?		/			
References	• Do the references and citations match?		/			
	• Are the writing of references correct?		/		Add the latest sources from reputable journals.	
Quality Criteria	• Do the title, problem, objectives, methods and conclusion are in line? Is it well organized?		/			
	• The quality of the language is satisfactory		/			
	• The work relevant and novel		/			
	• Are there strong consistencies among the parts of the manuscript? (introduction, methods, results and discussion, and conclusion)		/			

LAMPIRAN 2.5

PROSES REVISI KE-2



ANALYSIS OF THE ROLE OF ANDROID-BASED LEARNING MEDIA IN LEARNING CRITICAL THINKING SKILLS AND SCIENTIFIC ATTITUDE

DOI:

Accepted: Approved: Published: ...

ABSTRACT

This study aims to analyze and describe the role of android-based learning media in an effort to teach critical thinking skills and scientific attitudes for students. The learning media are android-based webcomic (Androwebic) and e-book on plant diversity in Banjarnegara (E-Bokarmban), which have been developed previously. This research is a qualitative descriptive study, involving 301 students, 6 biology teachers and 6 high school students. The data collected includes critical thinking skills, analytical skills, scientific attitudes, environmental care attitudes, media components supporting student competence, student learning activities, and teacher and student responses. Data on critical thinking skills were measured using tests and non-tests, other data was measured using non-test instruments, including interview guides, scientific attitude observation sheets, students' environmental care attitudes, media component observation sheets, learning activity observation sheets, and student and teacher questionnaires. Quantitative data on critical thinking skills and analytical skills were analyzed using the n-gain test, while other data were analyzed descriptively. The results showed that the E-Bokarmban and Androwebic media have components that support facilitating critical thinking skills, analytical skills, environmental care attitudes in students. Androwebic media is able to train students' analytical thinking skills and scientific attitude very well. The two media developed were considered to be very helpful in the learning process. Conclusion: Android-based media in the form of Androwebic and E-Bokarmban have a very important role to train critical thinking skills, scientific attitudes and environmental care attitudes.

© 20xx Science Education Study Program FMIPA UNNES Semarang

Keywords: androwebic, e-bokartumban, critical thinking skills, scientific attitude

INTRODUCTION

Biology learning involves skills and reasoning (Amoah & Emmanuel, 2018). In developing reasoning power and skills, learning is needed that can emphasize aspects of application, analysis, synthesis, and evaluation, not only emphasizing aspects of understanding and knowledge. For this reason, a learning process is needed that can improve cognitive, affective, psychomotor competencies, as well as learning methods that can motivate students to be creative, confident, and think critically needed to assess information, critical (Pujiasih et al., 2020). Critical thinking skills are needed to explain reasons and solve problems (Thomas, 2011). Teaching critical thinking and problem-solving skills can be done with problem-based learning/ PBL (Yew & Goh, 2016).

The development of critical thinking skills in students must focus on activities to teach content/knowledge and methods or ways to find, process, and evaluate information (Nath et al, 2018). Basically, students have the ability to think critically in learning, but this ability sometimes does not develop well. Therefore, it is necessary to use a method that is able to develop students' critical thinking skills. Students who have critical thinking skills will be easy to analyze, evaluate, and can relate it to evidence/arguments, before deciding or assessing an information (Mutakinati et al., 2018). In the learning process, students' critical thinking skills play an important role in achieving learning achievement, formal reasoning, and creativity (Puspita et al., 2017). (in vocational schools/vocational schools) are still low.

Learning that facilitates critical thinking skills can be realized if there is cooperation and participation from all parties, from policy makers to teacher universities, local education departments, schools, and families (Nhat et al, 2018). The results of Seventika et al (2018) research show that students' critical thinking skills.

Biology learning in schools is still dominated by textbooks and modules with few pictures, and learning is still teacher-centred. This causes students' mindsets to be limited, and students' understanding of biology concepts weakens, so that students' critical thinking skills and scientific attitudes are still weak. This statement is reinforced by the results of interviews by several state high school/MA teachers in Banjarnegara and Jepara. Information obtained from the results of the interview, among others: (1) Learning has not utilized student-centered media to its full potential; (2) students are allowed to bring smartphones but they have not been used properly; (3) technology (smartphone) as a tool or media that does not support learning, (4) limited learning time.

Based on the results of interviews with teachers, it can be concluded that these problems can be minimized by utilizing the technology owned by students, and utilizing student-centered learning strategies to the fullest. Examples of biological materials that need to be taught using media are the circulatory system and biodiversity. The material on the circulatory system needs to be taught with the media because it contains complex concepts, so that it can be presented in a more interesting way. Biodiversity material (especially on plant diversity) also really needs to be taught by optimizing electronic media, to present a plant diversity environment in the classroom.

The availability of learning media will facilitate interaction between teachers and students, so that learning activities will be more effective and efficient (Puspitasari et al., 2018). The existence of learning media facilitates ease of learning, fosters interest in learning, and makes it easier for students to learn independently so that the learning process will be more effective (Surjanti et al., 2018). The use of android-based media can make students more interested in learning. The use of pictorial technology media also attracts students' attention more than the use of textbooks. Taking this into account, it is clear that optimizing the use of modern technology-based media in learning is an urgent matter, especially during a pandemic like today. In learning during the Covid-19 pandemic, the use of media and technology must be able to make a real contribution to knowledge and the emergence of educational practices with online and digital education formats (Williamson et al, 2020)

Based on the existing problems, it is clear that currently optimizing learning media that are useful for visualizing learning materials appropriately. The media should have a simple structure that focuses on one goal. Learning media that are expected to be useful (good) to overcome the learning problems mentioned earlier are media that are easy to carry and use anywhere. Sukenda et al (2019) stated that multimedia-based learning media can be packaged into software that is able to present material.

One of the important learning media packaged into software is the environment. The environment is useful for equipping students with a conscious mind and care for the environment, and for all issues related to the environment (Amini, 2015-02). The environment is also important to instill knowledge, skills, attitudes, behavior, motivation, and commitment to work together in solving environmental problems, as well as an attitude of caring for the environment. The results of Putri & Prodjosantoso's research (2020) prove that science comics media (guided inquiry-based science comics) can improve critical thinking skills and scientific attitudes. Scientific attitude is an attitude that encourages students to solve problems (Hasanah et al, 2020). Khasanah et al. (2017) stated that the module based on critical thinking skills on respiratory system material is useful for practicing critical thinking skills.

Based on the description above, it is clear that the media is very necessary in learning, among others, to instill skills and attitudes in students. One of these media is android-based media, as software. In this study, the role of android-based media was analyzed in teaching/training attitudes and skills to students. There are 2 android-based media, namely 1) e-booklets about plant diversity in Banjarnegara (named E-Bokartumban), and 2) android-based webcomic about the circulatory system (named Androwebic). The media is expected to improve critical thinking skills, analytical skills, scientific attitudes, and environmental care attitudes in students.

Beberapa pertanyaan yang perlu dijawab dalam penelitian ini ialah sebagai berikut.

1. Apakah media E-Bokartumban berperan dalam membelajarkan keterampilan berpikir kritis dan sikap peduli lingkungan siswa?
2. Apakah media Androwebic berperan peran dalam membelajarkan kemampuan analisis dan sikap ilmiah siswa?
3. Bagaimana proses berfungsinya media E-Bokartumban dalam membelajarkan keterampilan berpikir kritis dan sikap peduli lingkungan pada siswa?

4. Bagaimana proses berfungsinya media Androwebic dalam membelajarkan kemampuan analisis dan sikap ilmiah?
5. Aktivitas belajar apa saja yang dilakukan siswa selama belajar menggunakan kedua media berbasis android itu?
6. Bagaimana tanggapan/respon siswa dan guru terhadap kedua media tersebut

non-test instruments include interview guides, scientific attitude observation sheets, student environmental care attitudes, media component observation sheets, learning activity observation sheets, and student and teacher questionnaires.

Data analysis

Quantitative data on critical thinking skills and analytical skills were analyzed using the n-gain test, while other data were analyzed descriptively qualitatively. Descriptive qualitative data analysis was carried out in 4 stages, namely data collection, data reduction, data presentation, and drawing conclusions.

METHOD

Types of research

This study aims to analyze (and describe) in depth the role of android-based learning media in an effort to teach/train critical thinking skills, analytical skills, scientific attitudes, and environmental care attitudes. Therefore, the research design used is a descriptive qualitative research design (Sugiyono, 2016).

Research Sample

The samples (subjects) of this study were 6 biology teachers, 196 class X students from three high schools in Banjarnegara and 105 students in class XI from three high schools in Jepara. The research sample was selected using purposive sampling technique.

Research Data and Instruments

The data collected includes data on critical thinking skills, analytical skills, scientific attitudes, environmental care attitudes, media components supporting student competence, student learning activities, and teacher and student responses. Data were collected in several ways, namely tests, observations, and questionnaires, and documentation. Data on critical thinking skills and analytical skills were measured using a test instrument, while other data were measured using a non-test instrument. The

RESULTS AND DISCUSSION

The Role of Media in Biology Learning

The role of Androwebics in Biology learning

The analytical ability of students in learning using Androwebic was obtained from the results of the pretest and posttest (Table 1). Table 1 shows the significant difference between the pretest and posttest scores achieved by students. The results of the pretest showed an average score of 53.65 (not yet reached the value of 75), while the posttest score achieved by students was an average of 88.83 (beyond the KKM). The increase in students' analytical thinking skills was obtained from the results of the n-gain test on the pretest and posttest scores achieved by students. The results of the n-gain test showed that students who achieved high, medium and low analytical skills were 72%, 24% and 4%, respectively. From these results it can be stated that the Androwebic media is effectively used to improve students' analytical skills, especially in learning material about the circulation system.

Table 1. Students' Pretest and posttest Score in Biology Learning Using Androwebic Media

Information	Pretest Score (n=105)	Posttest Score (n=105)
Highest score	93.33	100
Lowest score	13.33	60
Average value	53.65	88.83
Number of students completed	11	97
The number of students is not complete	94	8
Classical completeness%	10.48	92.38

Androwebic media has this potential because it is equipped with various menus such as discussion questions (see Table 2), which contain problems in the context of everyday life. The availability of various menus on Androwebic media stimulates students' curiosity and encourages students to practice problem solving. Both activities require analytical thinking skills, so that students' abilities in that regard are well trained. This is in accordance with the research of Prawita et al. (2019) and Sari et al. (2019) which states that the use of

learning media that presents problems can improve student learning outcomes and analytical thinking skills. During the discussion stage in biology learning using Androwebic media, students are trained to discuss and exchange ideas about problem solutions systematically and logically. Thus students become trained to think analytically. This is in accordance with the statement of Sari et al. (2019) which proves that learning by actively involving students to solve

problems can improve analytical thinking skills and student learning outcomes. The ability to think analytically is one component of critical thinking skills (Facione 2015). So it can be stated that Androwebic media has the potential to train critical thinking skills.

Information about students' scientific attitudes in learning using Androwebic media was

obtained from observing students' scientific attitudes using observation sheets. Androwebic media was created specifically, in such a way that it has a number of useful facilities to practice 6 aspects of scientific attitude (see Table 3). Students' scientific attitude was observed by student activities carried out during the learning process using Androwebic media, presented in Table 3.

Table 2. Components of Andro-Webcomic Media that support in facilitating analytical thinking competence and scientific attitude.

No	Indicators of Analytical Thinking Ability	Media Components
1	Differentiating	Task to differentiate in group discussion questions
2	Organizing	Task for grouping on group discussion questions
3	Connecting	The task concludes with group discussion questions
Scientific Attitude		
1	Curiosity	Task to observe on the webcomic
2	Respect for data/facts	Group discussion task in the media investigation section
3	Flexibility in thinking	Group discussion task in the media investigation section
4	Open minded and cooperate	Group discussion task in the media investigation section
5	Perseverance	The task of presenting the observations to be presented

Table 3. Students' scientific attitudes during the learning process using androwebic media

Indicator	Σ Score	Max Score	Score (%)	Criteria
Attention to every new thing	1086	1260	86.19	Very good
Appreciate and conclude according to facts	1056	1260	83.81	Very good
Not always fell right, changing opinion after considering the evidence	1035	1260	82.14	Very good
Ask questions and give opinions	1124	1260	89.21	Very good
Participate in groups	1107	1260	87.86	Very good
Record complete observations	1068	1260	84.76	Very good

In Table 3 it can be seen that the average scientific attitude of students is in the very good category. This happens because since the beginning of the learning process, students are always motivated to learn and seek information independently, so that during the learning process in class students show a more caring attitude, respect, and draw conclusions according to facts. During the learning process, students are also accustomed to not always feel right, dare to ask questions, dare to express opinions, be active in groups, and record complete observations. In the learning process students must complete discussion questions that contain contextual problems. Every activity carried out during the discussion process made a positive contribution to the formation of scientific attitudes. This is what can encourage students to think analytically in solving problems. This is in accordance with the statement of Dwianto et al. (2017) that the application of learning media that presents contextual problems through discussion can make a positive contribution to the formation of scientific attitudes in students.

The role of E-Bokarmban media in learning

Android-based E-Bokarmban media contains information about the diversity of plants found in Banjarnegara. The information in question includes the scientific classification of each type of plant and a description of its morphology, a dissertation with color pictures with a very attractive appearance. With its characteristics, the E-Bokarmban media is useful for presenting the natural environment (environment) to the classroom. The E-Bokarmban format in the form of an application that can be operated using a smartphone makes it very easy for students to use it. The results of the n-gain test showed that after learning to use the E-Bokarmban media, students experienced an increase in critical thinking skills. The increase in critical thinking skills (n-gain) achieved by students was 0.69 in the medium category (tend to be high). Students who achieve high, medium and low critical thinking skills are 53%, 45% and 2%, respectively. From these results it can be stated that the E-Bokarmban media has an important role to improve critical thinking skills. This role is supported by the characteristics of the E-Bokarmban media which has a useful supporting component to facilitate the emergence of critical thinking skills (see Table 4).

Table 4. E-Bokartumban Media Components that facilitate critical thinking skills competencies

No.	Indicators Critical thinking skills	Media Components
1	Give a simple explanation	Evaluation questions on the media, students discussion sheets
2	Build basic skills	Evaluation questions on the media, students discussion sheets
3	Conclude	Evaluation questions on the media, students discussion sheets
4	Identify terms and consider a definition	Evaluation questions on the media, students discussion sheets
5	Set strategy and tactics	Evaluation questions on the media, students discussion sheets

Table 4 shows that the E-Bokarmban media has components that function to facilitate each competency studied in this study. There are five stages of thinking with each indicator, namely 1) providing simple explanations, 2) building basic skills, 3) concluding, 4) identifying terms, & 5) considering a definition, setting strategies and tactics (Ennis cit Kartimi & Liliasari. 2012). This thinking indicator can be measured when students work on student discussion sheets and evaluation questions on the media.

Wiguna et al (2019) and Damopolil & Kurniadi (2019) explained that an increase in learning outcomes occur in students after they take part in learning using android-based media.

Based on the description above, it can be emphasized that the E-Bokarmban media has an

important role in teaching or practicing critical thinking skills. Arista & Kuswanto (2018) stated that media that can be operated using smartphones can increase enthusiasm, interest, and motivation in learning activities. All of these things can increase the independence and understanding of concepts in students.

E-Bokarmban media also has various components that play an important role in growing various indicators of environmental care attitudes (Table 5). In Table 5, various sections of the media (column 3) are presented which are useful for strengthening various indicators of environmental care attitudes which are presented in column 2 of Table 5.

Table 5. Competency indicators of environmental care attitudes in students and components of the E-Bokartumban media that facilitate the emergence of these attitude indicators

No.	Aspects and Indicators e nvironmental Care Attitude	Media Components
1	Have thought that plants and animals have rights were equal to humans	Introduction to the materials
2	Have feelings/emotions about human actions that caused disaster	Introduction to the materials
3	Have thought that the environment is very fragile and easily disturbed balance	Student discussion sheets, materials on the media
4	Have feelings and tendencies of behavior that the tendency of human beings there is a limit in controlling nature	Student discussion sheets, materials on the media
5	Tend to take advantage of the source power of nature that has been used	Student discussion sheets, materials on the media
6	Tend not to be arbitrary towards the environment	Student discussion sheets, materials on the media
7	Have thoughts and attracted to environmental issues	Student discussion sheets, materials on the media
8	Have emotional feelings about actions that can cause environmental damage	Student discussion sheets, materials on the media

From the data in Table 5, it can be seen that indicators of environmental care attitudes use a scale adapted from NEPS. Indicators of the attitude of caring for the environment in question are as follows. 1) Having the idea that plants and animals have the same rights as humans, 2) having feelings/emotions about human actions that cause disasters, 3) having the thought that the environment is very vulnerable and its balance is easily disturbed. The next attitude indicator is 4) having feelings and behavioral tendencies that human tendencies have limits in controlling nature, 5) having behavioral tendencies to take

advantage of used natural resources. The 6th

indicator has a behavioral tendency not to be arbitrary towards the environment, 7) has thoughts and is interested in environmental issues, and 8) has emotional feelings towards actions that can cause environmental damage. All indicators of environmental care attitudes can be measured as long as students use the media, namely when reading the material and during group discussions during the learning process.

Learning with the E-Bokarmban media is able to make a positive contribution in improving students' environmental care attitudes. Environmental care attitudes are attitudes and actions that always try to prevent damage to the

surrounding natural environment and develop efforts to repair natural damage (Yaumi, 2014). The attitude of caring for the environment can be shown by attitudes and actions that always try to prevent environmental damage and try to repair the natural damage that has occurred (Mardikaningtyas, 2016).

Based on the description in the paragraph above, it can be stated that the use of android-based learning media is very effective in increasing student understanding. This is in accordance with the opinion of Sudarsana et al. (2019) which states that the use of technology-based learning media can improve student learning outcomes. Junaedi et al. (2018) and Damopolil & Kurniadi (2019) found that learning by applying android-based media can improve student learning outcomes. Learning that uses technology can increase student interest and learning outcomes (Sudarsana et al., 2019). Wiguna et al. (2019) and Damopolil & Kurniadi

(2019) reported an increase in student learning outcomes after participating in learning using media android based. This statement is also in accordance with the explanation of Jenou et al. (2017), which states that the learning process using android-based media can improve student learning outcomes.

Student and Teacher Responses to Android-Based Media used in Biology learning

Student and teacher responses to Androwebic media

Student responses to learning using Androwebic media were obtained from student response questionnaires given at the end of the lesson. Information about students' positive responses to Androwebic media is presented in Table 6.

Table 6. Results of Student Responses to Androwebic Media

Indicators	Score Obtained	Max. Score	Percentage (%)	Criteria
Affective consideration	755	840	89.88	Very good
Learning	1116	1260	88.57	Very good
Multimedia display	2308	2520	91.59	Very good
Navigation	1487	1680	88.51	Very good
Robustness	1507	1680	89.40	Very good
Average			89.59	Very good

The data in Table 6 shows the average of each aspect/indicator showing very good criteria. In some aspects, the student response rate shows the maximum score. This shows that students are interested and motivated to learn with comics on the media. Besides being interested and motivated by comics, students also acknowledged that the material equipped with pictures on Androwebic media was very helpful and made it easier for students to learn, because it had been summarized in a structured way. The problems presented in the Androwebic media also have the potential to increase student activity in problem based learning activities that can be learned. In the learning process, students not only listen, but also try, discover, and conclude. Therefore, students' understanding, analytical thinking ability, and scientific attitude will be higher.

In terms of appearance, Androwebic media received high points, with very good criteria. This shows that students are very interested in the appearance of Androwebic media. Androwebic Media equipped with pictures on every detail of the material, so as to provide the

right visualization. This makes it easier for students to understand abstract blood circulation material. Androwebic media can also help students understand and discover concepts about the circulatory system. The use of appropriate learning media and in accordance with the character of students in learning, can help students to find concepts contextually. The media in question must be interesting, contain extensive learning resources, contain information whose presentation is accompanied by visual images. The use of a problem-based learning approach that is complemented by the use of learning media has been proven to be able to foster student interest and motivation to be more active in learning so as to create fun learning, understanding the material of the circulatory system will increase (Maulana & Sulistyoningrum, 2018; Lee et al., 2015).

The level of positive response from teachers to the implementation of the learning process using Androwebic media is obtained from the teacher's responses which are presented in Table 7.

Table 7. Levels of Teacher's Positive Response to Androwebic Media

Indicators/aspects	Score Obtained	Max. Score	Percentage (%)	Criteria
---------------------------	-----------------------	-------------------	-----------------------	-----------------

Affective consideration	22	24	91.67	Very good
Learning	30	36	83.33	Very good
Multimedia display	64	72	88.89	Very good
Navigation	41	48	85.42	Very good
Robustness	42	48	87.50	Very good
Average			87.36	Very good

From the data in Table 7, it is known that the average score for each aspect is 87.36%, with a very good category. The teacher said that Androwebic media was very good, easy to use, up-to-date, the material presented was equipped with attractive visuals, it could be used anytime and anywhere on condition that it used an android device. This is confirmed by Sung et al. (2016) which states that the use of android devices such as smartphones in learning is better and more effective than conventional learning. Students are more enthusiastic because the learning process is student-centered, while the teacher only directs and guides. This is in accordance with the findings of Ali (2019) which proves that student-centered learning will improve students' ability to understand the material being studied and problem-solving skills. In such circumstances, the teacher simply directs and guides as necessary.

Student and teacher responses to E-Bokarmban

The responses of students and teachers in this section were obtained from the questionnaire, which was described from 10 indicators. Through the questionnaire, the teacher and student responses/responses to the Ebokarmban media were obtained. The results of descriptive analysis of the data on student and teacher responses to Ebokarmban media show that students and teachers each gave a response of 89.13% and 90.09% (very good category).

The teacher stated that the E-Bokarmban media used in this study was able to help students in building the concept of biodiversity material. The teacher also gave a positive response to student activities in learning, because it was able to make students very enthusiastic when they discussed. The teacher said that the E-Bokarmban media is an attractive, contemporary, easy to use, easy to carry media, and the material presented is very clear. Thus, it can be emphasized that the E-Bokarmban media is a very good medium to use in learning, and it is clear that this media has excellent potential to train critical thinking skills and environmental care attitudes, as previously stated.

Based on the description, it is clearly stated that Androwebic media can train students' analytical thinking skills by 92.68% and scientific attitude by 85.66%. The Android-based media was responded positively by students and teachers. E-Bokarmban media is also proven to be able to train critical thinking skills and an attitude of caring for the environment. E-

Bokarmban media also responded very positively by students and teachers by 89.13% and 90.09%, respectively. Thus, it can be stated that the Androwebic and E-Bokarmban media developed in this study are valid, and have the potential to be used to train students' critical thinking skills and scientific attitudes in learning Biology.

CONCLUSION

From the discussion above, the following conclusions can be drawn. 1). E-Bokarmban media shows an important role in teaching students critical thinking skills and environmental care attitudes. 2) Androwebic media shows an important role in teaching students analytical skills and scientific attitudes. The level of critical thinking skills, analytical skills, scientific attitudes, and environmental care attitudes of students after learning to use android-based media increased to good and very good. 3). E-Bokarmban media can function / be used to teach students critical thinking skills and environmental care attitudes, because it contains various components that are able to facilitate activities which are indicators of critical thinking skills and environmental care attitudes. 4). Androwebic media functions / can be used to teach analytical skills and scientific attitudes to students, because it contains various components that are able to facilitate activities which are indicators because they contain various components that are able to facilitate activities which are indicators of analytical skills and scientific attitudes. 5). The learning activities carried out by students while learning to use the two android-based media include various activities that match the indicators of critical thinking skills, analytical skills, scientific attitudes, and environmental care attitudes. 6) Students and teachers showed a very good response to Androwebic and E-Bokarmban used in Biology learning. Two types of Android-based media, namely Androwebic and E-Bokarmban used in Biology learning have proven to have a very important role in teaching students critical thinking skills, analytical skills, scientific attitudes, and environmental care attitudes.

The authors would like to thank Prof. Dr. Enni Suwarsi Rahayu, M.Si., and Prof. Dr. Retno Sri Iswari, S.U., as the material expert validator, Dr. Budi Naini Mindiyarto, M.App.Sc., and Mohammad Fikri, S.Sn (Pusdatin Kemendikbud) as media expert validators who have provided very useful suggestions for improving this research. The

authors also would like to thanks Dr. Sigit Saptan, M.Pd (Coordinator of S2 Science Education study program). This research was supported by the Lembaga Penelitian dan Pengabdian Masyarakat Universitas Negeri Semarang, which has funded this research (the contract number of the funding letter: SP DIPA-023.17.2.677507/2020, 27-12-2019, in accordance with the Letter of Assignment of Research Implementation of UNNES DIPA Funds Year 2020, Number 166.23.4/UN37/PPK.3.1/2020, 23-04-2020.

REFERENCES

- Ali, S. S. (2019). Problem based learning: a student-centered approach. *English Language Teaching*, 12(5), 73-78.
- Amini, R. (2015). Outdoor Based Environmental Education Learning and its Effect in Caring Attitude Toward Environment. *Journal Pendidikan IPA Indonesia*, 4(1), 43-47.
- Amoah A. C., & Emmanuel E. (2018). Assessing the reasoning skills of biology students in selected senior high schools in the central region of Ghana. *International Journal of Scientific Research and Management (IJSRM)*, 6(4), 299-304.
- Arista, F. S., & Kuswanto, H. (2018). Virtual physics laboratory application based on the android smartphone to improve learning independence and conceptual understanding. *International Journal of Instruction*, 11(1), 1-16.
- Damopolil, I., & Kurniadi, B. (2019). The development of android-based mobile learning supported by problem-based learning strategy for students' learning success. *International Journal of Scientific and Technology research*, 8(7), 190-193.
- Dwianto, A., Wilujeng, I., Prasetyo, Z. K., & Suryadarma, I. G. P. (2017). The development of science domain based learning tool which is integrated with local wisdom to improve science process skill and scientific attitude. *Jurnal Pendidikan IPA Indonesia*, 6(1): 23-31.
- Facione, P. A. (2015). *Critical Thinking: What It Is and Why It Counts*. In Insight assessment (Issue ISBN 13: 978-1-891557-07-1).
- Hasanah, S. I., Mustofa, R. F., & Ardiansyah, R. (2020). Correlation between Generic Science Skills and Scientific Attitudes on Learning Outcomes. *BIOEDUSCIENCE*, 4(2), 124-128.
- Jeno, L. M., Grytnes, J. A., & Vandvik, V. (2017). The effect of a mobile-application tool on biology students' motivation and achievement in species identification: A Self-Determination Theory perspective. *Computer & Education*, 107, 1-12.
- Junaedi, J., Irviani, R., Muslihudin, M., Hidayat, S., Maselena, A., Gumanti, M., & Fauzi, A. N. (2018). Application program learning based on android for students experiences. *International Journal of Engineering and Technology (UAE)*, 7(2.27), 194-198.
- Kartimi, & Liliarsari. 2012. Pengembangan Alat Ukur Berpikir Kritis pada Konsep Termokimia untuk Siswa SMA Berperingkat Atas dan Menengah. *Jurnal Pendidikan IPA Indonesia*, 1(1): 21-26.
- Lee, S., Kang, E., & Kim, H. B. (2015). Exploring impact of students' learning approach on collaborative group modeling of blood circulation. *Journal of Science Education and Technology*, 24(2): 234-255.
- Maulana, H., & Sulistyoningrum. (2018). Implementation Mirror Technique 3D Objects for Interactive Learning Media "Circulatory System" Virtual Reality-Based. *Journal of Physics: Conference Series*, 1364 012036.
- Mutakinati, L., Anwari, I., & Yoshisuke, K. (2018). Analysis of students' critical thinking skill of middle school through STEM education project-based learning. *Jurnal Pendidikan IPA Indonesia*, 7(1), 54-65.
- Nhat, H. T., Lien, N. T., Tinh, N. T., Hang, N. V. T., & Trang, N. T. (2018). The Development of Critical Thinking for Students in Vietnamese Schools: From Policies to Practices. *American Journal of Educational Research*, 6(5), 431-435.
- Prawita, W., Prayitno, B. A., & Sugiyarto. (2019). Effectiveness of generative learning-based biology module to improve the analytical thinking skills of the students with high and low reading motivation. *International Journal of Instruction*, 12(1), 1459-1476.
- Pujiasih, P., Wiwi I., & Saiful R. (2020). Android-based e-booklet development to train students' critical thinking and attitude of caring for environment. *Journal of Innovative Science Education*, 10 (1), 95-101.
- Puspita, I., Kaniawati, I., & Suwarma, R. (2017). Analysis of critical thinking skills on the topic static fluid. *Journal of Physics: Conference Series*, 895 012100.
- Puspitasari, E. D. T., Surjono, H. D., & Minghat, A. D. (2018). Utilizing web based learning as 21st century learning media for vocational education. *International Journal of Engineering & Technology*, 7(4.33), 157-160.
- Putri, M. A., & Prodjosantoso, A. K. (2020). Improving Critical Thinking Skills and Scientific Attitudes by Using Comic. *Psychology, Evaluation, and Technology in Educational Research*, 2(2), 69-80.
- Sari, R., Perdana, R., Riwayani, Jumadi, Wilujeng, I., & Kuswanto, H. (2019) The implementation of problem-based learning model with online simulation to enhance the student's analytical thinking skill in

- learning physics. *Journal of Physics: Conference Series*, 1233 012030.
- Sudarsana, I. K., Nakayanti, A. R., Sapta, S., Haimah, Satria, E., Saddhono, K., GS, D. A., Putut, E., Helda, T., & Mursalin, M. (2019). Technology application in education and learning process. *Journal of Physics: Conference Series*, 1363 012061.
- A., Putut, E., Helda, T., & Mursalin, M. (2019). Technology application in education and learning process. *Journal of Physics: Conference Series*, 1363 012061.
- Sugiyono. (2015). *Metode penelitian pendidikan*. Bandung: Alfabeta.
- Sukenda, Anjani, M., & Yustim, B. (2019). Learning Media for Biology Subject Based on Multimedia in Junior High School Level. *Universal Journal of Educational Research*, 7(4A), 43-51.
- Sung, H. Y., Hwang, G. J., Chen, C. Y., & Liu, W. X. (2019). A contextual learning model for developing interactive e-books to improve students' performances of learning the analects of confucius. *Interactive Learning Environments*, 1-14.
- Surjanti, J., Seno, D. N., Hadi, H. K., Maroah, S., Siswanti, Y., Muafi., & Isfianadewi, D. (2018). The role of m-learning on effective learning media in higher education. *International Journal of Civil Engineering and Technology*, 9(4): 77-85.
- Thomas, T. (2011). Developing First Year Student's Critical Thinking Skills. *Asian Social Science*, 7(4), 26-35
- Wiguna, D., Irwansyah, F. S., Windayani, N., Aulawi, H., & Ramdhani, M. A. (2019). Development of android-based chemistry learning media oriented towards generic science skills. *Journal of Physics: Conference Series*, 1157 042047.
- Williamson, B., Eynon, R., & Potter, J. (2020). Pandemic Politics, Pedagogies and Practices: Digital Technologies and Distance Education during the Coronavirus Emergency. *Learning, Media and Technology*, 45(2), 107-114.
- Yew, E. H. J., & Goh, K. (2016). Problem-Based Learning: An Overview of its Process and Impact on Learning. *Health Professions Education*, 2(2), 75-79.

LAMPIRAN 2.6
PROSES REVIEW KE-3



ANALYSIS OF THE ROLE OF ANDROID-BASED LEARNING MEDIA IN LEARNING CRITICAL THINKING SKILLS AND SCIENTIFIC ATTITUDE

DOI:

Accepted: ... Approved: ... Published: ...

ABSTRACT

This study aims to analyze and describe the role of android-based learning media in an effort to teach critical thinking skills and scientific attitudes for students. The learning media are android-based webcomic (Androwebic) and e-book on plant diversity in Banjarnegara (E-Bokarmban), which have been developed previously. This research is a qualitative descriptive study, involving 301 students, 6 biology teachers and 6 high school students. The data collected includes critical thinking skills, analytical skills, scientific attitudes, environmental care attitudes, media components supporting student competence, student learning activities, and teacher and student responses. Data on critical thinking skills were measured using tests and non-tests, other data was measured using non-test instruments, including interview guides, scientific attitude observation sheets, students' environmental care attitudes, media component observation sheets, learning activity observation sheets, and student and teacher questionnaires. Quantitative data on critical thinking skills and analytical skills were analyzed using the n-gain test, while other data were analyzed descriptively. The results showed that the E-Bokarmban and Androwebic media have components that support facilitating critical thinking skills, analytical skills, environmental care attitudes in students. Androwebic media is able to train students' analytical thinking skills and scientific attitude very well. The two media developed were considered to be very helpful in the learning process. Conclusion: Android-based media in the form of Androwebic and E-Bokarmban have a very important role to train critical thinking skills, scientific attitudes and environmental care attitudes.

© 20xx Science Education Study Program FMIPA UNNES Semarang

Keywords: androwebic, e-bokartumban, critical thinking skills, scientific attitude

INTRODUCTION

Biology learning involves skills and

reasoning (Amoah & Emmanuel, 2018). In developing reasoning power and skills, learning is needed that can emphasize aspects of application, analysis, synthesis, and evaluation, not only emphasizing aspects of understanding and knowledge. For this reason, a learning process is needed that can improve cognitive, affective, psychomotor competencies, as well as learning methods that can motivate students to be creative, confident, and think critically needed to assess information, critical (Pujasih et al., 2020). Critical thinking skills are needed to explain reasons and solve problems (Thomas, 2011). Teaching critical thinking and problem-solving skills can be done with problem-based learning/ PBL (Yew & Goh, 2016).

The development of critical thinking skills in students must focus on activities to teach content/knowledge and methods or ways to find,

process, and evaluate information (Nath et al, 2018). Basically, students have the ability to think critically in learning, but this ability sometimes does not develop well. Therefore, it is necessary to use a method that is able to develop students' critical thinking skills. Students who have critical thinking skills will be easy to analyze, evaluate, and can relate it to evidence/arguments, before deciding or assessing an information (Mutakinati et al., 2018). In the learning process, students' critical thinking skills play an important role in achieving learning achievement, formal reasoning, and creativity (Puspita et al., 2017). (in vocational schools/vocational schools) are still low.

Commented [U1]: This section must cover the background, gap analysis, research objective, research status, research urgency, research novelty supported by the data of previous research.

NOTE: Research status is the point of this study towards other studies, whether it supports, debates, or corrects, and this section lacks of it. In addition, the research novelty and urgency have not also been stated clearly.

Learning that facilitates critical thinking skills can be realized if there is cooperation and participation from all parties, from policy makers to teacher universities, local education departments, schools, and families (Nhat et al, 2018). The results of Seventika et al (2018) research show that students' critical thinking skills.

Biology learning in schools is still dominated by textbooks and modules with few pictures, and learning is still teacher-centred. This causes students' mindsets to be limited, and students' understanding of biology concepts weakens, so that students' critical thinking skills and scientific attitudes are still weak. This statement is reinforced by the results of interviews by several state high school/MA teachers in Banjarnegara and Jepara. Information obtained from the results of the interview, among others: (1) Learning has not utilized student-centered media to its full potential; (2) students are allowed to bring smartphones but they have not been used properly; (3) technology (smartphone) as a tool or media that does not support learning, (4) limited learning time.

Based on the results of interviews with teachers, it can be concluded that these problems can be minimized by utilizing the technology owned by students, and utilizing student-centered learning strategies to the fullest. Examples of biological materials that need to be taught using media are the circulatory system and biodiversity. The material on the circulatory system needs to be taught with the media because it contains complex concepts, so that it can be presented in a more interesting way. Biodiversity material (especially on plant diversity) also really needs to be taught by optimizing electronic media, to present a plant diversity environment in the classroom.

The availability of learning media will facilitate interaction between teachers and students, so that learning activities will be more effective and efficient (Puspitasari et al., 2018). The existence of learning media facilitates ease of learning, fosters interest in learning, and makes it easier for students to learn independently so that the learning process will be more effective (Surjanti et al., 2018). The use of android-based media can make students more interested in learning. The use of pictorial technology media also attracts students' attention more than the use of textbooks. Taking this into account, it is clear that optimizing the use of modern technology-based media in learning is an urgent matter, especially during a pandemic like today. In learning during the Covid-19 pandemic, the use of media and technology must be able to make a real contribution to knowledge and the emergence of educational practices with online and digital education formats (Williamson et al, 2020)

Based on the existing problems, it is clear that currently optimizing learning media that are useful for visualizing learning materials appropriately. The media should have a simple structure that focuses on one goal. Learning media that are expected to be useful (good) to overcome the learning problems mentioned earlier are media that are easy to carry and use anywhere. Sukenda et al (2019) stated that multimedia-based learning media can be packaged into software that is able to present material.

One of the important learning media packaged into software is the environment. The environment is useful for equipping students with a conscious mind and care for the environment, and for all issues related to the environment (Amini, 2015-02). The environment is also important to instill knowledge, skills, attitudes, behavior, motivation, and commitment to work together in solving environmental problems, as well as an attitude of caring for the environment. The results of Putri & Prodjosantoso's research (2020) prove that science comics media (guided inquiry-based science comics) can improve critical thinking skills and scientific attitudes. Scientific attitude is an attitude that encourages students to solve problems (Hasanah et al, 2020). Khasanah et al. (2017) stated that the module based on critical thinking skills on respiratory system material is useful for practicing critical thinking skills.

Based on the description above, it is clear that the media is very necessary in learning, among others, to instill skills and attitudes in students. One of these media is android-based media, as software. In this study, the role of android-based media was analyzed in teaching/training attitudes and skills to students. There are 2 android-based media, namely 1) e-booklets about plant diversity in Banjarnegara (named E-Bokartumban), and 2) android-based webcomic about the circulatory system (named Androwebic). The media is expected to improve critical thinking skills, analytical skills, scientific attitudes, and environmental care attitudes in students.

Beberapa pertanyaan yang perlu dijawab dalam penelitian ini ialah sebagai berikut.

1. Apakah media E-Bokartumban berperan dalam membelajarkan keterampilan berpikir kritis dan sikap peduli lingkungan siswa?
2. Apakah media Androwebic berperan peran dalam membelajarkan kemampuan analisis dan sikap ilmiah siswa?
3. Bagaimana proses berfungsinya media E-Bokartumban dalam membelajarkan keterampilan berpikir kritis dan sikap peduli lingkungan pada siswa?

4. Bagaimana proses berfungsinya media Androwebic dalam membelajarkan kemampuan analisis dan sikap ilmiah?
5. Aktivitas belajar apa saja yang dilakukan siswa selama belajar menggunakan kedua media berbasis android itu?
6. Bagaimana tanggapan/respon siswa dan guru terhadap kedua media tersebut?

METHOD

Types of research

This study aims to analyze (and describe) in depth the role of android-based learning media in an effort to teach/train critical thinking skills,

analytical skills, scientific attitudes, and environmental care attitudes. Therefore, the research design used is a descriptive qualitative research design (Sugiyono, 2016).

Research Sample

The samples (subjects) of this study were 6 biology teachers, 196 class X students from three high schools in Banjarnegara and 105 students in class XI from three high schools in Jepara. The research sample was selected using purposive sampling technique.

Research Data and Instruments

The data collected includes data on critical thinking skills, analytical skills, scientific attitudes, environmental care attitudes, media components supporting student competence, student learning activities, and teacher and student responses. Data were collected in several ways, namely tests, observations, and questionnaires, and documentation. Data on critical thinking skills and analytical skills were measured using a test instrument, while other data were measured using a non-test instrument. The

non-test instruments include interview guides, scientific attitude observation sheets, student environmental care attitudes, media component observation sheets, learning activity observation sheets, and student and teacher questionnaires.

Data analysis

Quantitative data on critical thinking skills and analytical skills were analyzed using the n-gain test, while other data were analyzed descriptively qualitatively. Descriptive qualitative data analysis was carried out in 4 stages, namely data collection, data reduction, data presentation,

and drawing conclusions.

RESULTS AND DISCUSSION

The Role of Media in Biology Learning

The role of Androwebics in Biology learning

The analytical ability of students in learning using Androwebic was obtained from the results of the pretest and posttest (Table 1). Table 1 shows the significant difference between the pretest and posttest scores achieved by students. The results of the pretest showed an average score of 53.65 (not yet reached the value of 75), while the posttest score achieved by students was an average of 88.83 (beyond the KKM). The increase in students' analytical thinking skills was obtained from the results of the n-gain test on the pretest and posttest scores achieved by students. The results of the n-gain test showed that students who achieved high, medium and low analytical skills were 72%, 24% and 4%, respectively. From these results it can be stated that the Androwebic media is effectively used to improve students' analytical skills, especially in learning material about the circulation system.

Table 1. Students' Pretest and posttest Score in Biology Learning Using Androwebic Media

Information	Pretest Score (n=105)	Posttest Score (n=105)
Highest score	93.33	100
Lowest score	13.33	60
Average value	53.65	88.83
Number of students completed	11	97
The number of students is not complete	94	8
Classical completeness%	10.48	92.38

Androwebic media has this potential because it is equipped with various menus such as discussion questions (see Table 2), which contain problems in the context of everyday life. The availability of various menus on Androwebic media stimulates students' curiosity and encourages students to practice problem solving. Both activities require analytical thinking skills, so that students' abilities in that regard are well trained. This is in accordance with the research of Prawita et al. (2019) and Sari et al. (2019) which states that the use of

learning media that presents problems can improve student learning outcomes and analytical thinking skills. During the discussion stage in biology learning using Androwebic media, students are trained to discuss and exchange ideas about problem solutions systematically and logically. Thus students become trained to think analytically. This is in accordance with the statement of Sari et al. (2019) which proves that learning by actively involving students to solve

Commented [U4]: Need more information of the instruments used in this study.

Commented [U5R4]: What is the type of test? Multiple choice test or open ended questions?

Commented [U2]: In English

Commented [U6]: Need more information of the data analysis used in this study.

Commented [U7]: You need to explain the learning media used in this study Androwebic and E-Bokartumban. Probably, you can explain the part of these learning media.

Commented [U3]: Why using purposive random sampling? And what are the considerations choosing this sample?

Commented [U8]: What is KKM? Significant difference need to prove by statistical analysis.

Commented [U9]: What do you mean by this information?

Commented [U10]: What do you mean by this information?

Commented [U11]: Could you explain more of this statement?

problems can improve analytical thinking skills and student learning outcomes. The ability to think analytically is one component of critical thinking skills (Facione 2015). So it can be stated that Androwebic media has the potential to train critical thinking skills.

Information about students' scientific attitudes in learning using Androwebic media was

obtained from observing students' scientific attitudes using observation sheets. Androwebic media was created specifically, in such a way that it has a number of useful facilities to practice 6 aspects of scientific attitude (see Table 3). Students' scientific attitude was observed by student activities carried out during the learning process using Androwebic media, presented in Table 3.

Table 2. Components of Andro-Webcomic Media that support in facilitating analytical thinking competence and scientific attitude.

No	Indicators of Analytical Thinking Ability	Media Components
1	Differentiating	Task to differentiate in group discussion questions
2	Organizing	Task for grouping on group discussion questions
3	Connecting	The task concludes with group discussion questions
Scientific Attitude		
1	Curiosity	Task to observe on the webcomic
2	Respect for data/facts	Group discussion task in the media investigation section
3	Flexibility in thinking	Group discussion task in the media investigation section
4	Open minded and cooperate	Group discussion task in the media investigation section
5	Perseverance	The task of presenting the observations to be presented

Table 3. Students' scientific attitudes during the learning process using androwebic media

Indicator	Σ Score	Max Score	Score (%)	Criteria
Attention to every new thing	1086	1260	86.19	Very good
Appreciate and conclude according to facts	1056	1260	83.81	Very good
Not always fell right, changing opinion after considering the evidence	1035	1260	82.14	Very good
Ask questions and give opinions	1124	1260	89.21	Very good
Participate in groups	1107	1260	87.86	Very good
Record complete observations	1068	1260	84.76	Very good

In Table 3 it can be seen that the average scientific attitude of students is in the very good category. This happens because since the beginning of the learning process, students are always motivated to learn and seek information independently, so that during the learning process in class students show a more caring attitude, respect, and draw conclusions according to facts. During the learning process, students are also accustomed to not always feel right, dare to ask questions, dare to express opinions, be active in groups, and record complete observations. In the learning process students must complete discussion questions that contain contextual problems. Every activity carried out during the discussion process made a positive contribution to the formation of scientific attitudes. This is what can encourage students to think analytically in solving problems. This is in accordance with the statement of Dwianto et al. (2017) that the application of learning media that presents contextual problems through discussion can make a positive contribution to the formation of scientific attitudes in students.

The role of E-Bokarmban media in learning

Android-based E-Bokarmban media contains information about the diversity of plants found in Banjarnegara. The information in question includes the scientific classification of each type of plant and a description of its morphology, a dissertation with color pictures with a very attractive appearance. With its characteristics, the E-Bokarmban media is useful for presenting the natural environment (environment) to the classroom. The E-Bokarmban format in the form of an application that can be operated using a smartphone makes it very easy for students to use it. The results of the n-gain test showed that after learning to use the E-Bokarmban media, students experienced an increase in critical thinking skills. The increase in critical thinking skills (n-gain) achieved by students was 0.69 in the medium category (tend to be high). Students who achieve high, medium and low critical thinking skills are 53%, 45% and 2%, respectively. From these results it can be stated that the E-Bokarmban media has an important role to improve critical thinking skills. This role is supported by the characteristics of the E-Bokarmban media which has a useful supporting

Commented [U12]: From where this criteria are coming from?

Commented [U13R12]: Why all criteria are very good

Commented [U14]: Is this statement related to learning media used in this study?

component to facilitate the emergence of critical thinking skills (see Table 4).

Table 4. E- Bokartumban Media Components that facilitate critical thinking skills competencies

No.	Indicators Critical thinking skills	Media Components
1	Give a simple explanation	Evaluation questions on the media, students discussion sheets
2	Build basic skills	Evaluation questions on the media, students discussion sheets
3	Conclude	Evaluation questions on the media, students discussion sheets
4	Identify terms and consider a definition	Evaluation questions on the media, students discussion sheets
5	Set strategy and tactics	Evaluation questions on the media, students discussion sheets

Table 4 shows that the E-Bokarmban media has components that function to facilitate each competency studied in this study. There are five stages of thinking with each indicator, namely 1) providing simple explanations, 2) building basic skills, 3) concluding, 4) identifying terms, & 5) considering a definition, setting strategies and tactics (Ennis cit Kartimi & Liliarsari. 2012). This thinking indicator can be measured when students work on student discussion sheets and evaluation questions on the media.

Wiguna et al (2019) and Damopolil & Kurniadi (2019) explained that an increase in learning outcomes occur in students after they take part in learning using android-based media.

Based on the description above, it can be emphasized that the E-Bokarmban media has an

important role in teaching or practicing critical thinking skills. Arista & Kuswanto (2018) stated that media that can be operated using smartphones can increase enthusiasm, interest, and motivation in learning activities. All of these things can increase the independence and understanding of concepts in students.

E-Bokarmban media also has various components that play an important role in growing various indicators of environmental care attitudes (Table 5). In Table 5, various sections of the media (column 3) are presented which are useful for strengthening various indicators of environmental care attitudes which are presented in column 2 of Table 5.

Table 5. Competency indicators of environmental care attitudes in students and components of the E-Bokartumban media that facilitate the emergence of these attitude indicators

No.	Aspects and Indicators e nvironmental Care Attitude	Media Components
1	Have thought that plants and animals have rights were equal to humans	Introduction to the materials
2	Have feelings/emotions about human actions that cause disaster	Introduction to the materials
3	Have thought that the environment is very fragile and easily disturbed balance	Student discussion sheets, materials on the media
4	Have feelings and tendencies of behavior that the tendency of human beings there is a limit in controlling nature	Student discussion sheets, materials on the media
5	Tend to take advantage of the source power of nature that has been used	Student discussion sheets, materials on the media
6	Tend not to be arbitrary towards the environment	Student discussion sheets, materials on the media
7	Have thoughts and attracted to environmental issues	Student discussion sheets, materials on the media
8	Have emotional feelings about actions that can cause environmental damage	Student discussion sheets, materials on the media

From the data in Table 5, it can be seen that indicators of environmental care attitudes use a scale adapted from NEPS. Indicators of the attitude of caring for the environment in question are as follows. 1) Having the idea that plants and animals have the same rights as humans, 2) having feelings/emotions about human actions that cause disasters, 3) having the thought that the environment is very vulnerable and its balance is easily disturbed. The next attitude indicator is 4) having feelings and behavioral tendencies that human tendencies have limits in controlling

nature, 5) having behavioral tendencies to take advantage of used natural resources. The 6th indicator has a behavioral tendency not to be arbitrary towards the environment, 7) has thoughts and is interested in environmental issues, and 8) has emotional feelings towards actions that can cause environmental damage. All indicators of environmental care attitudes can be measured as long as students use the media, namely when reading the material and during group discussions during the learning process.

Commented [U15]: You need to put figure of each part of media component

Learning with the E-Bokarmban media is able to make a positive contribution in improving students' environmental care attitudes. Environmental care attitudes are attitudes and actions that always try to prevent damage to the surrounding natural environment and develop efforts to repair natural damage (Yaumi, 2014). The attitude of caring for the environment can be shown by attitudes and actions that always try to prevent environmental damage and try to repair the natural damage that has occurred (Mardikaningtyas, 2016).

Based on the description in the paragraph above, it can be stated that the use of android-based learning media is very effective in increasing student understanding. This is in accordance with the opinion of Sudarsana et al. (2019) which states that the use of technology-based learning media can improve student learning outcomes. Junaedi et al. (2018) and Damopolil & Kurniadi (2019) found that learning by applying android-based media can improve student learning outcomes. Learning that

uses technology can increase student interest and learning outcomes (Sudarsana et al., 2019). Wiguna et al. (2019) and Damopolil & Kurniadi (2019) reported an increase in student learning outcomes after participating in learning using media android based. This statement is also in accordance with the explanation of Jen0 et al. (2017), which states that the learning process using android-based media can improve student learning outcomes.

Student and Teacher Responses to Android-Based Media used in Biology learning

Student and teacher responses to Androwebic media

Student responses to learning using Androwebic media were obtained from student response questionnaires given at the end of the lesson. Information about students' positive responses to Androwebic media is presented in Table 6.

Table 6. Results of Student Responses to Androwebic Media

Indicators	Score Obtained	Max. Score	Percentage (%)	Criteria
Affective consideration	755	840	89.88	Very good
Learning	1116	1260	88.57	Very good
Multimedia display	2308	2520	91.59	Very good
Navigation	1487	1680	88.51	Very good
Robustness	1507	1680	89.40	Very good
Average			89.59	Very good

The data in Table 6 shows the average of each aspect/indicator showing very good criteria. In some aspects, the student response rate shows the maximum score. This shows that students are interested and motivated to learn with comics on the media. Besides being interested and motivated by comics, students also acknowledged that the material equipped with pictures on Androwebic media was very helpful and made it easier for students to learn, because it had been summarized in a structured way. The problems presented in the Androwebic media also have the potential to increase student activity in problem based learning activities that can be learned. In the learning process, students not only listen, but also try, discover, and conclude. Therefore, students' understanding, analytical thinking ability, and

right visualization. This makes it easier for students to understand abstract blood circulation material. Androwebic media can also help students understand and discover concepts about the circulatory system. The use of appropriate learning media and in accordance with the character of students in learning, can help students to find concepts contextually. The media in question must be interesting, contain extensive learning resources, contain information whose presentation is accompanied by visual images. The use of a problem-based learning approach that is complemented by the use of learning media has been proven to be able to foster student interest and motivation to be more active in learning so as to create fun learning, understanding the material of the circulatory system will increase (Maulana &

scientific attitude will be higher.

In terms of appearance, Androwebic media received high points, with very good criteria. This shows that students are very interested in the appearance of Androwebic media. Androwebic Media equipped with pictures on every detail of the material, so as to provide the

The level of positive response from teachers to the implementation of the learning process using Androwebic media is obtained from the teacher's responses which are presented in Table 7.

Table 7. Levels of Teacher's Positive Response to Androwebic Media

Indicators/aspects	Score Obtained	Max. Score	Percentage (%)	Criteria
Affective consideration	22	24	91.67	Very good
Learning	30	36	83.33	Very good
Multimedia display	64	72	88.89	Very good
Navigation	41	48	85.42	Very good
Robustness	42	48	87.50	Very good
Average			87.36	Very good

From the data in Table 7, it is known that the average score for each aspect is 87.36%, with a very good category. The teacher said that Androwebic media was very good, easy to use, up-to-date, the material presented was equipped with attractive visuals, it could be used anytime and anywhere on condition that it used an android device. This is confirmed by Sung et al. (2016) which states that the use of android devices such as smartphones in learning is better and more effective than conventional learning. Students are more enthusiastic because the learning process is student-centered, while the teacher only directs and guides. This is in accordance with the findings of Ali (2019) which proves that student-centered learning will improve students' ability to understand the material being studied and problem-solving skills. In such circumstances, the teacher simply directs and guides as necessary.

Student and teacher responses to E-Bokarmban

The responses of students and teachers in this section were obtained from the questionnaire, which was described from 10 indicators. Through the questionnaire, the teacher and student responses/responses to the Ebokarmban media were obtained. The results of descriptive analysis of the data on student and teacher responses to Ebokarmban media show that students and teachers each gave a response of 89.13% and 90.09% (very good category).

The teacher stated that the E-Bokarmban media used in this study was able to help students in building the concept of biodiversity material. The teacher also gave a positive response to student activities in learning, because it was able to make students very enthusiastic when they discussed. The teacher said that the E-Bokarmban media is an attractive, contemporary, easy to use, easy to carry media, and the material presented is very clear. Thus, it can be emphasized that the E-Bokarmban media is a very good medium to use in learning, and it is clear that this media has excellent potential to train critical thinking skills and environmental care attitudes, as previously stated.

Based on the description, it is clearly stated that Androwebic media can train students' analytical thinking skills by 92.68% and scientific attitude by 85.66%. The Android-based media was responded positively by students and teachers. E-Bokarmban media is also proven to be able to train critical thinking skills and an

attitude of caring for the environment. E-Bokarmban media also responded very positively by students and teachers by 89.13% and 90.09%, respectively. Thus, it can be stated that the Androwebic and E-Bokarmban media developed in this study are valid, and have the potential to be used to train students' critical thinking skills and scientific attitudes in learning Biology.

CONCLUSION

From the discussion above, the following conclusions can be drawn. 1). E-Bokarmban media shows an important role in teaching students critical thinking skills and environmental care attitudes. 2) Androwebic media shows an important role in teaching students analytical skills and scientific attitudes. The level of critical thinking skills, analytical skills, scientific attitudes, and environmental care attitudes of students after learning to use android-based media increased to good and very good. 3). E-Bokarmban media can function / be used to teach students critical thinking skills and environmental care attitudes, because it contains various components that are able to facilitate activities which are indicators of critical thinking skills and environmental care attitudes. 4). Androwebic media functions / can be used to teach analytical skills and scientific attitudes to students, because it contains various components that are able to facilitate activities which are indicators because they contain various components that are able to facilitate activities which are indicators of analytical skills and scientific attitudes. 5). The learning activities carried out by students while learning to use the two android-based media include various activities that match the indicators of critical thinking skills, analytical skills, scientific attitudes, and environmental care attitudes. 6) Students and teachers showed a very good response to Androwebic and E-Bokarmban used in Biology learning. Two types of Android-based media, namely Androwebic and E-Bokarmban used in Biology learning have proven to have a very important role in teaching students critical thinking skills, analytical skills, scientific attitudes, and environmental care attitudes.

The authors would like to thanks Prof. Dr. Enni Suwarsi Rahayu, M.Si., and Prof. Dr. Retno Sri Iswari, S.U., as the material expert validator, Dr. Budi Naini Mindiyarto, M.App.Sc., and Mohammad Fikri, S.Sn (Pusdatin Kemendikbud)

Commented [U16]: This study is lack of discussions. The discussion chapter is where you delve into the meaning, importance and relevance of your results. It should focus on explaining and evaluating what you found, showing how it relates to your literature review and research questions, and making an argument in support of your overall conclusion.

as media expert validators who have provided very useful suggestions for improving this research. The authors also would like to thanks Dr. Sigit Sapton, M.Pd (Coordinator of S2 Science Education study program). This research was supported by the Lembaga Penelitian dan Pengabdian Masyarakat Universitas Negeri Semarang, which has funded this research (the contract number of the funding letter: SP DIPA-023.17.2.677507/2020, 27-12-2019, in accordance with the Letter of Assignment of Research Implementation of UNNES DIPA Funds Year 2020, Number 166.23.4/UN37/PPK.3.1/2020, 23-04-2020).

REFERENCES

- Ali, S. S. (2019). Problem based learning: a student-centered approach. *English Language Teaching*, 12(5), 73-78.
- Amini, R. (2015). Outdoor Based Environmental Education Learning and its Effect in Caring Attitude Toward Environment. *Jurnal Pendidikan IPA Indonesia*, 4(1), 43-47.
- Amoah A. C., & Emmanuel E. (2018). Assessing the reasoning skills of biology students in selected senior high schools in the central region of Ghana. *International Journal of Scientific Research and Management (IJSRM)*, 6(4), 299-304.
- Arista, F. S., & Kuswanto, H. (2018). Virtual physics laboratory application based on the android smartphone to improve learning independence and conceptual understanding. *International Journal of Instruction*, 11(1), 1-16.
- Damopolih, I., & Kurniadi, B. (2019). The development of android-based mobile learning supported by problem-based learning strategy for students' learning success. *International Journal of Scientific and Technology research*, 8(7), 190-193.
- Dwianto, A., Wilujeng, I., Prasetyo, Z. K., & Suryadarma, I. G. P. (2017). The development of science domain based learning tool which is integrated with local wisdom to improve science process skill and scientific attitude. *Jurnal Pendidikan IPA Indonesia*, 6(1): 23-31.
- Facione, P. A. (2015). *Critical Thinking: What It Is and Why It Counts*. In Insight assessment (Issue ISBN 13: 978-1-891557-07-1.).
- Hasanah, S. I., Mustofa, R. F., & Ardiansyah, R. (2020). Correlation between Generic Science Skills and Scientific Attitudes on Learning Outcomes. *BIOEDUSCIENCE*, 4(2), 124-128.
- Jeno, L. M., Grytnes, J. A., & Vandvik, V. (2017). The effect of a mobile-application tool on biology students' motivation and achievement in species identification: A Self-Determination Theory perspective. *Computer & Education*, 107, 1-12.
- Junaedi, J., Irviani, R., Muslihudin, M., Hidayat, S., Maselena, A., Gumanti, M., & Fauzi, A. N. (2018). Application program learning based on android for students experiences. *International Journal of Engineering and Technology (UAE)*, 7(2.27), 194-198.
- Kartimi, & Liliyasi. 2012. Pengembangan Alat Ukur Berpikir Kritis pada Konsep Termokimia untuk Siswa SMA Berperingkat Atas dan Menengah. *Jurnal Pendidikan IPA Indonesia*, 1(1): 21-26.
- Lee, S., Kang, E., & Kim, H. B. (2015). Exploring impact of students' learning approach on collaborative group modeling of blood circulation. *Journal of Science Education and Technology*, 24(2): 234-255.
- Maulana, H., & Sulistyoningrum. (2018). Implementation Mirror Technique 3D Objects for Interactive Learning Media "Circulatory System" Virtual Reality-Based. *Journal of Physics: Conference Series*, 1364 012036.
- Mutakinati, L., Anwari, I., & Yoshisuke, K. (2018). Analysis of students' critical thinking skill of middle school through STEM education project-based learning. *Jurnal Pendidikan IPA Indonesia*, 7(1), 54-65.
- Nhat, H. T., Lien, N. T., Tinh, N. T., Hang, N. V. T., & Trang, N. T. (2018). The Development of Critical Thinking for Students in Vietnamese Schools: From Policies to Practices. *American Journal of Educational Research*, 6(5), 431-435.
- Prawita, W., Prayitno, B. A., & Sugiyarto. (2019). Effectiveness of generative learning-based biology module to improve the analytical thinking skills of the students with high and low reading motivation. *International Journal of Instruction*, 12(1), 1459-1476.
- Pujiasih, P., Wiwi L., & Saiful R. (2020). Android-based e-booklet development to train students' critical thinking and attitude of caring for environment. *Journal of Innovative Science Education*, 10 (1), 95-101.
- Puspita, I., Kaniawati, I., & Suwarma, R. (2017). Analysis of critical thinking skills on the topic static fluid. *Journal of Physics: Conference Series*, 895 012100.
- Puspitasari, E. D. T., Surjono, H. D., & Minghat, A. D. (2018). Utilizing web based learning as 21st century learning media for vocational education. *International Journal of Engineering & Technology*, 7(4.33), 157-160.
- Putri, M. A., & Prodjosantoso, A. K. (2020). Improving Critical Thinking Skills and Scientific Attitudes by Using Comic. *Psychology, Evaluation, and Technology in Educational Research*, 2(2), 69-80.
- Sari, R., Perdana, R., Riwayani, Jumadi, Wilujeng, I., & Kuswanto, H. (2019) The implementation of problem-based learning model with online simulation to enhance

Commented [U17]: Put in the acknowledgement

Commented [U18]: Add more the latest sources from reputable or international journals. Taken from the last 10 years (>2011)

- the student's analytical thinking skill in learning physics. *Journal of Physics: Conference Series*, 1233 012030.
- Sudarsana, I. K., Nakayanti, A. R., Sapta, S., Haimah, Satria, E., Saddhono, K., GS, D. A., Putut, E., Helda, T., & Mursalin, M. (2019). Technology application in education and learning process. *Journal of Physics: Conference Series*, 1363 012061.
- A., Putut, E., Helda, T., & Mursalin, M. (2019). Technology application in education and learning process. *Journal of Physics: Conference Series*, 1363 012061.
- Sugiyono. (2015). *Metode penelitian pendidikan*. Bandung: Alfabeta.
- Sukenda, Anjani, M., & Yustim, B. (2019). Learning Media for Biology Subject Based on Multimedia in Junior High School Level. *Universal Journal of Educational Research*, 7(4A), 43-51.
- Sung, H. Y., Hwang, G. J., Chen, C. Y., & Liu, W. X. (2019). A contextual learning model for developing interactive e-books to improve students' performances of learning the analects of confucius. *Interactive Learning Environments*, 1-14.
- Surjanti, J., Seno, D. N., Hadi, H. K., Maroah, S., Siswanti, Y., Muafi., & Isfianadewi, D. (2018). The role of m-learning on effective learning media in higher education. *International Journal of Civil Engineering and Technology*, 9(4): 77-85.
- Thomas, T. (2011). Developing First Year Student's Critical Thinking Skills. *Asian Social Science*, 7(4), 26-35
- Wiguna, D., Irwansyah, F. S., Windayani, N., Aulawi, H., & Ramdhani, M. A. (2019). Development of android-based chemistry learning media oriented towards generic science skills. *Journal of Physics: Conference Series*, 1157 042047.
- Williamson, B., Eynon, R., & Potter, J. (2020). Pandemic Politics, Pedagogies and Practices: Digital Technologies and Distance Education during the Coronavirus Emergency. *Learning, Media and Technology*, 45(2), 107-114.
- Yew, E. H. J., & Goh, K. (2016). Problem-Based Learning: An Overview of its Process and Impact on Learning. *Health Professions Education*, 2(2), 75-79.

LAMPIRAN 2.7
PROSES REVISI KE-3



JPII x (x) (20xx) xxx-xxx

Jurnal Pendidikan IPA Indonesia<http://journal.unnes.ac.id/index.php/jpii>

**ANALYSIS OF THE ROLE OF ANDROID-BASED LEARNING MEDIA
IN LEARNING CRITICAL THINKING SKILLS AND SCIENTIFIC
ATTITUDE**

DOI:

Accepted: Approved: Published: ...

ABSTRACT

This study aims to analyze and describe the role of android-based learning media in an effort to teach critical thinking skills and scientific attitudes for students. The learning media are android-based webcomic (Androwebic) and e-book on plant diversity in Banjarnegara (E-Bokartumban), which have been developed previously. This research is a qualitative descriptive study, involving 301 students, 6 biology teachers and 6 high school students. The data collected includes critical thinking skills, analytical skills, scientific attitudes, environmental care attitudes, media components supporting student competence, and teacher and student responses. Data on critical thinking skills and analysis ability were measured using tests and non-tests, other data was measured using non-test instruments, including interview guides, scientific attitude observation sheets, students' environmental care attitudes, media component observation sheets, and student and teacher questionnaires. Quantitative data on critical thinking skills and analytical skills were analyzed using the n-gain test, while other data were analyzed descriptively. The results of research showed that the E-Bokartumban and Androwebic media have components that support facilitating critical thinking skills, analytical skills, environmental care attitudes in students. Androwebic media is able to train students' analytical thinking skills and scientific attitude very well. The two media developed were considered to be very helpful in the learning process. Conclusion: Android-based media in the form of Androwebic and E-Bokartumban have a very important role to train critical thinking skills, analysis ability, scientific attitudes and environmental care attitudes.

© 20xx Science Education Study Program FMIPA UNNES
Semarang**Keywords:** androwebic, e-bokartumban, critical thinking skills, scientific attitude**INTRODUCTION**

Biology learning involves skills and reasoning (Amoah & Emmanuel, 2018). In developing reasoning power and skills, learning is needed that can emphasize aspects of application, analysis, synthesis, and evaluation, not only emphasizing aspects of understanding and knowledge. For this reason, a learning process is needed that can improve cognitive, affective, psychomotor competencies, as well as learning methods that can motivate students to be creative, confident, and think critically needed to assess information, critical (Pujiasih et al., 2021).

Critical thinking skills are needed to explain reasons and solve problems (Thomas, 2011). Teaching critical thinking and problem-solving skills can be done with problem-based learning/ PBL (Yew & Goh, 2016). The development of critical thinking skills in students must focus on activities to teach content (knowledge) and methods or ways to find process, and evaluate information (Nath et al, 2018). Basically, students have the ability to think critically in learning, but this ability sometimes does not develop well. Therefore, it is necessary to use a method that is able to develop students' critical thinking skills. **One of the teaching methods that is considered appropriate for this is teaching using android-based media. The learning media in this study are android-based webcomic (Androwebic) and e-book on plant diversity in**

*Correspondence Address
E-mail:

Banjarnegara (e-bokartumban), which have been developed previously. Androwebic media has proven to be effective for teaching analytical skills and scientific attitudes (Sujatmiko et al (2021). E-Bokartumban media is also effective for improving critical thinking skills and environmental care attitudes (Pujiasih et al, 2021). However, neither Sujatmiko nor Pujiasih explained about the role of the two android-based media in improving students' competencies and attitudes.

The urgency, novelty, and purpose of this study is to analyze/describe the role of androwebic and e-bokartumban media in teaching students' skills and attitudes. These skills and attitudes include critical thinking skills, analytical ability, scientific attitude and environmental care attitude in students. The status of this research is to support previous research (Sujatmiko et al, 2021 and Pujiasih et al, 2021).

Mutakinati et al (2018) stated that students who have critical thinking skills will be easy to analyze, evaluate, and make connections with evidence/arguments, before deciding or assessing an information. In the learning process, students' critical thinking skills play an important role in achieving learning achievement, formal reasoning, and creativity (Puspita et al., 2017). Learning that facilitates critical thinking skills can be realized if there is cooperation and participation from all parties, from policy makers to teacher universities, local education departments, schools, and families (Nhat et al, 2018). The results of Seventika et al (2018) research show that most (>55%) of 11th grade students of vocational schools in Indramayu have a low level of critical thinking skills.

Biology learning in schools is still dominated by textbooks and modules with few pictures, and learning is still teacher-centred. This causes students' mindsets to be limited, and students' understanding of biology concepts weakens, so that students' critical thinking skills and scientific attitudes are still weak. This statement is reinforced by the results of interviews by several state high school/MA teachers in Banjarnegara and Jepara. Information obtained from the results of the interview, among others: (1) Learning has not utilized student-centered media to its full potential; (2) students are allowed to bring smartphones but they have not been used properly; (3) technology (smartphone) as a tool or media that does not support learning, (4) limited learning time.

Based on the results of interviews with teachers, it can be concluded that these problems can be minimized by utilizing the technology owned by students, and utilizing student-centered learning strategies to the fullest. Examples of biological materials that need to be taught using media are the circulatory system and biodiversity. The material on the circulatory system needs to be

taught with the media because it contains complex concepts, so that it can be presented in a more interesting way. Biodiversity material (especially on plant diversity) also really needs to be taught by optimizing electronic media, to present a plant diversity environment in the classroom.

The availability of learning media will facilitate interaction between teachers and students, so that learning activities will be more effective and efficient (Puspitasari et al., 2018). The existence of learning media facilitates ease of learning, fosters interest in learning, and makes it easier for students to learn independently so that the learning process will be more effective (Surjanti et al., 2018). The use of android-based media can make students more interested in learning. The use of pictorial technology media also attracts students' attention more than the use of textbooks. Taking this into account, it is clear that optimizing the use of modern technology-based media in learning is an urgent matter, especially during a pandemic like today. In learning during the Covid-19 pandemic, the use of media and technology must be able to make a real contribution to knowledge and the emergence of educational practices with online and digital education formats (Williamson et al, 2020)

Based on the existing problems, it is clear that currently optimizing learning media that are useful for visualizing learning materials appropriately. The media should have a simple structure that focuses on one goal. Learning media that are expected to be useful (good) to overcome the learning problems mentioned earlier are media that are easy to carry and use anywhere. Sukenda et al (2019) stated that multimedia-based learning media can be packaged into software that is able to present material.

One of the important learning media packaged into software is the environment. The environment is useful for equipping students with a conscious mind and care for the environment, and for all issues related to the environment (Amini, 2015). The environment is also important to instill knowledge, skills, attitudes, behavior, motivation, and commitment to work together in solving environmental problems, as well as an attitude of caring for the environment. The results of Putri & Prodjosantoso's research (2020) prove that science comics media (guided inquiry-based science comics) can improve critical thinking skills and scientific attitudes. Scientific attitude is an attitude that encourages students to solve problems (Hasanah et al, 2020). Khasanah et al. (2017) stated that the module based on critical thinking skills on respiratory system material is useful for practicing critical thinking skills.

Based on the description above, it is clear that the media is very necessary in learning, among others, to instill skills and attitudes in

students. One of these media is android-based media, as software. In this study, the role of android-based media was analyzed in teaching/training attitudes and skills to students. There are 2 android-based media, namely 1) e-booklets about plant diversity in Banjarnegara (named e-bokartumban), and 2) android-based webcomic about the circulatory system (named Androwebic). From previous studies it has been known that both media (Sujatmiko et al, 2021 and Pujiasih et al, 2021) are useful for improve critical thinking skills, analytical ability, scientific attitudes, and environmental care attitudes in students.

Some of the questions that need to be answered in this research are as follows.

1. Does Androwebic media play a role in teaching students' analytical skills and scientific attitudes?
2. Does the E-Bokartumban media play a role in teaching students critical thinking skills and environmental care attitudes?
3. How does the Androwebic media function in teaching analytical skills and scientific attitudes?
4. How does the E-Bokartumban media function in teaching critical thinking skills and environmental care to students?
5. What learning activities do students do while learning to use the two android-based media?
6. How do students and teachers respond to the two media

METHOD

Types of research

This study aims to analyze (and describe) in depth the role of android-based learning media in an effort to teach/train critical thinking skills, analytical skills, scientific attitudes, and environmental care attitudes. Therefore, the research design used is a descriptive qualitative research design (Sugiyono, 2015).

Research Sample

The samples (subjects) of this study were 6 biology teachers, 196 class X students from three high schools in Banjarnegara and 105 students in class XI from three high schools in Jepara. The research sample was selected using purposive sampling technique. Purposive sampling technique is used in this study because it requires research subjects that are relevant to the characteristics that have been determined.

Research Data and Instruments

The data collected includes data on critical thinking skills, analytical ability/skills, scientific attitudes, environmental care attitudes, media components supporting student competence, student learning activities, and teacher and student responses. Data were collected in several

ways, namely tests, observations, and questionnaires, and documentation. Data on critical thinking skills and analytical skills were measured using a test instrument, while other data were measured using a non-test instrument. Test instrument used contains multiple choice questions with 5 choices. The non-test instruments include interview guides, scientific attitude observation sheets, student environmental care attitudes, media component observation sheets, learning activity observation sheets, and student and teacher questionnaires.

Data analysis

Quantitative data on critical thinking skills and analytical skills were analyzed using the n-gain test, while other data were analyzed descriptively qualitatively. Descriptive qualitative data analysis was carried out in 4 stages, namely data collection, data reduction, data presentation, and drawing conclusions (Rochmadi & Nasucha, 2015). The data that has been collected is collected according to their respective categories, including test result data, questionnaire results and observation data. The data is then reduced, in order to obtain data that focuses on research problems, namely to analyze and describe the role of Androwebic and E-Bokartumban media in teaching the skills and attitudes which have been set. The data obtained are presented in tabular or narrative form, depending on the characteristics of each data. The last stage is drawing conclusions based on the available data.

RESULTS AND DISCUSSION

Results of research

Androwebic and E-bokartumban media Overview

Androwebic and E-bokartumban media have a general picture as shown in Figures 1, 2 and 3. The components of the androwebic media that are considered to play a role in teaching students' skills/abilities and attitudes are presented in Table 2. The components of the E-bokartumban media that are considered to play a role in teaching students' skills/abilities and attitudes are presented in Tables 4 and 5.

The analytical ability of students

The analytical ability of students in learning using Androwebic was obtained from the results of the pretest and posttest (Table 1). Table 1 shows higher post test scores than pre test scores. The results of the pretest showed an average score of 53.65 (not yet reached the value of 75/KKM), while the posttest score achieved by students was an average of 88.83 (beyond the KKM. KKM is the minimum completeness criteria. KKM is a reference for educators in assessing student competence in the subjects they follow).

The increase in students' analytical thinking skills was obtained from the results of the n-gain test on the pretest and posttest scores achieved by students. The results of the n-gain test showed that students who achieved high, medium and low analytical skills were 72%, 24% and 4%, respectively. From these results it can be stated

that the Androwebic media is effectively used to improve students' analytical skills, especially in learning material about the circulation system.

Androwebic media has this potential because it is equipped with various menus such as discussion questions (see Table 2), which contain problems in the context of everyday life.

Tabel 1. Students' Pretest and posttest Score in Biology Learning Using Androwebic Media

Information	Pretest Score (n=105)	Posttest Score (n=105)
Highest score	93.33	100
Lowest score	13.33	60
Average value	53.65	88.83

Students' scientific attitudes during the learning process using androwebic media

Information about students' scientific attitudes in learning using Androwebic media was obtained from observing students' scientific attitudes using observation sheets. Androwebic media was created specifically, in such a way that

it has a number of useful facilities to practice 6 aspects of scientific attitude (see Table 3). Students' scientific attitude was observed by student activities carried out during the learning process using Androwebic media, presented in Table 3. In Table 3 it can be seen that the average scientific attitude of students is in the very good category.



Figure 1: Androwebic media display, showing discussion topics 1, 2 and 3 (top) and pictures on discussion topics 1, 2 and 3 (lower).



Figure 2: Example of E-Bokartumbuhan media components at the beginning section

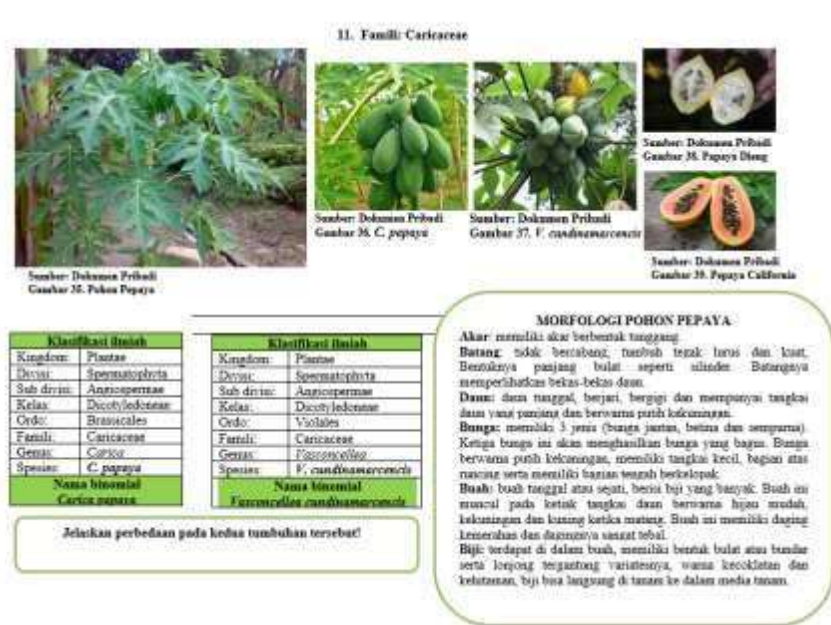


Figure 3: Example of E-Bokartumbuhan media components at the material section

Table 2. Components of Andro-Webcomic Media that support in facilitating analytical thinking ability (A) and scientific attitude (B).

No	Indicators of analytical thinking ability	Media Components
A Analytical thinking ability		
1	Differentiating	Task to differentiate in group discussion questions
2	Organizing	Task for grouping on group discussion questions
3	Connecting	The task concludes with group discussion questions
B Scientific attitude		
1	Curiosity	Task to observe on the webcomic
2	Respect for data/facts	Group discussion task in the media investigation section
3	Flexibility in thinking	Group discussion task in the media investigation section
4	Open minded and cooperate	Group discussion task in the media investigation section
5	Perseverance	The task of presenting the observations to be presented

Students' scientific attitudes during the learning process using androwebic media

Information about students' scientific attitudes in learning using Androwebic media was obtained from observing students' scientific attitudes using observation sheets. Androwebic media was created specifically, in such a way that

it has a number of useful facilities to practice 6 aspects of scientific attitude (see Table 3). Students' scientific attitude was observed by student activities carried out during the learning process using Androwebic media, presented in Table 3. In Table 3 it can be seen that the average scientific attitude of students is in the very good category.

Table 3. Students' scientific attitudes during the learning process using androwebic media

Indicator	Σ Score	Max Score	Score (%)	Criteria*)
Attention to every new thing	1086	1260	86.19	Very good
Appreciate and conclude according to facts	1056	1260	83.81	Very good
Not always fell right, changing opinion after considering the evidence	1035	1260	82.14	Very good
Ask questions and give opinions	1124	1260	89.21	Very good
Participate in groups	1107	1260	87.86	Very good
Record complete observations	1068	1260	84.76	Very good

*) : Sugiyono (2015): very good: 81-100; good: 61-80; 41-60: enough/currently

Keterampilan berpikir kritis siswa yang belajar menggunakan media E-Bokartumban

Android-based E-Bokartumban media contains information about the diversity of plants found in Banjarnegara. The information in question includes the scientific classification of each type of plant and a description of its morphology, a dissertation with color pictures with a very attractive appearance. With its characteristics, the e-bokartumban media is useful for presenting the natural environment to the classroom. The e-bokartumban format in the form of an application that can be operated using a smartphone makes it very easy for students to use it. The results of the n-gain test showed that after learning to use the e-bokartumban media, students experienced an increase in critical thinking skills. The increase in critical thinking skills (n-gain) achieved by students was 0.69 in the medium

category (tend to be high). Students who achieve high, medium and low critical thinking skills are 53%, 45% and 2%, respectively. From these results it can be stated that the e-bokartumban media has an important role to improve critical thinking skills. This role is supported by the characteristics of the E-Bokartumban media which has a useful supporting component to facilitate the emergence of critical thinking skills (see Table 4).

E-bokartumban media also has various components that play an important role in growing various indicators of environmental care attitudes (Table 5). In Table 5, various sections of the media (column 3) are presented which are useful for strengthening various indicators of environmental care attitudes which are presented in column 2 of Table 5.

Table 4. E-bokartumban media components that facilitate critical thinking skills competencies

No.	Indicators Critical thinking skills	Media Components
1	Give a simple explanation	Evaluation questions*), students discussion sheets
2	Build basic skills	Evaluation questions*), students discussion sheets
3	Conclude	Evaluation question*), students discussion sheets
4	Identify terms and consider a definition	Evaluation questions*), students discussion sheets
5	Set strategy and tactics	Evaluation questions*), students discussion sheets

*) : Examples of evaluation questions are presented in table 6

Table 5. Competency indicators of environmental care attitudes in students and components of the e-bokartumban media that facilitate the emergence of these attitude indicators.

No.	Aspects and Indicators environmental care attitude	Media Components *)
1	Have thought that plants and animals have rights were equal to humans	Introduction to the materials
2	Have feelings/emotions about human actions that cause disaster	Introduction to the materials
3	Have thought that the environment is very fragile and easily disturbed balance	Student discussion sheets, materials on the media
4	Have feelings and tendencies of behavior that the tendency of human beings there is a limit in controlling nature	Student discussion sheets, materials on the media
5	Tend to take advantage of the source power of nature that has been used	Student discussion sheets, materials on the media
6	Tend not to be arbitrary towards the environment	Student discussion sheets, materials on the media
7	Have thoughts and attracted to environmental issues	Student discussion sheets, materials on the media
8	Have emotional feelings about actions that can cause environmental damage	Student discussion sheets, materials on the media

*) : The examples of the components of the e-bokartumban media are presented in Figure 2 and 3.

Student and teacher responses to Androwebic media

Student responses to learning using Androwebic media were obtained from student response questionnaires given at the end of the lesson. Information about students'

positive responses to Androwebic media is presented in Table 6. The level of positive response from teachers to the implementation of the learning process using Androwebic media is obtained from the teacher's responses which are presented in Table 7.

Table 6. Results of Student Responses to Androwebic Media

Indicators	Score Obtained	Max. Score	Percentage (%)	Criteria
Affective consideration	755	840	89.88	Very good
Learning	1116	1260	88.57	Very good
Multimedia display	2308	2520	91.59	Very good
Navigation	1487	1680	88.51	Very good
Robustness	1507	1680	89.40	Very good
Average			89.59	Very good

Table 7. Levels of Teacher's Positive Response to Androwebic Media

Indicators/aspects	Score Obtained	Max. Score	Percentage (%)	Criteria
Affective consideration	22	24	91.67	Very good
Learning	30	36	83.33	Very good
Multimedia display	64	72	88.89	Very good
Navigation	41	48	85.42	Very good
Robustness	42	48	87.50	Very good
Average			87.36	Very good

Dicussion

The Role of Androwebic Media in Biology Learning

Role of androwebic media in learning analytical skills.

The problems raised in the discussion menu related to daily events, for example, are about the work of the heart, normal and non-normal blood conditions, about blood type. Those are all everyday things that are very often experienced by students. The availability of various menus on Androwebic media (see Fig 1 and Table 2) stimulates students' curiosity and encourages students to practice problem solving. Both activities require analytical thinking skills, so that students' abilities in that regard are well trained. This is in accordance with the research of Prawita et al. (2019) and Sari et al. (2019) which states that the use of learning media that presents problems can improve student learning outcomes and analytical thinking skills.

Comics help students learn by simplifying science concepts and making them easier to remember (Ozdemir, 2017). Comics also contribute to arousing students' enjoyment of science and the perception of success in science. Demirci & Zürek (2017) state that the cartoon concept can develop students' critical thinking skills more effectively. Colorful cartoons attract attention and can encourage active participation of students in learning activities (think more

actively). Indirectly it plays an important role in helping to develop critical thinking skills. An active learning process is also very useful for improving students' critical thinking skills (Styers et al, 2018) During the discussion stage in biology learning using Androwebic media, students are trained to discuss and exchange ideas about problem solutions systematically and logically (Figure 1). Thus, students become trained to think analytically. This is in accordance with the statement of Sari et al. (2019) which proves that learning by actively involving students to solve problems can improve analytical thinking skills and student learning outcomes. The ability to think analytically is one component of critical thinking skills (Facione 2015).

The teacher said that the Andro-Webcomic media based on problem-based learning was very good, easy to use, up to date, the material presented was equipped with attractive visuals, could be used anytime and anywhere with the condition of using an Android device. This is confirmed by research (Sung et al, 2016) which stated the use of Android devices (smartphones) in learning was better and more effective than conventional learning.

In this study, comics are used to teach material about the circulation system, which is very complex in nature and cannot be observed directly. The choice of comics to be used in androwebic turned out to be very appropriate, because it got a very good response from

teachers and students (see Table 6 and 7). This is also in accordance with the statement of Morel et al. (2019) which states that comics are an excellent tool to help educators teach complex subjects and explain the unseen world. Based on the above description, it can be stated that Androwebic media has a important role to train critical thinking skills.

Role of androwebic media in teaching scientific attitude

In Table 3 it can be seen that the average scientific attitude of students is in the very good category. It happened because since the beginning of the learning process using androwebic media students are always motivated to learn and seek information independently. During the learning process assisted by Androwebic media students show a more caring attitude, respect, and draw conclusions according to facts. During the learning process, students are also accustomed to not always feel right, dare to ask questions, dare to express opinions, be active in groups, and record complete observations. In the learning process students must complete discussion questions that contain contextual problems. Every activity carried out during the discussion process made a positive contribution to the formation of scientific attitudes. This is what can encourage students to think analytically in solving problems. This is in accordance with the statement of Dwianto et al. (2017) that the application of learning media that presents contextual problems through discussion can make a positive contribution to the formation of scientific attitudes in students.

The Role of E-Bocartumban Media in Biology Learning

The role of E-Bokartumban media in learning critical thinking skills

Table 4 shows that the E-Bokartumban media has components that function to facilitate each competency studied in this study. There are five stages of thinking with each indicator, namely 1) providing simple explanations, 2) building basic skills, 3) concluding, 4) identifying terms, & 5) considering a definition, setting strategies and tactics (Ennis cit Kartimi & Liliyasi. 2012). This thinking indicator can be measured when students work on student discussion sheets and evaluation questions on the media. Wiguna et al (2019) and Damopolil & Kurniadi (2019) explained that an increase in learning outcomes occur in students after they take part in learning using android-based media.

Based on the description above, it can be emphasized that the E-Bokartumban media has an important role in teaching or practicing critical thinking skills. Arista & Kuswanto (2018) stated that media that can be operated using smartphones can increase enthusiasm, interest, and motivation

in learning activities. All of these things can increase the independence and understanding of concepts in students.

The role of E-Bocartumban media in learning of environmental care attitudes

From the data in Table 5, it can be seen that indicators of environmental care attitudes use a scale adapted from NEPS. Indicators of the attitude of caring for the environment in question are as follows. 1) Having the idea that plants and animals have the same rights as humans, 2) having feelings/emotions about human actions that cause disasters, 3) having the thought that the environment is very vulnerable and its balance is easily disturbed. The next attitude indicator is 4) having feelings and behavioral tendencies that human tendencies have limits in controlling nature, 5) having behavioral tendencies to take advantage of used natural resources. The 6th indicator has a behavioral tendency not to be arbitrary towards the environment, 7) has thoughts and is interested in environmental issues, and 8) has emotional feelings towards actions that can cause environmental damage. All indicators of environmental care attitudes can be measured as long as students use the media, namely when reading the material and during group discussions during the learning process.

Learning with the e-bokartumban media is able to make a positive contribution in improving students' environmental care attitudes. Environmental care attitudes are attitudes and actions that always try to prevent damage to the surrounding natural environment and develop efforts to repair natural damage (Yaumi, 2014). The attitude of caring for the environment can be shown by attitudes and actions that always try to prevent environmental damage and try to repair the natural damage that has occurred (Mardikaningtyas, 2016).

Based on the description in the paragraph above, it can be stated that the use of android-based learning media is very effective in increasing student understanding. This is in accordance with the opinion of Sudarsana et al. (2019) which states that the use of technology-based learning media can improve student learning outcomes. Junaedi et al. (2018) and Damopolil & Kurniadi (2019) found that learning by applying android-based media can improve student learning outcomes. Learning that uses technology can increase student interest and learning outcomes (Sudarsana et al., 2019).

Student and Teacher Responses to Android-Based Media used in Biology learning

Student and teacher responses to Androwebic media

Student responses to learning using Androwebic media were obtained from student response questionnaires given at the end of the lesson. Information about students' positive

responses to Androwebic media is presented in Table 6.

The data in Table 6 shows the average of each aspect/indicator showing very good criteria. In some aspects, the student response rate shows the maximum score. This shows that students are interested and motivated to learn with comics on the media. Besides being interested and motivated by comics, students also acknowledged that the material equipped with pictures on Androwebic media was very helpful and made it easier for students to learn, because it had been summarized in a structured way. The problems presented in the Androwebic media also have the potential to increase student activity in problem based learning activities that can be learned. In the learning process, students not only listen, but also try, discover, and conclude. Therefore, students' understanding, analytical thinking ability, and scientific attitude will be higher.

In terms of appearance, Androwebic media received high points, with very good criteria. This shows that students are very interested in the appearance of Androwebic media. Androwebic Media equipped with pictures on every detail of the material, so as to provide the right visualization. This makes it easier for students to understand abstract blood circulation material. Androwebic media can also help students understand and discover concepts about the circulatory system. The use of appropriate learning media and in accordance with the character of students in learning, can help students to find concepts contextually. The media in question must be interesting, contain extensive learning resources, contain information whose presentation is accompanied by visual images. The use of a problem-based learning approach that is complemented by the use of learning media has been proven to be able to foster student interest and motivation to be more active in learning so as to create fun learning, understanding the material of the circulatory system will increase (Maulana & Sulistyoningrum, 2018; Lee et al., 2015).

From the data in Table 7, it is known that the average score for each aspect is 87.36%, with a very good category. The teacher said that Androwebic media was very good, easy to use, up-to-date, the material presented was equipped with attractive visuals, it could be used anytime and anywhere on condition that it used an android device. This is confirmed by Sung et al. (2016) which states that the use of android devices such as smartphones in learning is better and more effective than conventional learning. Students are more enthusiastic because the

learning process is student-centered, while the teacher only directs and guides. This is in accordance with the findings of Ali (2019) which proves that student-centered learning will improve students' ability to understand the material being studied and problem-solving skills. In such circumstances, the teacher simply directs and guides as necessary.

Student and teacher responses to E-Bokarmban

The responses of students and teachers in this section were obtained from the questionnaire, which was described from 10 indicators. Through the questionnaire, the teacher and student responses/responses to the e-bokartumban media were obtained. The results of descriptive analysis of the data on student and teacher responses to e-bokartumban media show that students and teachers each gave a response of 89.13% and 90.09% (very good category).

The teacher stated that the E-Bokarmban media used in this study was able to help students in building the concept of biodiversity material. The teacher also gave a positive response to student activities in learning, because it was able to make students very enthusiastic when they discussed. The teacher said that the E-Bokartumban media is an attractive, contemporary, easy to use, easy to carry media, and the material presented is very clear. Thus, it can be emphasized that the E-Bokartumban media is a very good medium to use in learning, and it is clear that this media has excellent potential to train critical thinking skills and environmental care attitudes, as previously stated.

Based on the description, it is clearly stated that Androwebic media can train students' analytical thinking skills by 92.68% and scientific attitude by 85.66%. The Android-based media was responded positively by students and teachers. E-Bokartumban media is also proven to be able to train critical thinking skills and an attitude of caring for the environment. E-Bokarmban media also responded very positively by students and teachers by 89.13% and 90.09%, respectively. Thus, it can be stated that the Androwebic and e-bokartumban media analyzed in this study analyzed in this study responded well to students and teachers, and played an important role in teaching skills and attitudes. This media has an important role to teach students' analytical ability, critical thinking skills and scientific attitudes, and environmental care attitude in learning Biology.

CONCLUSION

From the discussion above, the following conclusions can be drawn. 1). E-bokarmban media shows an important role in teaching students critical thinking skills and

environmental care attitudes. 2) Androwebic media shows an important role in teaching students' analytical skills and scientific attitudes. The level of critical thinking skills, analytical skills, scientific attitudes, and environmental care attitudes of students after learning to use android-based media increased to good and very good. 3). E-bokartumban media can function/be used to teach students critical thinking skills and environmental care attitudes, because it contains various components that are able to facilitate activities which are indicators of critical thinking skills and environmental care attitudes. 4). Androwebic media functions/can be used to teach analytical skills and scientific attitudes to students, because it contains various components that are able to facilitate activities which are indicators because they contain various components that are able to facilitate activities which are indicators of analytical skills and scientific attitudes. 5). The learning activities carried out by students while learning to use the two android-based media include various activities that match the indicators of critical thinking skills, analytical skills, scientific attitudes, and environmental care attitudes. 6) Students and teachers showed a very good response to Androwebic and e-bokartumban used in Biology learning. Two types of Android-based media, namely Androwebic and e-bokartumban used in Biology learning have proven to have a very important role in teaching students critical thinking skills, analytical skills, scientific attitudes, and environmental care attitudes.

Acknowledgement

The authors would like to thanks Prof. Dr. Enni Suwarsi Rahayu, M.Si., and Prof. Dr. Retno Sri Iswari, S.U., as the material expert validator, Dr. Budi Naini Mindiyarto, M.App.Sc., and Mohammad Fikri, S.Sn (Pusdatin Kemendikbud) as media expert validators who have provided very useful suggestions for improving this research. The authors also would like to thanks Dr. Sigit Sapton, M.Pd (Coordinator of S2 Science Education study program). This research was supported by the Lembaga Penelitian dan Pengabdian Masyarakat Universitas Negeri Semarang, which has funded this research (the contract number of the funding letter: SP DIPA-023.17.2.677507/2020, 27-12-2019, in accordance with the Letter of Assignment of Research Implementation of UNNES DIPA Funds Year 2020, Number 166.23.4/UN37/PPK.3.1/2020, 23-04-2020.

REFERENCES

Ali, S. S. (2019). Problem based learning: a student-centered approach. *English Language Teaching*, 12(5), 73-78.

- Amini, R. (2015). Outdoor Based Environmental Education Learning and its Effect in Caring Attitude Toward Environment. *Journal Pendidikan IPA Indonesia*, 4(1), 43-47.
- Amoah A. C., & Emmanuel E. (2018). Assessing the reasoning skills of biology students in selected senior high schools in the central region of Ghana. *International Journal of Scientific Research and Management (IJSRM)*, 6(4), 299-304.
- Anwar, B., & Mumthas, N. S. (2014). Taking Triarchic Teaching to Classrooms : Giving Everybody A Fair Chance. *International Journal of Advanced Research*, 2(5):455-458
- Arista, F. S., & Kuswanto, H. (2018). Virtual physics laboratory application based on the android smartphone to improve learning independence and conceptual understanding. *International Journal of Instruction*, 11(1), 1-16.
- Chung E. Y. (2019). Facilitating learning of community-based rehabilitation through problem-based learning in higher education. *BMC medical education*, 19 (1), 433.
- Demirci, F. & Özyürek, C. (2017). The Effects of Using Concept Cartoons in Astronomy Subjects on Critical Thinking Skills among Seventh Grade Student. *International Electronic Journal of Elementary Education*, 10 (2), 243-254.
- Damopolil, I., & Kurniadi, B. (2019). The development of android-based mobile learning supported by problem-based learning strategy for students' learning success. *International Journal of Scientific and Technology research*, 8(7), 190-193.
- Dwianto, A., Wilujeng, I., Prasetyo, Z. K., & Suryadarma, I. G. P. (2017). The development of science domain based learning tool which is integrated with local wisdom to improve science process skill and scientific attitude. *Jurnal Pendidikan IPA Indonesia*, 6(1): 23-31.
- Facione, P. A. (2015). *Critical Thinking: What It Is and Why It Counts*. In Insight assessment (Issue ISBN 13: 978-1-891557-07-1.).
- Hasanah, S. I., Mustofa, R. F., & Ardiansyah, R. (2020). Correlation between Generic Science Skills and Scientific Attitudes on Learning Outcomes. *BIOEDUSCIENCE*, 4(2), 124-128.
- Jeno, L. M., Grytnes, J. A., & Vandvik, V. (2017). The effect of a mobile-application tool on biology students' motivation and achievement in species identification: A Self-Determination Theory perspective. *Computer & Education*, 107, 1-12.
- Junaedi, J., Irviani, R., Muslihudin, M., Hidayat, S., Maseleno, A., Gumanti, M., & Fauzi, A. N. (2018). Application program learning based on android for students experiences.

- International Journal of Engineering and Technology (UAE)*, 7(2.27), 194-198.
- Kartimi, & Liliyasari. 2012. Pengembangan Alat Ukur Berpikir Kritis pada Konsep Termokimia untuk Siswa SMA Berperingkat Atas dan Menengah. *Jurnal Pendidikan IPA Indonesia*, 1(1): 21-26.
- Lee, S., Kang, E., & Kim, H. B. (2015). Exploring impact of students' learning approach on collaborative group modeling of blood circulation. *Journal of Science Education and Technology*, 24(2): 234-255.
- Maulana, H., & Sulistyoningrum. (2018). Implementation Mirror Technique 3D Objects for Interactive Learning Media "Circulatory System" Virtual Reality-Based. *Journal of Physics: Conference Series*, 1364 012036.
- Morel, M., Peruzzo, N., Juele, A. R., & Amarelle, V. (2019). Comics as an Educational Resource To Teach Microbiology in the Classroom. *Journal of microbiology & biology education*, 20 (1), 1-4
- Mutakinati, L., Anwari, I., & Yoshisuke, K. (2018). Analysis of students' critical thinking skill of middle school through STEM education project-based learning. *Jurnal Pendidikan IPA Indonesia*, 7(1), 54-65.
- Nhat, H. T., Lien, N. T., Tinh, N. T., Hang, N. V. T., & Trang, N. T. (2018). The Development of Critical Thinking for Students in Vietnamese Schools: From Policies to Practices. *American Journal of Educational Research*, 6(5), 431-435.
- Özdemir, E. (2017). Humor in Elementary Science: Development and Evaluation of Comic Strips about Sound. *International Electronic Journal of Elementary Education*, 9(4), 837-850.
- Prawita, W., Prayitno, B. A., & Sugiyarto. (2019). Effectiveness of generative learning-based biology module to improve the analytical thinking skills of the students with high and low reading motivation. *International Journal of Instruction*, 12(1), 1459-1476.
- Pujiasih, P., Wiwi I., & Saiful R. (2021). Android-based e-booklet development to train students' critical thinking and attitude of caring for environment. *Journal of Innovative Science Education*, 10 (1), 95-101.
- Puspita, I., Kaniawati, I., & Suwarma, R. (2017). Analysis of critical thinking skills on the topic static fluid. *Journal of Physics: Conference Series*, 895 012100.
- Puspitasari, E. D. T., Surjono, H. D., & Minghat, A. D. (2018). Utilizing web-based learning as 21st century learning media for vocational education. *International Journal of Engineering & Technology*, 7(4-33), 157-160.
- Putri, M. A., & Prodjosantoso, A. K. (2020). Improving Critical Thinking Skills and Scientific Attitudes by Using Comic. *Psychology, Evaluation, and Technology in Educational Research*, 2(2), 69-80.
- Rochmadi, M., & Nasucha, Y. (2015). *Dasar-dasar Penelitian: Bahasa, Sastra, dan Pengajaran*. Buku. Pustaka Brilliant, Surakarta.
- Sari, R., Perdana, R., Riwayani, Jumadi, Wilujeng, I., & Kuswanto, H. (2019) The implementation of problem-based learning model with online simulation to enhance the student's analytical thinking skill in learning physics. *Journal of Physics: Conference Series*, 1233 012030.
- Styers, M. L., Van Zandt, P. A., & Hayden, K. L. (2018). Active Learning in Flipped Life Science Courses Promotes Development of Critical Thinking Skills. *CBE life sciences education*, 17(3), ar39.
- Sudarsana, I. K., Nakayanti, A. R., Sapta, S., Haimah, Satria, E., Saddhono, K., GS, D. A., Putut, E., Helda, T., & Mursalin, M. (2019). Technology application in education and learning process. *Journal of Physics: Conference Series*, 1363 012061.
- Sugiyono. (2015). *Metode penelitian pendidikan*. Bandung: Alfabeta.
- Sukenda, Anjani, M., & Yustim, B. (2019). Learning Media for Biology Subject Based on Multimedia in Junior High School Level. *Universal Journal of Educational Research*, 7(4A), 43-51.
- Sung, Y. T., Chang, K. E., & Liu, T. C. (2016). The Effects of Integrating mobile Devices with Teaching and Learning on Students' Learning Performance: A Meta-Analysis and Research Synthesis. *Computers & Education*, 94: 252-275.
- Sung, H. Y., Hwang, G. J., Chen, C. Y., & Liu, W. X. (2019). A contextual learning model for developing interactive e-books to improve students' performances of learning the analects of confucius. *Interactive Learning Environments*, 1-14.
- Surjanti, J., Seno, D. N., Hadi, H. K., Maroah, S., Siswanti, Y., Muafi., & Isfianadewi, D. (2018). The role of m-learning on effective learning media in higher education. *International Journal of Civil Engineering and Technology*, 9(4): 77-85.
- Thomas, T. (2011). Developing First Year Student's Critical Thinking Skills. *Asian Social Science*, 7(4), 26-35
- Wiguna, D., Irwansyah, F. S., Windayani, N., Aulawi, H., & Ramdhani, M. A. (2019). Development of android-based chemistry learning media oriented towards generic science skills. *Journal of Physics: Conference Series*, 1157 042047.
- Williamson, B., Eynon, R., & Potter, J. (2020). Pandemic Politics, Pedagogies and Practices: Digital Technologies and Distance Education during the Coronavirus

Emergency. *Learning, Media and Technology*,
45(2), 107-114.

Impact on Learning. *Health Professions
Education*, 2 (2), 75-79.

Yew, E. H. J., & Goh, K. (2016). Problem-Based
Learning: An Overview of its Process and

LAMPIRAN 2.8
PROSES REVIEW KE-4



**ANALYSIS OF THE ROLE OF ANDROID-BASED LEARNING
MEDIA IN CRITICAL THINKING SKILLS AND SCIENTIFIC
ATTITUDE**

DOI:

Accepted: Approved: Published:

ABSTRACT

This study aims to analyze and describe android-based learning media's role in teaching students critical thinking skills and scientific attitudes. The learning media are Androwebic (android-based webcomic) and E-Bokartumban (e-book on plant diversity in Banjarnegara), developed previously. This research is a qualitative descriptive study involving 301 students, six biology teachers and six high school students. The data collected includes critical thinking skills, analytical skills, scientific attitudes, environmental care attitudes, media components supporting student competence, and teacher and student responses. Data on critical thinking and analytical skills were measured using tests and non-tests. Other data were measured using non-test instruments, including interview guides, scientific attitude observation sheets, students' environmental care attitudes, media component observation sheets, and student and teacher questionnaires. Quantitative data on critical thinking and analytical skills were analyzed using the n-gain test, while other data were descriptively analyzed. The research results showed that the E-Bokartumban and Androwebic components support students' critical thinking skills, analytical skills, and environmental care attitudes. Androwebic can train students' analytical thinking skills and scientific attitude. The two media developed were considered very helpful in the learning process. The study concluded that Android-based media in Androwebic and E-Bokartumban have a vital role in training critical thinking skills, analytical skills, scientific attitudes, and environmental care attitudes.

Keywords: androwebic, e-bokartumban, critical thinking skills, scientific attitude

INTRODUCTION

Biology learning involves skills and reasoning (Amoah & Emmanuel, 2018). In developing reasoning power and skills, learning that can emphasize aspects of application, analysis, synthesis, and evaluation, not only emphasizing aspects of understanding and knowledge, is needed. For this reason, a learning process that can improve cognitive, affective, psychomotor competencies and learning methods that can motivate students to be creative, confident, and think critically are needed to assess information (Pujiasih et al., 2021).

Critical thinking skills are needed to explain and solve problems (Thomas, 2011). Teaching critical thinking and problem-solving skills can be done with problem-based learning/ PBL (Yew & Goh, 2016). Students' development of critical thinking skills must focus on activities to teach content (knowledge) and methods or ways to find the process and evaluate information (Nath et al., 2018). Students can think critically in learning, but this skill sometimes does not develop well. Therefore, it is necessary to use a method to develop students' critical thinking skills. One of the teaching methods considered appropriate is teaching using android-based media. The learning media in this study are Androwebic (android-based webcomic) and e-Bokartumban (e-book of plant diversity in Banjarnegara), developed previously. Androwebic has proven effective for teaching analytical skills and scientific attitudes (Sujatmiko et al., 2021). E-Bokartumban also effectively improves critical thinking skills and environmental care attitudes (Pujiasih et al., 2021). However, neither Sujatmiko nor Pujiasih explained the role of the two android-based media in improving students' competencies and attitudes.

This study's urgency, novelty, and purpose are to analyze or describe the role of Androwebic and e-Bokartumban in teaching students' skills and attitudes. These skills and attitudes include critical thinking skills, analytical skills, scientific attitude, and environmental care attitude in students. The status of this research is to support previous research by Sujatmiko et al. (2021) and Pujiasih et al. (2021).

Mutakinati et al. (2018) stated that students with critical thinking skills easily analyze, evaluate, and connect with evidence or arguments before deciding or assessing information. Students' critical thinking skills play an important role in achieving learning achievement, formal reasoning, and creativity (Puspita et al., 2017). Learning that facilitates critical thinking skills can be realized if all parties, from policymakers to teacher universities, local education departments, schools, and families, cooperate and participate

(Nhat et al., 2018). The research results of Seventika et al. (2018) show that most (>55%) of 11th-grade students of vocational schools in Indramayu have a low level of critical thinking skills.

Textbooks and modules with few pictures still dominate biology learning in schools, and learning is still teacher-centred. This situation causes students' mindsets to be limited, and students' understanding of biology concepts weakens so that students' critical thinking skills and scientific attitudes are still weak. The results of interviews with several state high school/MA teachers in Banjarnegara and Jepara reinforce this statement. Information obtained from the results of the interview, among others: (1) Learning has not utilized student-centered media to its full potential; (2) students are allowed to bring smartphones, but they have not been appropriately used; (3) technology (smartphone) as a tool or media that does not support learning, (4) limited learning time.

Based on the interview with teachers, it can be concluded that these problems can be minimized by utilizing the technology owned by students and student-centered learning strategies to the fullest. The circulatory system and biodiversity are examples of biology learning materials that must be taught using media. The material on the circulatory system needs to be taught with the media because it contains complex concepts to be presented more interestingly. Biodiversity material, especially plant diversity, also needs to be taught by optimizing electronic media to present a plant diversity environment in the classroom.

The availability of learning media will facilitate interaction between teachers and students so that learning activities will be more effective and efficient (Puspitasari et al., 2018). The existence of learning media facilitates ease of learning, fosters interest in learning, and makes it easier for students to learn independently so that the learning process will be more effective (Surjanti et al., 2018). The use of Android-based media can make students more interested in learning. The use of pictorial technology media also attracts students' attention more than textbooks. Taking this into account, it is clear that optimizing the use of modern technology-based media in learning is an urgent matter, especially during the current pandemic. In learning during the Covid-19 pandemic, the use of media and technology must make a real contribution to knowledge and the emergence of educational practices with online and digital education formats (Williamson et al., 2020)

Commented [U1]: Nhat?

Commented [U2]: Cannot be found in the references.

Commented [U3]:

Commented [U4]: Cannot be found in the references.

Based on the problem, optimizing learning media is helpful for appropriately visualizing learning materials. The media should have a

simple structure that focuses on one goal. Learning media that are expected to be useful or good to overcome the learning problems mentioned earlier should be easy to carry and use anywhere. Sukenda et al. (2019) stated that multimedia-based learning media should be packaged into software to present material.

One of the important learning media packaged into software is the environment. The environment is useful for equipping students with a conscious mind and care for the environment and its issues (Amini, 2015). The environment is also essential to instill knowledge, skills, attitudes, behavior, motivation, commitment to solving environmental problems, and environmental care attitude. The results of Putri & Prodjosantoso's research (2020) prove that science comics media (guided inquiry-based science comics) can improve critical thinking skills and scientific attitudes. A scientific attitude is an attitude that encourages students to solve problems (Hasanah et al., 2020). Khasanah et al. (2017) stated that the module based on critical thinking skills on respiratory system material helps practice critical thinking skills.

Based on the description above, media is essential in learning to instill skills and attitudes in students. One of these media is android-based media, as software. In this study, the role of android-based media was analyzed in teaching or training attitudes and skills to students. There are two android-based media: 1) E-Bokartumban, an e-booklet about plant diversity in Banjarnegara, 2) Androwebic, an android-based webcomic about the circulatory system. From previous studies by Sujatmiko et al. (2021) and Pujiasih et al. (2021), both media are useful for improving critical thinking skills, analytical skills, scientific attitudes, and environmental care attitudes in students.

Some questions need to be answered in this research.

1. Does Androwebic play a role in teaching students' analytical skills and scientific attitudes?
2. Does the E-Bokartumban play a role in teaching students critical thinking skills and environmental care attitudes?
3. How does the Androwebic function in teaching students analytical skills and scientific attitudes?
4. How does the E-Bokartumban function in teaching students critical thinking skills and environmental care?
5. What learning activities do students do while learning using the two android-based media?
6. How do students and teachers respond to both media?

METHODS

Types of research

This study aims to analyze (and describe) the role of android-based learning media in teaching or training critical thinking skills, analytical skills, scientific attitudes, and environmental care attitudes. Therefore, the research design used is descriptive qualitative (Sugiyono, 2015).

Research Sample

The samples (subjects) were six biology teachers, 196 10th-grade students from three high schools in Banjarnegara, and 105 11th-grade students from three high schools in Jepara. The research sample was selected using the purposive sampling technique. This study used the technique because it requires research subjects relevant to the determined characteristics.

Research Data and Instruments

The data collected includes critical thinking skills, analytical skills, scientific attitudes, environmental care attitudes, media components supporting student competence, student learning activities, and teacher and student responses. Data were collected in several ways: tests, observations, questionnaires, and documentation. Data on critical thinking and analytical skills were measured using a test instrument, while other data were measured using a non-test instrument. The test instrument used contains multiple-choice questions with five choices. The non-test instruments include interview guides, scientific attitude observation sheets, student environmental care attitudes, media component observation sheets, learning activity observation sheets, and student and teacher questionnaires.

Data analysis

Quantitative data on critical thinking skills and analytical skills were analyzed using the n-gain test, while other data were analyzed descriptively qualitatively. Descriptive qualitative data analysis was carried out in 4 stages: data collection, data reduction, data presentation, and concluding (Rochmadi & Nasucha, 2015). The data that has been collected is collected according to their respective categories, including test result data, questionnaire results and observation data. The data is then reduced to obtain data that focuses on research problems: to analyze and describe the role of Androwebic and E-Bokartumban media in teaching the chosen skills and attitudes. The data obtained are presented in tabular or narrative form, depending on the characteristics of each data. The last stage is concluding based on the available data.

RESULTS AND DISCUSSION

Results

Overview of Androwebic and e-Bokartumban

Androwebic and E-bokartumban have a general picture, as shown in Figures 1, 2 and 3.

Commented [U5]: Cannot be found in the references.

Commented [U6]: Cannot be found in the references.

The Androwebic components that are considered to play a role in teaching students skills and attitudes are presented in Table 2. The e-Bokartumban media that are considered to play a role in teaching students skills and attitudes are

presented in Tables 4 and 5.

Students' Analytical Skills

Students' analytical skills in learning using Androwebic were obtained from the pretest and posttest results (Table 1). Table 1 shows the score of posttest is higher than pretest. The pretest showed an average score of 53.65 (not yet reached 75 as KKM), while the posttest score achieved by students was an average of 88.83 (beyond the KKM). KKM is the minimum mastery criteria. KKM is a reference for educators in assessing students' competence in the subjects.

The increase in students' analytical thinking skills was obtained from the results of the n-gain test on the students' pretest and posttest scores. The results of the n-gain test showed that students who achieved high, medium and low analytical skills were 72%, 24% and 4%, respectively. From these results, the Androwebic effectively improves students' analytical skills, especially in learning material about the circulation system.

Androwebic has this potential because it contains various menus such as discussion

questions (see Table 2) containing everyday problems.

Table 1. Students' Pretest and Posttest Scores in Biology Learning Using Androwebic

Information	Pretest Score (n=105)	Posttest Score (n=105)
Highest score	93.33	100
Lowest score	13.33	60
Average value	53.65	88.83

Students' scientific attitudes during the learning process using Androwebic media

Information about students' scientific attitudes in learning using Androwebic media was obtained from observing students' scientific attitudes using observation sheets. Androwebic was created specifically so that it has several good facilities to practice six aspects of scientific attitude (see Table 3). Students' scientific attitude was observed using student activities during the learning process using Androwebic media, presented in Table 3. In Table 3, it can be seen that the average of students' scientific attitude is in the very good category.



Figure 1. Androwebic Media Display

Commented [U7]: 1. Each picture/table is preceded by an introduction to the description, and after the picture/table is given a description of the results shown.
2. The pictures/tables must not be consecutive.



Figure 2. Examples of e-Bokartumban components at the beginning section



Figure 3: Examples of e-Bokartumban components at the material section

Table 2. Androwebic Component that support analytical thinking skills (A) and scientific attitude (B)

No	Indicators of analytical thinking skills	Media Components
A	Analytical thinking skills	
1	Differentiating	Task to differentiate in group discussion questions
2	Organizing	Task for grouping on group discussion questions
3	Connecting	The task concludes with group discussion questions
B	Scientific attitude	
1	Curiosity	Task to observe on the webcomic
2	Respect for data/facts	Group discussion task in the media investigation section
3	Flexibility in thinking	Group discussion task in the media investigation section
4	Open minded and cooperate	Group discussion task in the media investigation section
5	Perseverance	The task of presenting the observations to be presented

Students' scientific attitudes in learning using Androwebic

Information about students' scientific attitudes in learning using Androwebic media was obtained from observing students' scientific attitudes using observation sheets. Androwebic media was explicitly created to have several valuable facilities to practice six aspects of

scientific attitude (see Table 3). Students' scientific attitude was observed using student activities carried out during the learning process using Androwebic media, presented in Table 3. In Table 3, the average of students' scientific attitude is in the very good category.

Table 3. Students' scientific attitudes during the learning process using androwebic media

Indicator	Σ Score	Max Score	Score (%)	Criteria*
Pay attention to every new thing	1086	1260	86.19	Very good
Appreciate and conclude according to facts	1056	1260	83.81	Very good
Not always feel right, change opinion after considering the evidence	1035	1260	82.14	Very good

Ask questions and give opinions	1124	1260	89.21	Very good
Participate in groups	1107	1260	87.86	Very good
Record complete observations	1068	1260	84.76	Very good

*) : Sugiyono (2015): very good: 81-100; good: 61-80; 41-60: enough/currently

Students' critical thinking skills during the learning process using E-Bokartumban

Android-based E-Bokartumban media contains information about the diversity of plants in Banjarnegara. The information in question includes the scientific classification of each type of plant and a description of its morphology, a dissertation with attractive colored pictures. The e-bokartumban is useful for presenting the natural environment to the classroom with its characteristics. The e-bokartumban as a smartphone application makes it very easy for students to use it. The results of the n-gain test showed that after learning to use E-bokartumban, students experienced an increase in critical thinking skills. The increase in students' critical thinking skills (n-gain) was 0.69 in the medium

category (tend to be high). Students who achieve high, medium and low critical thinking skills are 53%, 45% and 2%, respectively. From these results, it can be stated that E-bokartumban has an important role to improve critical thinking skills. This role is supported by the characteristics of the E-Bokartumban, which has a useful supporting component to facilitate the emergence of critical thinking skills (see Table 4).

E-bokartumban also has various components that play an important role in growing various indicators of environmental care attitudes (Table 5). In Table 5, various sections of the media (column 3) are presented, which are useful for strengthening various indicators of environmental care attitudes presented in column 2 of Table 5.

Table 4. E-bokartumban components that facilitate critical thinking skills competencies

No.	Indicators of Critical Thinking Skills	Media Components
1	Give a simple explanation	Evaluation questions*), students discussion sheets
2	Build basic skills	Evaluation questions*), students discussion sheets
3	Conclude	Evaluation question*)s, students discussion sheets
4	Identify terms and consider a definition	Evaluation questions*), students discussion sheets
5	Set strategy and tactics	Evaluation questions*), students discussion sheets

*) : Examples of evaluation questions are presented in Table 6

Table 5. Competency indicators of environmental care attitudes in students and components of the E-Bokartumban media that facilitate the emergence of these attitude indicators

No	Aspects and Indicators of Environmental Care Attitude	Media Components *)
1	Have thought that plants and animals have rights were equal to humans	Introduction to the materials
2	Have feelings/emotions about human actions that cause disaster	Introduction to the materials
3	Have thought that the environment is very fragile and easily disturbed balance	Student discussion sheets, materials on the media
4	Have feelings and tendencies of behavior that the tendency of human beings there is a limit in controlling nature	Student discussion sheets, materials on the media
5	Tend to take advantage of the source power of nature that has been used	Student discussion sheets, materials on the media
6	Tend not to be arbitrary towards the environment	Student discussion sheets, materials on the media
7	Have thoughts and attracted to environmental issues	Student discussion sheets, materials on the media
8	Have emotional feelings about actions that can cause environmental damage	Student discussion sheets, materials on the media

*) : The examples of the components of the e-bokartumban media are presented in Figures 2 and 3.

Responses of Students and Teachers to Androwebic

Students' responses to learning using Androwebic were obtained from questionnaires given at the end of the lesson. Information about

students' positive responses to Androwebic media is presented in Table 6. The level of positive response from teachers to the learning using Androwebic media is obtained from the teachers' responses presented in Table 7.

Commented [U8]: 1. Each picture/table is preceded by an introduction to the description, and after the picture/table is given a description of the results shown.
2. The pictures/tables must not be consecutive.

Table 6. Results of Student Responses to Androwebic Media

Indicators	Score	Max. Score	Percentage (%)	Criteria
Affective consideration	755	840	89.88	Very good
Learning	1116	1260	88.57	Very good
Multimedia display	2308	2520	91.59	Very good
Navigation	1487	1680	88.51	Very good
Robustness	1507	1680	89.40	Very good
Average			89.59	Very good

Table 7. Levels of Teachers' Positive Response to Androwebic Media

Indicators/aspects	Score	Max. Score	Percentage (%)	Criteria
Affective consideration	22	24	91.67	Very good
Learning	30	36	83.33	Very good
Multimedia display	64	72	88.89	Very good
Navigation	41	48	85.42	Very good
Robustness	42	48	87.50	Very good
Average			87.36	Very good

Discussion

The Role of Androwebic in Biology Learning

Role of Androwebic in Analytical Skills

The problems in the discussion menu are related to daily events. For example, the work of the heart, normal and non-normal blood conditions and blood type. Those are all everyday things that students often experience. The availability of various menus on Androwebic (see Figure 1 and Table 2) stimulates students' curiosity and encourages students to practice problem-solving. Both activities require analytical thinking skills so that students' skills are well trained. This statement is under the research of Prawita et al. (2019) and Sari et al. (2019), which states that the use of learning media that presents problems can improve students' learning outcomes and analytical thinking skills.

Comics help students learn by simplifying science concepts and making them easier to remember (Ozdemir, 2017). Comics also contribute to arousing students' enjoyment of science and the perception of success in science. Demirci and Zyürek (2017) state that the cartoon concept can effectively develop critical thinking skills. Colorful cartoons attract attention and encourage students' active participation in learning activities (think more actively). Indirectly, it plays an important role in helping to develop critical thinking skills. An active learning process is also very useful for improving students' critical thinking skills (Styers et al., 2018).

During the discussion stage in biology learning using Androwebic, students are trained to discuss and exchange ideas about problem solutions systematically and logically (Figure 1). Thus, students become trained to think analytically. Sari et al. (2019) proved that learning by actively involving students to solve problems improved analytical thinking skills and learning outcomes. Analytical thinking skills is one component of critical thinking skills (Facione 2015).

The teacher said that the Andro-Webcomic media based on problem-based learning was very good, easy to use, up to date. The material presented was equipped with attractive visuals, ready to use anytime and anywhere with Android devices. Sung et al. (2016) stated that using Android devices (smartphones) in learning was better and more effective than conventional learning.

In this study, comics are used to teach material about the circulation system, which is very complex and cannot be observed directly. The choice of comics to be used in Androwebic turned out to be very appropriate because it got an outstanding response from teachers and students (see Tables 6 and 7). This statement follows Morel et al. (2019), which states that comics is an excellent tool to help educators teach complex subjects and explain the unseen world. Based on the above description, it can be stated that Androwebic media has an important role to train critical thinking skills.

Role of Androwebic in Scientific Attitude

In Table 3, the average scientific attitude of students is in the very good category. It happened because, since the beginning of the learning using Androwebic, students are always motivated to learn and seek information independently. During the learning process assisted by Androwebic media, students show a more caring attitude, respect, and conclude according to facts. During the learning process, students are also accustomed not always to feeling right, daring to ask questions, daring to express opinions, being active in groups, and recording complete observations. Students must complete discussion questions that contain contextual problems in the learning process. Every activity carried out during the discussion process positively contributed to scientific attitudes. This is what can encourage students to think analytically in solving problems. This is under the statement of Dwianto et al. (2017) that the application of learning media that presents contextual problems

Commented [U9]: 1. Each picture/table is preceded by an introduction to the description, and after the picture/table is given a description of the results shown.
2. The pictures/tables must not be consecutive.

through discussion can positively contribute to students' formation of scientific attitudes.

The Role of E-Bokartumban in Biology Learning

The role of E-Bokartumban in critical thinking skills

Table 4 shows that the E-Bokartumban media has components facilitating each competency in this study. There are five stages of thinking with each indicator: 1) providing simple explanations, 2) building basic skills, 3) concluding, 4) identifying terms, 5) considering a definition, setting strategies and tactics (Ennis cit Kartimi & Liliyasi, 2012). These thinking indicators can be measured when students work on discussion sheets and evaluation questions on the media. Wiguna et al. (2019) and Damopolil & Kurniadi (2019) explained that students' learning outcomes increase after using android-based media.

Based on the description above, it can be emphasized that the E-Bokartumban has an important role in teaching or practicing critical thinking skills. Arista and Kuswanto (2018) stated that smartphones' media increases enthusiasm, interest, and motivation in learning activities. All of these things can increase students' independence and understanding of concepts.

The role of e-Bokartumban in Environmental Care Attitudes

From Table 5, indicators of environmental care attitudes use a scale adapted from NEPS. Indicators of the environmental care attitude are as follow: 1) Having the idea that plants and animals have the same rights as humans, 2) having feelings/emotions about human actions that cause disasters, 3) having the thought that the environment is very vulnerable and its balance is easily disturbed, 4) having feelings and behavioral tendencies that human tendencies have limits in controlling nature, 5) having behavioral tendencies to take advantage of used natural resources. The 6th indicator has a behavioral tendency not to be arbitrary towards the environment, 7) has thoughts and is interested in environmental issues, and 8) has emotional feelings towards actions that can cause environmental damage. All indicators of environmental care attitudes can be measured as long as students use the media when reading the material and during group discussions during the learning process.

Learning with e-Bokartumban positively contributes to improving students' environmental care attitudes. Environmental care attitudes are attitudes and actions that always try to prevent damage to the surrounding natural environment and develop efforts to repair natural damage (Yaumi, 2014). Environmental care attitudes can be shown by attitudes and actions that always try to prevent environmental damage and repair the natural damage (Mardikaningtyas, 2016).

Based on the description in the paragraph above, it can be stated that the use of android-based learning media is very effective in increasing student understanding. This statement follows the opinion of Sudarsana et al. (2019), which states that the use of technology-based learning media can improve student learning outcomes. Junaedi et al. (2018) and Damopolil & Kurniadi (2019) found that applying android-based media can improve student learning outcomes. Learning that uses technology can increase student interest and learning outcomes (Sudarsana et al., 2019).

Responses of Students and Teachers to Android-based Media in Biology Learning

Responses of Students and Teachers to Androwebic

Students' responses to learning using Androwebic were obtained from questionnaires given at the end of the lesson. Information about students' positive responses to Androwebic media is presented in Table 6.

Table 6 shows the average of each aspect/indicator showing very good criteria. In some aspects, the student response rate shows the maximum score. Students are interested and motivated to learn with comics on the media. Besides being interested and motivated by comics, students also acknowledged that the material equipped with pictures on Androwebic media was beneficial and made it easier for students to learn because it had been summarized in a structured way. The problems in the Androwebic media also increase students' activeness in problem-based learning activities. In the learning process, students not only listen but also try, discover, and conclude. Therefore, students' understanding, analytical thinking ability, and scientific attitude will be higher.

In terms of appearance, Androwebic media received high points in very good criteria, showing that students are very interested in the appearance of Androwebic media. Androwebic media with pictures on every material detail provides the proper visualization. It makes it easier for students to understand abstract blood circulation material. Androwebic media also help students understand and discover concepts about the circulatory system. Appropriate learning media and students' character in learning can help students find concepts contextually. The media in question must be engaging, contain extensive learning resources, contain information whose presentation is accompanied by visual images. The use of a problem-based learning approach that is complemented by the use of learning media has been proven to be able to foster student interest and motivation to be more active in learning to create fun learning, understanding the material of the circulatory system will increase (Maulana & Sulistyoningrum, 2018; Lee et al., 2015).

From the data in Table 7, it is known that the average score for each aspect is 87.36%, with a very

Commented [U10]: ?

Commented [U11]: Cannot be found in the references.

Commented [U12]: Cannot be found in the references.

good category. The teacher said that Androwebic media is very good, easy to use, up-to-date. The material is equipped with attractive visuals. It can be used anytime and anywhere on android devices. It is confirmed by Sung et al. (2016), which states that android devices such as smartphones are better and more effective than conventional learning. Students are more enthusiastic because the learning process is student-centered, while the teacher only directs and guides. This statement is under the findings of Ali (2019), which proves that student-centered learning will improve students' skills to understand the material and problem-solving skills. In such circumstances, the teacher directs and guides as necessary.

Responses of Students and Teachers to e-Bokartumban

The responses of students and teachers in this section were obtained from the questionnaire, described by ten indicators. The descriptive data analysis on responses to E-Bokartumban media shows that students and teachers each gave a response of 89.13% and 90.09% (very good category).

The teachers stated that the E-Bokartumban helped students build the concept of biodiversity. The teachers also positively responded to student activities in learning because it made students very enthusiastic during discussion. The teacher said that the E-Bokartumban media is an attractive, contemporary, easy to use, easy to carry media, and the material presented is evident. Thus, it can be emphasized that the E-Bokartumban media is a perfect medium to use in learning and has excellent potential to train critical thinking skills and environmental care attitudes, as previously stated.

The description clearly states that Androwebic media can train students' analytical thinking skills by 92.68% and scientific attitude by 85.66%. Students and teachers positively responded to the Android-based media. E-Bokartumban also trains critical thinking skills and environmental care attitudes. E-Bokartumban is also responded positively by students and teachers by 89.13% and 90.09%, respectively. Thus, it can be stated that the Androwebic and E-Bokartumban analyzed in this study responded well by students and teachers and played an essential role in teaching skills and attitudes. This media has a vital role in teaching students' analytical skills, critical thinking skills and scientific attitudes, and environmental care attitude in learning biology.

CONCLUSION

From the discussion above, the following conclusions can be drawn. E-Bokartumban media shows an essential role in teaching students critical thinking skills and environmental care attitudes. Androwebic media shows a vital role in teaching

students' analytical skills and scientific attitudes. The level of critical thinking skills, analytical skills, scientific attitudes, and environmental care attitudes of students after learning to use android-based media increased to good and very good. E-Bokartumban can teach students critical thinking skills and environmental care attitudes because it contains various components that can facilitate activities that are indicators of critical thinking skills and environmental care attitudes. Androwebic can be used to teach analytical skills and scientific attitudes to students. It contains various components that can facilitate activities that are indicators because they contain various components that can facilitate activities that are indicators of analytical skills and scientific attitudes. 5). The learning activities carried out by students while learning to use the two android-based media include various activities that match the indicators of critical thinking skills, analytical skills, scientific attitudes, and environmental care attitudes. 6) Students and teachers showed an excellent response to Androwebic and e-Bokartumban in Biology learning. Two types of Android-based media (Androwebic and e-bokartumban) in Biology learning have proven to have a vital role in teaching students critical thinking skills, analytical skills, scientific attitudes, and environmental care attitudes.

ACKNOWLEDGEMENT

The authors would like to thank Prof. Dr. Enni Suwarsi Rahayu, M.Si., and Prof. Dr. Retno Sri Iswari, S.U., as the material expert validator, Dr. Budi Naini Mindiyarto, M.App.Sc., and Mohammad Fikri, S.Sn (Pusdatin Kemendikbud) as media expert validators. The latter have provided beneficial suggestions for improving this research. The authors also would like to thank Dr. Sigit Saptono, M.Pd (Coordinator of S2 Science Education study program). This research was supported by the Lembaga Penelitian dan Pengabdian Masyarakat Universitas Negeri Semarang, which has funded this research (the contract number of the funding letter: SP DIPA-023.17.2.677507/2020, 27-12-2019, following the Letter of Assignment of Research Implementation of UNNES DIPA Funds Year 2020, Number 166.23.4/UN37/ PPK.3.1/2020, 23-04-2020.

REFERENCES

- Ali, S.S. (2019). Problem based learning: a student-centered approach. *English Language Teaching*, 12(5), 73-78.
- Amini, R. (2015). Outdoor Based Environmental Education Learning and its Effect in Caring Attitude Toward Environment. *Journal Pendidikan IPA Indonesia*, 4(1), 43-47.
- Amoah A. C., & Emmanuel E. (2018). Assessing the reasoning skills of biology students in selected senior high schools in the central region of Ghana. *International Journal of*

- Scientific Research and Management (IJSRM)*, 6(4), 299-304.
- Anwar, B., & Mumthas, N. S. (2014). Taking Triarchic Teaching to Classrooms : Giving Everybody A Fair Chance. *International Journal of Advanced Research*, 2(5): 455-458
- Arista, F. S., & Kuswanto, H. (2018). Virtual physics laboratory application based on the android smartphone to improve learning independence and conceptual understanding. *International Journal of Instruction*, 11(1), 1-16.
- Chung E. Y. (2019). Facilitating learning of community-based rehabilitation through problem-based learning in higher education. *BMC medical education*, 19 (1), 433.
- Demirci, F. & Özyürek, C. (2017). The Effects of Using Concept Cartoons in Astronomy Subjects on Critical Thinking Skills among Seventh Grade Student. *International Electronic Journal of Elementary Education*, 10 (2), 243-254.
- Damopolil, I., & Kurniadi, B. (2019). The development of android-based mobile learning supported by problem-based learning strategy for students' learning success. *International Journal of Scientific and Technology research*, 8(7), 190-193.
- Dwianto, A., Wilujeng, I., Prasetyo, Z. K., & Suryadarma, I. G. P. (2017). The development of science domain based learning tool which is integrated with local wisdom to improve science process skill and scientific attitude. *Jurnal Pendidikan IPA Indonesia*, 6(1): 23-31.
- Facione, P. A. (2015). *Critical Thinking: What It Is and Why It Counts*. In Insight assessment (Issue ISBN 13: 978-1-891557-07-1).
- Hasanah, S. I., Mustofa, R. F., & Ardiansyah, R. (2020). Correlation between Generic Science Skills and Scientific Attitudes on Learning Outcomes. *BIOEDUSCIENCE*, 4(2), 124-128.
- Jeno, L. M., Grytnes, J. A., & Vandvik, V. (2017). The effect of a mobile-application tool on biology students' motivation and achievement in species identification: A Self-Determination Theory perspective. *Computer & Education*, 107, 1-12.
- Junaedi, J., Irviani, R., Muslihudin, M., Hidayat, S., Maseleno, A., Gumanti, M., & Fauzi, A. N. (2018). Application program learning based on android for students experiences. *International Journal of Engineering and Technology (UAE)*, 7(2.27), 194-198.
- Kartimi, & Liliarsari. 2012. Pengembangan Alat Ukur Berpikir Kritis pada Konsep Termokimia untuk Siswa SMA Berperingkat Atas dan Menengah. *Jurnal Pendidikan IPA Indonesia*, 1(1): 21-26.
- Lee, S., Kang, E., & Kim, H. B. (2015). Exploring impact of students' learning approach on collaborative group modeling of blood circulation. *Journal of Science Education and Technology*, 24(2): 234-255.
- Maulana, H., & Sulistyoningrum. (2018). Implementation Mirror Technique 3D Objects for Interactive Learning Media "Circulatory System" Virtual Reality-Based. *Journal of Physics: Conference Series*, 1364 012036.
- Morel, M., Peruzzo, N., Juele, A. R., & Amarelle, V. (2019). Comics as an Educational Resource To Teach Microbiology in the Classroom. *Journal of microbiology & biology education*, 20 (1), 1-4
- Mutakinati, L., Anwari, I., & Yoshisuke, K. (2018). Analysis of students' critical thinking skill of middle school through STEM education project-based learning. *Jurnal Pendidikan IPA Indonesia*, 7(1), 54-65.
- Nhat, H. T., Lien, N. T., Tinh, N. T., Hang, N. V. T., & Trang, N. T. (2018). The Development of Critical Thinking for Students in Vietnamese Schools: From Policies to Practices. *American Journal of Educational Research*, 6(5), 431-435.
- Özdemir, E. (2017). Humor in Elementary Science: Development and Evaluation of Comic Strips about Sound. *International Electronic Journal of Elementary Education*, 9(4), 837-850.
- Prawita, W., Prayitno, B. A., & Sugiyarto. (2019). Effectiveness of generative learning-based biology module to improve the analytical thinking skills of the students with high and low reading motivation. *International Journal of Instruction*, 12(1), 1459-1476.
- Pujiasih, P., Wiwi I., & Saiful R. (2021). Android-based e-booklet development to train students' critical thinking and attitude of caring for environment. *Journal of Innovative Science Education*, 10 (1), 95-101.
- Puspita, I., Kaniawati, I., & Suwarma, R. (2017). Analysis of critical thinking skills on the topic static fluid. *Journal of Physics: Conference Series*, 895 012100.
- Puspitasari, E. D. T., Surjono, H. D., & Minghat, A. D. (2018). Utilizing web-based learning as 21st century learning media for vocational education. *International Journal of Engineering & Technology*, 7(4.33), 157-160.
- Putri, M. A., & Prodjosantoso, A. K. (2020). Improving Critical Thinking Skills and Scientific Attitudes by Using Comic. *Psychology, Evaluation, and Technology in Educational Research*, 2(2), 69-80.
- Rochmadi, M., & Nasucha, Y. (2015). Dasar-dasar Penelitian: Bahasa, Sastra, dan Pengajaran. *Buku*. Pustaka Brilliant, Surakarta.
- Sari, R., Perdana, R., Riwayani, Jumadi, Wilujeng, I., & Kuswanto, H. (2019) The implementation of problem-based learning model with online simulation to enhance the student's analytical thinking skill in learning physics. *Journal of Physics: Conference Series*, 1233 012030.

Commented [U13]: Cannot be found in the body of article.

Commented [U14]: Cannot be found in the body of article.

Commented [U15]: Not in alphabetical order.

Commented [U16]: Cannot be found in the body of article.

- Styers, M. L., Van Zandt, P. A., & Hayden, K. L. (2018). Active Learning in Flipped Life Science Courses Promotes Development of Critical Thinking Skills. *CBE life sciences education*, 17(3), ar39.
- Sudarsana, I. K., Nakayanti, A. R., Sapta, S., Haimah, Satria, E., Saddhono, K., GS, D. A., Putut, E., Helda, T., & Mursalin, M. (2019). Technology application in education and learning process. *Journal of Physics: Conference Series*, 1363 012061.
- Sugiyono. (2015). *Metode penelitian pendidikan*. Bandung: Alfabeta.
- Sukenda, Anjani, M., & Yustim, B. (2019). Learning Media for Biology Subject Based on Multimedia in Junior High School Level. *Universal Journal of Educational Research*, 7(4A), 43-51.
- Sung, Y. T., Chang, K. E., & Liu, T. C. (2016). The Effects of Integrating mobile Devices with Teaching and Learning on Students' Learning Performance: A Meta-Analysis and Research Synthesis. *Computers & Education*, 94: 252-275.
- Sung, H. Y., Hwang, G. J., Chen, C. Y., & Liu, W. X. (2019). A contextual learning model for developing interactive e-books to improve students' performances of learning the analects of confucius. *Interactive Learning Environments*, 1-14.
- Surjanti, J., Seno, D. N., Hadi, H. K., Maroah, S., Siswanti, Y., Muafi., & Isfianadewi, D. (2018). The role of m-learning on effective learning media in higher education. *International Journal of Civil Engineering and Technology*, 9(4): 77-85.
- Thomas, T. (2011). Developing First Year Student's Critical Thinking Skills. *Asian Social Science*, 7(4), 26-35
- Wiguna, D., Irwansyah, F. S., Windayani, N., Aulawi, H., & Ramdhani, M. A. (2019). Development of android-based chemistry learning media oriented towards generic science skills. *Journal of Physics: Conference Series*, 1157 042047.
- Williamson, B., Eynon, R., & Potter, J. (2020). Pandemic Politics, Pedagogies and Practices: Digital Technologies and Distance Education during the Coronavirus Emergency. *Learning, Media and Technology*, 45(2), 107-114.
- Yew, E. H. J., & Goh, K. (2016). Problem-Based Learning: An Overview of its Process and Impact on Learning. *Health Professions Education*, 2 (2), 75-79

Commented [U17]: Cannot be found in the body of article.

LAMPIRAN 2.9
PROSES REVISI KE-4



**ANALYSIS OF THE ROLE OF ANDROID-BASED LEARNING
MEDIA IN CRITICAL THINKING SKILLS AND SCIENTIFIC
ATTITUDE**

DOI:

Accepted: Approved: Published:

ABSTRACT

This study aims to analyze and describe android-based learning media's role in teaching students critical thinking skills and scientific attitudes. The learning media are androwebic (android-based webcomic) and e-bokartumban (e-book on plant diversity in Banjarnegara), developed previously. This research is a qualitative descriptive study involving 301 students, six biology teachers and six high school students. The data collected includes critical thinking skills, analytical skills, scientific attitudes, environmental care attitudes, media components supporting student competence, and teacher and student responses. Data on critical thinking and analytical skills were measured using tests and non-tests. Other data were measured using non-test instruments, including interview guides, scientific attitude observation sheets, students' environmental care attitudes, media component observation sheets, and student and teacher questionnaires. Quantitative data on critical thinking and analytical skills were analyzed using the n-gain test, while other data were descriptively analyzed. The research results showed that the e-bokartumban and androwebic components support students' critical thinking skills, analytical skills, and environmental care attitudes. Androwebic can train students' analytical thinking skills and scientific attitude. The two media developed were considered very helpful in the learning process. The study concluded that android-based media in androwebic and e-bokartumban have a vital role in training critical thinking skills, analytical skills, scientific attitudes, and environmental care attitudes.

Keywords: androwebic, e-bokartumban, critical thinking skills, scientific attitude

INTRODUCTION

Biology learning involves skills and reasoning (Amoah & Emmanuel, 2018). In developing reasoning power and skills, learning that can emphasize aspects of application, analysis, synthesis, and evaluation, not only emphasizing aspects of understanding and knowledge, is needed. For this reason, a learning process that can improve cognitive, affective, psychomotor competencies and learning methods that can motivate students to be creative, confident, and think critically are needed to assess information (Pujiasih et al., 2021). Critical thinking skills are needed to explain and solve problems (Thomas, 2011). Teaching critical thinking and problem-solving skills can be done with problem-based learning/PBL (Yew & Goh, 2016). PBL is a strategy to develop knowledge and problem-solving skills (Chung, 2019).

Students' development of critical thinking skills must focus on activities to teach content (knowledge) and methods or ways to find the process and evaluate information (Nhat et al., 2018). Students can think critically in learning, but this skill sometimes does not develop well. Therefore, it is necessary to use a method to develop students' critical thinking skills. One of the teaching methods considered appropriate is teaching using android-based media. The learning media in this study are androwebic (android-based webcomic) and e-bokartumban (e-book of plant diversity in Banjarnegara), developed previously. Androwebic has proven effective for teaching analytical skills and scientific attitudes (Sujatmiko et al., 2021). E-bokartumban also effectively improves critical thinking skills and environmental care attitudes (Pujiasih et al., 2021). However, neither Sujatmiko nor Pujiasih explained the role of the two android-based media in improving students' competencies and attitudes.

This study's urgency, novelty, and purpose are to analyze or describe the role of androwebic and e-bokartumban in teaching students' skills and attitudes. These skills and attitudes include critical thinking skills, analytical skills, scientific attitude, and environmental care attitude in students. The status of this research is to support previous research by Sujatmiko et al. (2021) and Pujiasih et al. (2021).

Mutakinati et al. (2018) stated that students with critical thinking skills easily analyze, evaluate, and connect with evidence or arguments before deciding or assessing information. Students' critical thinking skills play an important role in achieving learning achievement, formal reasoning, and creativity (Puspita et al., 2017). Learning that facilitates critical thinking skills can be realized if all parties, from policymakers to

teacher universities, local education departments, schools, and families, cooperate and participate (Nhat et al., 2018). The research results of Seventika et al. (2018) show that most (>55%) of 11th-grade students of vocational schools in Indramayu have a low level of critical thinking skills.

Textbooks and modules with few pictures still dominate biology learning in schools, and learning is still teacher-centred. This situation causes students' mindsets to be limited, and students' understanding of biology concepts weakens so that students' critical thinking skills and scientific attitudes are still weak. The results of interviews with several state high school/MA teachers in Banjarnegara and Jepara reinforce this statement. Information obtained from the results of the interview, among others: (1) Learning has not utilized student-centered media to its full potential; (2) students are allowed to bring smartphones, but they have not been appropriately used; (3) technology (smartphone) as a tool or media that does not support learning, (4) limited learning time.

Based on the interview with teachers, it can be concluded that these problems can be minimized by utilizing the technology owned by students and student-centered learning strategies to the fullest. The circulatory system and biodiversity are examples of biology learning materials that must be taught using media. The material on the circulatory system needs to be taught with the media because it contains complex concepts to be presented more interestingly. Biodiversity material, especially plant diversity, also needs to be taught by optimizing electronic media to present a plant diversity environment in the classroom.

The availability of learning media will facilitate interaction between teachers and students so that learning activities will be more effective and efficient (Puspitasari et al., 2018). The existence of learning media facilitates ease of learning, fosters interest in learning, and makes it easier for students to learn independently so that the learning process will be more effective (Surjanti et al., 2018). The use of android-based media can make students more interested in learning. The use of pictorial technology media also attracts students' attention more than textbooks. Taking this into account, it is clear that optimizing the use of modern technology-based media in learning is an urgent matter, especially during the current pandemic. In learning during the Covid-19 pandemic, the use of media and technology must make a real contribution to knowledge and the emergence of educational practices with online and digital education formats (Williamson et al., 2020)

Based on the problem, optimizing learning media is helpful for appropriately visualizing learning materials. The media should have a simple structure that focuses on one goal. Learning media that are expected to be useful or good to overcome the learning problems mentioned earlier should be easy to carry and use anywhere. Sukenda et al. (2019) stated that multimedia-based learning media should be packaged into software to present material.

One of the important learning media packaged into software is the environment. The environment is useful for equipping students with a conscious mind and care for the environment and its issues (Amini, 2015). The environment is also essential to instill knowledge, skills, attitudes, behavior, motivation, commitment to solving environmental problems, and environmental care attitude. The results of Putri & Prodjosantoso's research (2020) prove that science comics media (guided inquiry-based science comics) can improve critical thinking skills and scientific attitudes. A scientific attitude is an attitude that encourages students to solve problems (Hasanah et al., 2020). Khasanah et al. (2017) stated that the module based on critical thinking skills on respiratory system material helps practice critical thinking skills.

Based on the description above, media is essential in learning to instill skills and attitudes in students. One of these media is android-based media, as software. In this study, the role of android-based media was analyzed in teaching or training attitudes and skills to students. There are two android-based media: 1) E-bokartumban, an e-booklet about plant diversity in Banjarnegara, 2) Androwebic, an android-based webcomic about the circulatory system. From previous studies by Sujatmiko et al. (2021) and Pujiasih et al. (2021), both media are useful for improving critical thinking skills, analytical skills, scientific attitudes, and environmental care attitudes in students.

Some questions need to be answered in this research.

1. Does androwebic play a role in teaching students' analytical skills and scientific attitudes?
2. Does the e-bokartumban play a role in teaching students critical thinking skills and environmental care attitudes?
3. How does the androwebic function in teaching students analytical skills and scientific attitudes?
4. How does the e-bokartumban function in teaching students critical thinking skills and environmental care?
5. What learning activities do students do while learning using the two android-based media?
6. How do students and teachers respond to both media?

METHODS

Types of research

This study aims to analyze (and describe) the role of android-based learning media in teaching or training critical thinking skills, analytical skills, scientific attitudes, and environmental care attitudes. Therefore, the research design used is descriptive qualitative (Sugiyono, 2015).

Research Sample

The samples (subjects) were six biology teachers, 196 10th-grade students from three high schools in Banjarnegara, and 105 11th-grade students from three high schools in Jepara. The research sample was selected using the purposive sampling technique. This study used the technique because it requires research subjects relevant to the determined characteristics.

Research Data and Instruments

The data collected includes critical thinking skills, analytical skills, scientific attitudes, environmental care attitudes, media components supporting student competence, student learning activities, and teacher and student responses. Data were collected in several ways: tests, observations, questionnaires, and documentation. Data on critical thinking and analytical skills were measured using a test instrument, while other data were measured using a non-test instrument. The test instrument used contains multiple-choice questions with five choices. The non-test instruments include interview guides, scientific attitude observation sheets, student environmental care attitudes, media component observation sheets, learning activity observation sheets, and student and teacher questionnaires.

Data analysis

Quantitative data on critical thinking skills and analytical skills were analyzed using the n-gain test, while other data were analyzed descriptively qualitatively. Descriptive qualitative data analysis was carried out in 4 stages: data collection, data reduction, data presentation, and concluding (Rochmadi & Nasucha, 2015). The data that has been collected is collected according to their respective categories, including test result data, questionnaire results and observation data. The data is then reduced to obtain data that focuses on research problems: to analyze and describe the role of androwebic and e-bokartumban media in teaching the chosen skills and attitudes. The data obtained are presented in tabular or narrative form, depending on the characteristics of each data. The last stage is concluding based on the available data.

RESULTS AND DISCUSSION

Results

Overview of Androwebic and E-Bokartumban

In the following, the androwebic and e-bokartumban media are presented which were studied in this study. Media Androwebic have a general picture as shown in Figures 1.



Figure 1. Androwebic media display

Figure 1 shows the android component of the media, which contains 3 discussion activities. In each discussion activity, various questions and appropriate pictures are presented. The comics

are designed in such a way, to attract students' attention and interest in learning. Another learning media is e-bokartumbuhan, which can be illustrated by Figures 2 and 3.



Figure 2. Examples of e-bokartumbuhan media components at the beginning section.

Figure 2 presents the media display at the beginning of the media, showing the various menus available on the media. At the beginning of the e-bokartumbuhan media, information about the contents of the media, including the student competencies that are expected to be achieved, is informed. At the beginning of this media also informed about the content of the material

(content), assessment and bibliography. On the far right of Figure 2, an example of how material is displayed in the media is presented. An example of the presentation/display of material in the media is presented in Figure 3. An example of the presentation of material in the media is also presented in Figure 3.

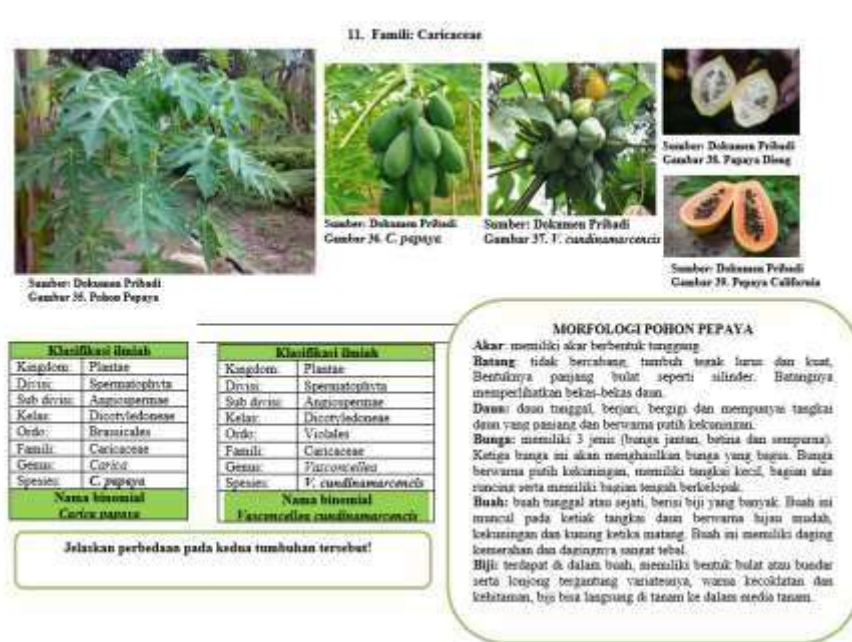


Figure 3: Examples of e-bokartumbuhan media components at the material section

In Figure 3, you can see the display of the contents of the material, containing colorful pictures of the leaves and fruits of the Caricaceae family, as well as their description and classification, as well as appropriate questions. The display of the material content on the e-bokartumbuhan media as shown in Figure 3 is useful for visualizing the original object of study that exists in the real world and bringing it to students, so that students can observe it more concretely.

Students' Analytical Skills

Students' analytical skills in learning using Androwebic were obtained from the pretest and posttest results (presented in Table 1).

Table 1. Students' pretest and posttest scores in biology learning using androwebic

Information	Pretest Score (n=105)	Posttest Score (n=105)
Highest score	93.33	100
Lowest score	13.33	60
Average value	53.65	88.83

Table 1 shows the score of posttest is higher than pretest. The pretest showed an average score of 53.65 (not yet reached 75 as KKM), while the posttest score achieved by students was an average of 88.83 (beyond the KKM). KKM is the minimum mastery criteria. KKM is a reference for educators in assessing students' competence in the subjects.

The increase in students' analytical thinking skills was obtained from the results of the n-gain test on the students' pretest and posttest scores (in Table 1). The results of the n-gain test showed that students who achieved high, medium and low analytical skills were 72%, 24% and 4%, respectively. From these results, the androwebic effectively improves students' analytical skills, especially in learning material about the circulation system. From these results, it can be

stated that androwebic media has an important role to teach students' analytical skills.

This happens because androwebic media has various menus/component which play an important role in teaching these abilities; this media also plays an important role in teaching scientific attitudes, as presented in Table 2.

Table 2. Androwebic component that support analytical thinking skills (A) and scientific attitude (B)

No	Indicators of analytical thinking skills	Media Components
A Analytical thinking skills		
1	Differentiating	Task to differentiate in group discussion questions
2	Organizing	Task for grouping on group discussion questions
3	Connecting	The task connects with group discussion questions
B Scientific attitude		
1	Curiosity	Task to observe on the webcomic
2	Respect for data/facts	Group discussion task in the media investigation section
3	Flexibility in thinking	Group discussion task in the media investigation section
4	Open minded and cooperate	Group discussion task in the media investigation section
5	Perseverance	The task of presenting the observations to be presented

From Table 3, information is obtained that androwebic media has 3 components to teach

analytical thinking skills (points A1-A3) and 5
components to instill scientific attitudes
(points

B1-B5). These eight components facilitate students to be skilled in analytical thinking and have a scientific attitudes.

Students' scientific attitudes during the learning process using Androwebic media

Information about students' scientific attitudes in learning using Androwebic media was

obtained from observing students' scientific attitudes using observation sheets. Androwebic was created specifically so that it has several good facilities to practice six aspects of scientific attitude (see Table 3). Students' scientific attitude was observed using student activities during the learning process using androwebic media, presented in Table 3.

Table 3. Students' scientific attitudes during the learning process using androwebic media

Indicator	Σ Score	Max Score	Score (%)	Criteria*)
Pay attention to every new thing	1086	1260	86.19	Very good
Appreciate and conclude according to facts	1056	1260	83.81	Very good
Not always feel right, change opinion after considering the evidence	1035	1260	82.14	Very good
Ask questions and give opinions	1124	1260	89.21	Very good
Participate in groups	1107	1260	87.86	Very good
Record complete observations	1068	1260	84.76	Very good

*) Sugiyono (2015): very good: 81-100; good: 61-80; 41-60: enough/currently

In Table 3, it can be seen that the average of students' scientific attitude is in the very good category. This very good category is determined based on the criteria from Sugiyono (2015).

Students' critical thinking skills during the learning process using E-Bokartumban

Android-based e-bokartumban media contains information about the diversity of plants in Banjarnegara. The information in question includes the scientific classification of each type of plant and a description of its morphology, a dissertation with attractive colored pictures. The e-bokartumban is useful for presenting the natural environment to the classroom with its

characteristics. The e-bokartumban as a smart phone application makes it very easy for students to use it. The results of the n-gain test showed that after learning to use e-bokartumban, students experienced an increase in critical thinking skills. The increase in students' critical thinking skills (n-gain) was 0.69 in the medium category (tend to be high). Students who achieve high, medium and low critical thinking skills are 53%, 45% and 2%, respectively. From these results, it can be stated that e-bokartumban has an important role to improve critical thinking skills. This role is supported by the characteristics of the e-bokartumban, which has a useful supporting component to facilitate the emergence of critical thinking skills (see Table 4).

Table 4. Indicators of students' critical thinking skills and e-bokartumban components that play a role in facilitating these skills.

No.	Indicators of Critical Thinking Skills	Media Components
1	Give a simple explanation	Evaluation questions, students discussion sheets
2	Build basic skills	Evaluation questions, students discussion sheets
3	Conclude	Evaluation questions, students discussion sheets
4	Identify terms and consider a definition	Evaluation questions, students discussion sheets
5	Set strategy and tactics	Evaluation questions, students discussion sheets

The data in Table 4 informs that students using e-bokartumban media practice to make simple statements, build basic skills, conclude, and so on, through various components of e-bokartumban media, namely in the evaluation/

assessment section and through several discussion activities provided.

E-bokartumban also has various components that play an important role in growing various indicators of environmental care attitudes (see Table 5).

Table 5. Competency indicators of environmental care attitudes in students and components of the e-bokartumban media that facilitate the emergence of these attitude indicators

No	Aspects and Indicators of Environmental Care Attitude	Media Components *)
1	Have thought that plants and animals have rights were equal to humans	Introduction to the materials
2	Have feelings/emotions about human actions that cause disaster	Introduction to the materials
3	Have thought that the environment is very fragile and easily	disturbed balance

- 4 Have feelings and tendencies of behavior that the tendency of human beings there is a limit in controlling nature
- Student discussion sheets, materials
- Student discussion sheets, materials

5	Tend to take advantage of the source power of nature that has been used	Student discussion sheets, materials
6	Tend not to be arbitrary towards the environment	Student discussion sheets, materials
7	Have thoughts and attracted to environmental issues	Student discussion sheets, materials
8	Have emotional feelings about actions that can cause environmental damage	Student discussion sheets, materials

*) The examples of the components of the e-bokartumban media are presented in Figures 2 and 3.

In Table 5, column 3, various sections of the media are presented that are useful for strengthening various indicators of environmental care attitudes (column 2 of Table 5). The various components of the e-bokartumban media are very useful to familiarize students with various attitudes that lead to the formation of environmental care attitudes in students. The components of the e-

bokartumban media in question are the material components and student worksheets.

Responses of Students and Teachers to Androwebic

Students' responses to learning using androwebic were obtained from questionnaires given at the end of the lesson. Information about students' positive responses to androwebic media is presented in Table 6.

Table 6. Student's Positive Response to Androwebic Media

Indicators of Androwebic media	Score	Max. Score	Percentage (%)	Criteria*)
Affective consideration	755	840	89.88	Very good
Learning	1116	1260	88.57	Very good
Multimedia display	2308	2520	91.59	Very good
Navigation	1487	1680	88.51	Very good
Robustness	1507	1680	89.40	Very good
Average			89.59	Very good

*) Sugiyono (2015): very good: 81-100; good: 61-80; 41-60: enough/currently

Table 6 shows that students give positive responses to androwebic media with very good category. Positive responses to androweb media were also obtained from teachers, through

questionnaires. The positive responses of teachers to androwebic media with a very good category are presented in Table 7.

Table 7. Teachers' Positive Response to Androwebic Media

Indicators of androwebic media	Score	Max. Score	Percentage (%)	Criteria*)
Affective consideration	22	24	91.67	Very good
Learning	30	36	83.33	Very good
Multimedia display	64	72	88.89	Very good
Navigation	41	48	85.42	Very good
Robustness	42	48	87.50	Very good
Average			87.36	Very good

*) Sugiyono (2015): very good: 81-100; good: 61-80; 41-60: enough/currently

From the results in Tables 6 and 7 it can be stated that androwebic media received a very good response from students and teachers. This means that androwebic media a) attracts and motivates students/users (affective considerate), b) the material is appropriate to students and can make students interact with the media (learning), c) the media display (multimedia display) is good, d) navigation good media, and 5) this media is sturdy (resistant) to use, easy to access and the menu is easy to choose (robustness).

The problems in the discussion menu are related to daily events. For example, the work of the heart, normal and non-normal blood

Discussion

The Role of Androwebic in Biology Learning Role of Androwebic in Analytical Skills Learning

conditions and blood type. Those are all everyday things that students often experience. The availability of various menus on androwebic stimulates students' curiosity and encourages students to practice problem-solving (see Figure 1 and Table 2). Both activities require analytical thinking skills so that students' skills are well trained. This statement is under the research of Prawita et al. (2019) and Sari et al. (2019), which states that the use of learning media that presents problems can improve students' learning outcomes and analytical thinking skills.

Comics help students learn by simplifying science concepts and making them easier to remember (Ozdemir, 2017). Comics also contribute to arousing students' enjoyment of science and the perception of success in science. Demirci and Zyürek (2017) state that the cartoon concept can effectively develop critical thinking

skills. Colorful cartoons attract attention and encourage students' active participation in learning activities (think more actively). Indirectly, it plays an important role in helping to develop critical thinking skills. An active learning process is also very useful for improving students' critical thinking skills (Styers et al., 2018)

During the discussion stage in biology learning using Androwebic, students are trained to discuss and exchange ideas about problem solutions systematically and logically (Figure 1). Thus, students become trained to think analytically. Sari et al. (2019) proved that learning by actively involving students to solve problems improved analytical thinking skills and learning outcomes. Analytical thinking skills is one component of critical thinking skills (Facione 2015).

The teacher said that the andro-webcomic media based on problem-based learning was very good, easy to use, up to date. The material presented was equipped with attractive visuals, ready to use anytime and anywhere with Android devices. Sung et al. (2016) stated that using android devices (smartphones) in learning was better and more effective than conventional learning.

In this study, comics are used to teach material about the circulation system, which is very complex and cannot be observed directly. The choice of comics to be used in Androwebic turned out to be very appropriate because it got an outstanding response from students and teachers (see Tables 6 and 7). This statement is in accordance with the statement of Morel et al. (2019), that comics are an excellent tool to help educators teach complex subjects and explain the occult world. Based on the above description, it can be stated that Androwebic media has an important role to train critical thinking skills.

Role of Androwebic Media in Scientific Attitude Learning

In Table 3 it is presented that the average scientific attitude of students is in the very good category. It happened because, since the beginning of the learning using Androwebic, students are always motivated to learn and seek information independently. During the learning process assisted by androwebic media, students show a more caring attitude, respect, and conclude according to facts. During the learning process, students are also accustomed not to always feel right, dare to ask questions, dare to express opinions, be active in groups, and record complete observations. Students must solve discussion questions that contain contextual problems in the learning process. Every activity carried out during the discussion process positively contributed to scientific attitudes. This is what can encourage students to think analytically in solving problems. This is under the statement of Dwianto et al. (2017) that the application of learning media that presents contextual problems through discussion

can positively contribute to students' formation of scientific attitudes.

The Role of E-Bokartumban in Biology Learning

The role of E-bokartumban in Critical Thinking Skills Learning

Table 4 shows that the e-bokartumban media has components that facilitate each indicator of critical thinking competence in this study. There are five stages of critical thinking with each indicator: 1) providing simple explanations, 2) building basic skills, 3) concluding, 4) identifying terms, 5) considering a definition, setting strategies and tactics (Kartimi & Liliyasi, 2012). These thinking indicators can be measured when students work on discussion sheets and evaluation questions on the media. Wiguna et al. (2019) and Damopolil & Kurniadi (2019) explained that students' learning outcomes increase after using android-based media.

Based on the description above, it can be emphasized that the e-bokartumban has an important role in teaching or practicing critical thinking skills. Arista and Kuswanto (2018) stated that smartphones' media increases enthusiasm, interest, and motivation in learning activities. All of these things can increase students' independence and understanding of concepts.

The Role of E-bokartumban in Environmental Care Attitudes Learning

From Table 5, indicators of environmental care attitudes use a scale adapted from NEPS. Indicators of the environmental care attitude are as follow: 1) Having the idea that plants and animals have the same rights as humans, 2) having feelings/emotions about human actions that cause disasters, 3) having the thought that the environment is very vulnerable and its balance is easily disturbed, 4) having feelings and behavioral tendencies that human tendencies have limits in controlling nature, 5) having behavioral tendencies to take advantage of used natural resources. The 6th indicator has a behavioral tendency not to be arbitrary towards the environment, 7) has thoughts and is interested in environmental issues, and 8) has emotional feelings towards actions that can cause environmental damage. All indicators of environmental care attitudes can be measured as long as students use the media when reading the material and during group discussions during the learning process.

Learning Biology (on plant diversity material) with e-bokartumban media makes a positive contribution to increasing students' environmental care attitudes. Environmental care attitudes are attitudes and actions that always try to prevent damage to the surrounding natural environment and develop efforts to repair natural damage (Yaumi, 2014). Environmental care attitudes can be shown by attitudes and actions that always try to prevent environmental damage and repair the natural damage (Mardikaningtyas, 2016).

Based on the description in the paragraph above, it can be stated that the use of android-based learning media is very effective in increasing student understanding. This statement follows the opinion of Sudarsana et al. (2019), which states that the use of technology-based learning media can improve student learning outcomes. Junaedi et al. (2018) and Damopolil & Kurniadi (2019) found that applying android-based media can improve student learning outcomes. Learning that uses technology can increase student interest and learning outcomes (Sudarsana et al., 2019).

Responses of Students and Teachers to Android-based Media in Biology Learning

Responses of Students and Teachers to Androwebic Media

Positive response of students to the androwebic media used in biology learning were obtained from questionnaires given at the end of the lesson. Information about students' positive responses to Androwebic media is presented in Table 6.

Table 6 shows the average score for each indicator that shows very good criteria. In some indicators, the student response rate shows the maximum score. Students are interested and motivated to learn with comics on the media. Besides being interested and motivated by comics, students also acknowledged that the material equipped with pictures on Androwebic media was beneficial and made it easier for students to learn because it had been summarized in a structured way. The problems in the Androwebic media also increase students' activeness in problem-based learning activities. In the learning process, students not only listen but also try, discover, and conclude. Therefore, students' understanding, analytical thinking ability, and scientific attitude will be higher.

In terms of appearance, Androwebic media received high points in very good criteria, showing that students are very interested in the appearance of Androwebic media. Androwebic media with pictures on every material detail provides the proper visualization. It makes it easier for students to understand abstract blood circulation material. Androwebic media also help students understand and discover concepts about the circulatory system. Appropriate learning media and students' character in learning can help students find concepts contextually. The media in question must be engaging, contain extensive learning resources, contain information whose presentation is accompanied by visual images. The use of a problem-based learning approach that is complemented by the use of learning media has been proven to be able to foster student interest and motivation to be more active in learning to create fun learning, understanding the material of the circulatory system will increase (Maulana & Sulistyoningrum, 2018; Lee et al., 2015).

From the data in Table 7, it is known that the average score for each indicators is 87.36%, with a very good category. The teacher said that androwebic media is very good, easy to use, and up-to-date. The material in these media is equipped with attractive visuals. It can be used anytime and anywhere on android devices. It is confirmed by Sung et al. (2016), which states that android devices such as smartphones are better and more effective than conventional learning. Students are more enthusiastic because the learning process is student-centered, while the teacher only directs and guides. This statement is under the findings of Ali (2019), which proves that student-centered learning will improve students' skills to understand the material and problem-solving skills. In such circumstances, the teacher directs and guides as necessary.

Responses of Students and Teachers to E-Bokartumban Media

The responses of students and teachers in this section were obtained from the questionnaire, described by ten indicators. The descriptive data analysis on responses to e-bokartumban media shows that students and teachers each gave a response of 89.13% and 90.09% (very good category).

The teachers stated that the e-bokartumban helped students build the concept of biodiversity. The teachers also positively responded to student activities in learning because it made students very enthusiastic during discussion. The teacher said that the E-Bokartumban media is an attractive, contemporary, easy to use, easy to carry media, and the material presented is evident. Thus, it can be emphasized that the e-bokartumban media is a perfect medium to use in learning and has excellent potential to train critical thinking skills and environmental care attitudes, as previously stated.

The description clearly states that Androwebic media can train students' analytical thinking skills by 92.68% and scientific attitude by 85.66%. Students and teachers positively responded to the android-based media. E-bokartumban also trains critical thinking skills and environmental care attitudes. E-Bokartumban is also responded positively by students and teachers by 89.13% and 90.09%, respectively. Thus, it can be stated that the androwebic and e-bokartumban analyzed in this study responded well by students and teachers and played an essential role in teaching skills and attitudes. This media has a vital role in teaching students' analytical skills, critical thinking skills and scientific attitudes, and environmental care attitude in learning biology.

CONCLUSION

From the discussion above, the following conclusions can be drawn. E-Bokartumban media shows an essential role in teaching students critical thinking skills and environmental care attitudes. Androwebic media shows a vital role in teaching students' analytical skills and scientific attitudes. The level of critical thinking skills, analytical skills,

scientific attitudes, and environmental care attitudes of students after learning to use android-based media increased to good and very good. E-Bokartumban can teach students critical thinking skills and environmental care attitudes because it contains various components that can facilitate activities that are indicators of critical thinking skills and environmental care attitudes. Androwebic can be used to teach analytical skills and scientific attitudes to students. It contains various components that can facilitate activities that are indicators because they contain various components that can facilitate activities that are indicators of analytical skills and scientific attitudes. 5) The learning activities carried out by students while learning to use the two android-based media include various activities that match the indicators of critical thinking skills, analytical skills, scientific attitudes, and environmental care attitudes. 6) Students and teachers showed an excellent response to Androwebic and e-Bokartumban in Biology learning. Two types of Android-based media (Androwebic and e-bokartumban) in Biology learning have proven to have a vital role in teaching students critical thinking skills, analytical skills, scientific attitudes, and environmental care attitudes.

ACKNOWLEDGEMENT

The authors would like to thank Prof. Dr. Enni Suwarsi Rahayu, M.Si., and Prof. Dr. Retno Sri Iswari, S.U., as the material expert validator, Dr. Budi Naini Mindiyarto, M.App.Sc., and Mohammad Fikri, S.Sn (Pusdatin Kemendikbud) as media expert validators. The latter have provided beneficial suggestions for improving this research. The authors also would like to thank Dr. Sigit Saptono, M.Pd (Coordinator of S2 Science Education study program). This research was supported by the Lembaga Penelitian dan Pengabdian Masyarakat Universitas Negeri Semarang, which has funded this research (the contract number of the funding letter: SP DIPA-023.17.2.677507/2020, 27-12-2019, following the Letter of Assignment of Research Implementation of UNNES DIPA Funds Year 2020, Number 166.23.4/UN37/ PPK.3.1/2020, 23-04-2020.

REFERENCES

- Ali, S. S. (2019). Problem based learning: a student-centered approach. *English Language Teaching*, 12(5), 73-78.
- Amini, R. (2015). Outdoor Based Environmental Education Learning and its Effect in Caring Attitude Toward Environment. *Journal Pendidikan IPA Indonesia*, 4(1), 43-47.
- Amoah A. C., & Emmanuel E. (2018). Assessing the reasoning skills of biology students in selected senior high schools in the central region of Ghana. *International Journal of Scientific Research and Management (IJSRM)*, 6(4), 299-304.
- Arista, F. S., & Kuswanto, H. (2018). Virtual physics laboratory application based on the android smartphone to improve learning independence and conceptual understanding. *International Journal of Instruction*, 11(1), 1-16.
- Chung E. Y. (2019). Facilitating learning of community-based rehabilitation through problem-based learning in higher education. *BMC medical education*, 19 (1), 433.
- Damopolil, I., & Kurniadi, B. (2019). The development of android-based mobile learning supported by problem-based learning strategy for students' learning success. *International Journal of Scientific and Technology research*, 8(7), 190-193.
- Demirci, F. & Özyürek, C. (2017). The Effects of Using Concept Cartoons in Astronomy Subjects on Critical Thinking Skills among Seventh Grade Student. *International Electronic Journal of Elementary Education*, 10 (2), 243-254.
- Dwianto, A., Wilujeng, I., Prasetyo, Z. K., & Suryadarma, I. G. P. (2017). The development of science domain based learning tool which is integrated with local wisdom to improve science process skill and scientific attitude. *Jurnal Pendidikan IPA Indonesia*, 6(1): 23-31.
- Facione, P. A. (2015). *Critical Thinking: What It Is and Why It Counts*. In Insight assessment (Issue ISBN 13: 978-1-891557-07-1).
- Hasanah, S. I., Mustofa, R. F., & Ardiansyah, R. (2020). Correlation between Generic Science Skills and Scientific Attitudes on Learning Outcomes. *BIOEDUSCIENCE*, 4(2), 124-128.
- Junaedi, J., Irviani, R., Muslihudin, M., Hidayat, S., Maselena, A., Gumanti, M., & Fauzi, A. N. (2018). Application program learning based on android for students experiences. *International Journal of Engineering and Technology (UAE)*, 7(2.27), 194-198.
- Kartimi, & Liliasari. 2012. Pengembangan Alat Ukur Berpikir Kritis pada Konsep Termokimia untuk Siswa SMA Berperingkat Atas dan Menengah. *Jurnal Pendidikan IPA Indonesia*, 1(1): 21-26.
- Khasanah, A.N., Sajidan, S. Widoretno, (2017). Effectiveness of Critical Thinking Indicator-Based Module in Empowering Student's Learning Outcome in Respiratory System Study Material. *JPII*, 6 (1) (2017) 187-195
- Lee, S., Kang, E., & Kim, H. B. (2015). Exploring impact of students' learning approach on collaborative group modeling of blood circulation. *Journal of Science Education and Technology*, 24(2): 234-255.
- Mardikaningtyas, A. D. (2016). Pengembangan Pembelajaran Pencemaran Lingkungan berbasis Penelitian Fitoremediasi untuk Menunjang Keterampilan Ilmiah, Sikap Peduli Lingkungan, dan Motivasi pada Matakuliah Dasar-dasar Ilmu Lingkungan. *Jurnal Pendidikan: Teori, Penelitian, dan Pengembangan*, 1(3), 499-506.
- Maulana, H., & Sulistyoningrum. (2018). Implementation Mirror Technique 3D

- Objects for Interactive Learning Media "Circulatory System" Virtual Reality-Based. *Journal of Physics: Conference Series*, 1364 012036.
- Morel, M., Peruzzo, N., Juele, A. R., & Amarelle, V. (2019). Comics as an Educational Resource to Teach Microbiology in the Classroom. *Journal of microbiology & biology education*, 20 (1), 1-4
- Mutakinati, L., Anwari, I., & Yoshisuke, K. (2018). Analysis of students' critical thinking skill of middle school through STEM education project-based learning. *Jurnal Pendidikan IPA Indonesia*, 7(1),54-65.
- Nhat, H. T., Lien, N. T., Tinh, N. T., Hang, N. V. T., & Trang, N. T. (2018). The Development of Critical Thinking for Students in Vietnamese Schools: From Policies to Practices. *American Journal of Educational Research*, 6(5), 431-435.
- Özdemir, E. (2017). Humor in Elementary Science: Development and Evaluation of Comic Strips about Sound. *International Electronic Journal of Elementary Education*, 9(4), 837-850.
- Prawita, W., Prayitno, B. A., & Sugiyarto. (2019). Effectiveness of generative learning-based biology module to improve the analytical thinking skills of the students with high and low reading motivation. *International Journal of Instruction*, 12(1), 1459-1476.
- Pujiasih, P., Isnaeni, W., & Ridlo, S. (2021). Android-based e-booklet development to train students' critical thinking and attitude of caring for environment. *Journal of Innovative Science Education*, 10(1), 95-101.
- Puspita, I., Kaniawati, I., & Suvarma, R. (2017). Analysis of critical thinking skills on the topic static fluid. *Journal of Physics: Conference Series*, 895 012100.
- Puspitasari, E. D. T., Surjono, H. D., & Minghat, A. D. (2018). Utilizing web-based learning as 21st century learning media for vocational education. *International Journal of Engineering & Technology*, 7(4.33), 157-160.
- Putri, M. A., & Prodjosantoso, A. K. (2020). Improving Critical Thinking Skills and Scientific Attitudes by Using Comic. *Psychology, Evaluation, and Technology in Educational Research*, 2(2), 69-80.
- Rochmadi, M., & Nasucha, Y. (2015). Dasar-dasar Penelitian: Bahasa, Sastra, dan Pengajaran. *Buku*. Pustaka Brilliant, Surakarta.
- Sari, R., Perdana, R., Riwayani, Jumadi, Wilujeng, I., & Kuswanto, H. (2019) The implementation of problem-based learning model with online simulation to enhance the student's analytical thinking skill in learning physics. *Journal of Physics: Conference Series*, 1233 012030.
- Styers, M. L., Van Zandt, P. A., & Hayden, K. L. (2018). Active Learning in Flipped Life Science Courses Promotes Development of Critical Thinking Skills. *CBE life sciences education*, 17(3), ar39.
- Sudarsana, I. K., Nakayanti, A. R., Sapta, S., Haimah, Satria, E., Saddhono, K., GS, D. A., Putut, E., Helda, T., & Mursalin, M. (2019). Technology application in education and learning process. *Journal of Physics: Conference Series*, 1363 012061.
- Sugiyono. (2015). *Metode penelitian pendidikan*. Bandung: Alfabeta.
- Sujatmiko, Y. A., Isnaeni, W., Ridlo, S. and Saptono, S. (2021). The development of androwebcomic media based on problem-based learning to improve analytical thinking ability and scientific attitude. ICMSE 2020 Journal of Physics: Conference Series. 1918 (2021) 052023. IOP Publishing. doi:10.1088/1742-6596/1918/5/052023
- Sukenda, Anjani, M., & Yustim, B. (2019). Learning Media for Biology Subject Based on Multimedia in Junior High School Level. *Universal Journal of Educational Research*, 7(4A), 43-51.
- Sung, Y. T., Chang, K. E., & Liu, T. C. (2016). The Effects of Integrating mobile Devices with Teaching and Learning on Students' Learning Performance: A Meta-Analysis and Research Synthesis. *Computers & Education*, 94: 252-275.
- Surjanti, J., Seno, D. N., Hadi, H. K., Maroah, S., Siswanti, Y., Muafi., & Isfianadewi, D. (2018). The role of m-learning on effective learning media in higher education. *International Journal of Civil Engineering and Technology*, 9(4): 77-85.
- Thomas, T. (2011). Developing First Year Student's Critical Thinking Skills. *Asian Social Science*, 7(4), 26-35
- Wiguna, D., Irwansyah, F. S., Windayani, N., Aulawi, H., & Ramdhani, M. A. (2019). Development of android-based chemistry learning media oriented towards generic science skills. *Journal of Physics: Conference Series*, 1157 042047.
- Williamson, B., Eynon, R., & Potter, J. (2020). Pandemic Politics, Pedagogies and Practices: Digital Technologies and Distance Education during the Coronavirus Emergency. *Learning, Media and Technology*, 45(2), 107-114.
- Yaumi, M. (2014). Pendidikan karakter: landasan, pilar, dan implementasi. Jakarta: Kencana
- Yew, E. H. J., & Goh, K. (2016). Problem-Based Learning: An Overview of its Process and Impact on Learning. *Health Professions Education*, 2 (2), 75-79.

LAMPIRAN 2.10
ARTIKEL PUBLISH



ANALYSIS OF THE ROLE OF ANDROID-BASED LEARNING MEDIA IN LEARNING CRITICAL THINKING SKILLS AND SCIENTIFIC ATTITUDE

W. Isnaeni*¹, Y. A. Sujatmiko², P. Pujiasih³

^{1,2,3}Universitas Negeri Semarang, Indonesia

DOI: 10.15294/jpii.v10i4.27597

Accepted: December 7th 2020. Approved: December 27th 2021. Published: December 31st 2021

ABSTRACT

This study aims to analyze and describe android-based learning media's role in teaching students critical thinking skills and scientific attitudes. The learning media are Androwebic (android-based webcomic) and E-Bokartumban (e-book on plant diversity in Banjarnegara), developed previously. This research is a qualitative descriptive study involving 301 students, six biology teachers and six high school students. The data collected includes critical thinking skills, analytical skills, scientific attitudes, environmental care attitudes, media components supporting student competence, and teacher and student responses. Data on critical thinking and analytical skills were measured using tests and non-tests. Other data were measured using non-test instruments, including interview guides, scientific attitude observation sheets, students' environmental care attitudes, media component observation sheets, and student and teacher questionnaires. Quantitative data on critical thinking and analytical skills were analyzed using the n-gain test, while other data were descriptively analyzed. The research results showed that the E-Bokartumban and Androwebic components support students' critical thinking skills, analytical skills, and environmental care attitudes. Androwebic can train students' analytical thinking skills and scientific attitude. The two media developed were considered very helpful in the learning process. The study concluded that Android-based media in Androwebic and E-Bokartumban have a vital role in training critical thinking skills, analytical skills, scientific attitudes, and environmental care attitudes.

© 2021 Science Education Study Program FMIPA UNNES Semarang

Keywords: androwebic; e-bokartumban; critical thinking skills; scientific attitude

INTRODUCTION

Biology learning involves skills and reasoning (Eshun & Amoah, 2018). In developing reasoning power and skills, learning that can emphasize aspects of application, analysis, synthesis, and evaluation, not only emphasizing aspects of understanding and knowledge, is needed. For this reason, a learning process that can improve cognitive, affective, psychomotor competencies and learning methods that can motivate students to be creative, confident, and think critically are needed to assess information (Pujiasih et al., 2021). Critical thinking skills are needed to explain and

solve problems (Thomas, 2011). Teaching critical thinking and problem-solving skills can be done with problem-based learning/PBL (Yew & Goh, 2016). PBL is a strategy to develop knowledge and problem-solving skills (Chung, 2019).

Students' development of critical thinking skills must focus on activities to teach content (knowledge) and methods or ways to find the process and evaluate information (Nhat et al., 2018). Students can think critically in learning, but this skill sometimes does not develop well. Therefore, it is necessary to use a method to develop students' critical thinking skills. One of the teaching methods considered appropriate is teaching using android-based media. The learning media in this study are androwebic (android-based webcomic)

*Correspondence Address
E-mail: wiiisna@mail.unnes.ac.id

and e-bokartumban (e-book of plant diversity in Banjarnegara), developed previously. Androwebic has proven effective for teaching analytical skills and scientific attitudes (Sujatmiko et al., 2021). E-bokartumban also effectively improves critical thinking skills and environmental care attitudes (Pujiasih et al., 2021). However, neither Sujatmiko nor Pujiasih explained the role of the two android-based media in improving students' competencies and attitudes. This study's urgency, novelty, and purpose are to analyze or describe the role of androwebic and e-bokartumban in teaching students' skills and attitudes. These skills and attitudes include critical thinking skills, analytical skills, scientific attitude, and environmental care attitude in students. The status of this research is to support previous research by Sujatmiko et al. (2021) and Pujiasih et al. (2021).

Mutakinati et al. (2018) stated that students with critical thinking skills easily analyze, evaluate, and connect with evidence or arguments before deciding or assessing information. Students' critical thinking skills play an important role in achieving learning achievement, formal reasoning, and creativity (Puspita et al., 2017; Purnami et al., 2021). Learning that facilitates critical thinking skills can be realized if all parties, from policymakers to teacher universities, local education departments, schools, and families, cooperate and participate (Nhat et al., 2018). The research results of Seventika et al. (2018) show that most (>55%) of 11th-grade students of vocational schools in Indramayu have a low level of critical thinking skills.

Textbooks and modules with few pictures still dominate biology learning in schools, and learning is still teacher-centred. This situation causes students' mindsets to be limited, and students' understanding of biology concepts weakens so that students' critical thinking skills and scientific attitudes are still weak. The results of interviews with several state high school/MA teachers in Banjarnegara and Jepara reinforce this statement. Information obtained from the results of the interview, among others: (1) Learning has not utilized student-centered media to its full potential; (2) students are allowed to bring smartphones, but they have not been appropriately used; (3) technology (smartphone) as a tool or media that does not support learning; (4) limited learning time. Based on the interview with teachers, it can be concluded that these problems can be minimized by utilizing the technology owned by students and student-centered learning strategies to the fullest. The circulatory system and biodiversity are examples of biology learning

materials that must be taught using media. The material on the circulatory system needs to be taught with the media because it contains complex concepts to be presented more interestingly. Biodiversity material, especially plant diversity, also needs to be taught by optimizing electronic media to present a plant diversity environment in the classroom.

The availability of learning media will facilitate interaction between teachers and students so that learning activities will be more effective and efficient (Puspitasari et al., 2018). The existence of learning media facilitates ease of learning, fosters interest in learning, and makes it easier for students to learn independently so that the learning process will be more effective (Surjanti et al., 2018). The use of android-based media can make students more interested in learning. The use of pictorial technology media also attracts students' attention more than textbooks. Taking this into account, it is clear that optimizing the use of modern technology-based media in learning is an urgent matter, especially during the current pandemic. In learning during the COVID-19 pandemic, the use of media and technology must make a real contribution to knowledge and the emergence of educational practices with online and digital education formats (Williamson et al., 2020). Based on the problem, optimizing learning media is helpful for appropriately visualizing learning materials. The media should have a simple structure that focuses on one goal. Learning media that are expected to be useful or good to overcome the learning problems mentioned earlier should be easy to carry and use anywhere. Sukenda et al. (2019) stated that multimedia-based learning media should be packaged into software to present material.

One of the important learning media packaged into software is the environment. The environment is useful for equipping students with a conscious mind and care for the environment and its issues (Amini, 2015). The environment is also essential to instill knowledge, skills, attitudes, behavior, motivation, commitment to solving environmental problems, and environmental care attitude. The results of Putri & Prodjosantoso's research (2020) prove that science comics media (guided inquiry-based science comics) can improve critical thinking skills and scientific attitudes. A scientific attitude is an attitude that encourages students to solve problems (Hasanah et al., 2020). Khasanah et al. (2017) stated that the module based on critical thinking skills on respiratory system material helps practice critical thinking skills.

Based on the description above, media is essential in learning to instill skills and attitudes in students. One of these media is android-based media, as software. In this study, the role of android-based media was analyzed in teaching or training attitudes and skills to students. There are two android-based media: 1) E-bokartumban, an e-booklet about plant diversity in Banjarnegara, 2) Androwebic, an android-based webcomic about the circulatory system. From previous studies by Sujatmiko et al. (2021) and Pujiasih et al. (2021), both media are useful for improving critical thinking skills, analytical skills, scientific attitudes, and environmental care attitudes in students.

Some questions need to be answered in this research: 1) Does androwebic play a role in teaching students' analytical skills and scientific attitudes?; 2) Does the e-bokartumban play a role in teaching students critical thinking skills and environmental care attitudes?; 3) How does the androwebic function in teaching students analytical skills and scientific attitudes?; 4) How does the e-bokartumban function in teaching students critical thinking skills and environmental care?; 5) What learning activities do students do while learning using the two android-based media?; 6) How do students and teachers respond to both media?

METHODS

This study aims to analyze (and describe) the role of android-based learning media in teaching or training critical thinking skills, analytical skills, scientific attitudes, and environmental care attitudes. Therefore, the research design used is descriptive qualitative (Sugiyono, 2015). The samples (subjects) were six biology teachers, 196 10th-grade students from three high schools in Banjarnegara, and 105 11th-grade students from three high schools in Jepara. The research sample was selected using the purposive sampling technique. This study used the technique because it requires research subjects relevant to the determined characteristics.

The data collected includes critical thinking skills, analytical skills, scientific attitudes, environmental care attitudes, media components supporting student competence, student learning activities, and teacher and student responses. Data were collected in several ways: tests, observations, questionnaires, and documentation. Data on critical thinking and analytical skills were measured using a test instrument, while other data were measured using a non-test instrument. The test instrument used contains multiple-

choice questions with five choices. The non-test instruments include interview guides, scientific attitude observation sheets, student environmental care attitudes, media component observation sheets, learning activity observation sheets, and student and teacher questionnaires.

Quantitative data on critical thinking skills and analytical skills were analyzed using the n-gain test, while other data were analyzed descriptively qualitatively. Descriptive qualitative data analysis was carried out in 4 stages: data collection, data reduction, data presentation, and concluding (Rohmadi & Nasucha, 2015). The data that has been collected is collected according to their respective categories, including test result data, questionnaire results and observation data. The data is then reduced to obtain data that focuses on research problems: to analyze and describe the role of androwebic and e-bokartumban media in teaching the chosen skills and attitudes. The data obtained are presented in tabular or narrative form, depending on the characteristics of each data. The last stage is concluding based on the available data.

RESULTS AND DISCUSSION

In the following, the androwebic and e-bokartumban media are presented which were studied in this study. Media Androwebic have a general picture as shown in Figures 1.



Figure 1. Androwebic Media Display

Figure 1 shows the android component of the media, which contains 3 discussion activities. In each discussion activity, various questions and appropriate pictures are presented. The comics

are designed in such a way, to attract students' attention and interest in learning. Another learning media is e-bokartumban, which can be illustrated by Figures 2 and 3.



Figure 2. Examples of E-bokartumban Media Components at the Beginning Section

Figure 2 presents the media display at the beginning of the media, showing the various menus available on the media. At the beginning of the e-bokartumban media, information about the contents of the media, including the student competencies that are expected to be achieved, is informed. At the beginning of this media also informed about the content of the material (con-

tent), assessment and bibliography. On the far right of Figure 2, an example of how material is displayed in the media is presented. An example of the presentation/display of material in the media is presented in Figure 3. An example of the presentation of material in the media is also presented in Figure 3.



Figure 3. Examples of E-bokartumban Media Components at the Material Section

In Figure 3, you can see the display of the contents of the material, containing colorful pictures of the leaves and fruits of the Caricaceae family, as well as their description and classification, as well as appropriate questions. The display of the material content on the e-bokartumban media as shown in Figure 3 is useful for visuali-

zing the original object of study that exists in the real world and bringing it to students, so that students can observe it more concretely.

Students' analytical skills in learning using Androwebic were obtained from the pretest and posttest results (presented in Table1).

Table 1. Students' Pretest and Posttest Scores in Biology Learning Using Androwebic

Information	Pretest Score (n=105)	Posttest Score (n=105)
Highest score	93.33	100
Lowest score	13.33	60
Average value	53.65	88.83

Table 1 shows the score of posttest is higher than pretest. The pretest showed an average score of 53.65 (not yet reached 75 as KKM), while the posttest score achieved by students was an average of 88.83 (beyond the KKM). KKM is the minimum mastery criteria. KKM is a reference for educators in assessing students' competence in the subjects.

The increase in students' analytical thinking skills was obtained from the results of the n-gain test on the students' pretest and posttest scores (in Table 1). The results of the n-gain test showed that students who achieved high, medium

and low analytical skills were 72%, 24% and 4%, respectively. From these results, the androwebic effectively improves students' analytical skills, especially in learning material about the circulation system. From these results, it can be stated that androwebic media has an important role to teach students' analytical skills.

This happens because androwebic media has various menus/component which play an important role in teaching these abilities; this media also plays an important role in teaching scientific attitudes, as presented in Table 2.

Table 2. Androwebic Component that Support Analytical Thinking Skills (A) and Scientific Attitude (B)

No	Indicators of Analytical Thinking Skills	Media Components
A Analytical Thinking Skills		
1	Differentiating	Task to differentiate in group discussion questions
2	Organizing	Task for grouping on group discussion questions
3	Connecting	The task concludes with group discussion questions
B Scientific Attitude		
1	Curiosity	Task to observe on the webcomic
2	Respect for data/facts	Group discussion task in the media investigation section
3	Flexibility in thinking	Group discussion task in the media investigation section
4	Open minded and cooperate	Group discussion task in the media investigation section
5	Perseverance	The task of presenting the observations to be presented

From Table 2, information is obtained that androwebic media has 3 components to teach analytical thinking skills (points A1-A3) and 5 components to instill scientific attitudes (points B1-B5). These eight components facilitate students to be skilled in analytical thinking and have a scientific attitudes. Information about students' scientific attitudes in learning using Androwebic

media was obtained from observing students' scientific attitudes using observation sheets. Androwebic was created specifically so that it has several good facilities to practice six aspects of scientific attitude (see Table 3). Students' scientific attitude was observed using student activities during the learning process using androwebic media, presented in Table 3.

Table 3. Students' Scientific Attitudes During the Learning Process Using Androwebic Media

Indicator	Σ Score	Max Score	Score (%)	Criteria*)
Pay attention to every new thing	1086	1260	86.19	Very good
Appreciate and conclude according to facts	1056	1260	83.81	Very good
Not always feel right, change opinion after considering the evidence	1035	1260	82.14	Very good
Ask questions and give opinions	1124	1260	89.21	Very good
Participate in groups	1107	1260	87.86	Very good
Record complete observations	1068	1260	84.76	Very good

*) Sugiyo (2015): very good: 81-100; good: 61-80; 41-60: enough/currently

In Table 3, it can be seen that the average of students' scientific attitude is in the very good category. This very good category is determined based on the criteria from Sugiyono (2015).

Android-based e-bokartumban media contains information about the diversity of plants in Banjarnegara. The information in question includes the scientific classification of each type of plant and a description of its morphology, a dissertation with attractive colored pictures. The e-bokartumban is useful for presenting the natural environment to the classroom with its characteristics. The e-bokartumban as a smart phone application makes it very easy for students to use

it. The results of the n-gain test showed that after learning to use e-bokartumban, students experienced an increase in critical thinking skills. The increase in students' critical thinking skills (n-gain) was 0.69 in the medium category (tend to be high). Students who achieve high, medium and low critical thinking skills are 53%, 45% and 2%, respectively. From these results, it can be stated that e-bokartumban has an important role to improve critical thinking skills. This role is supported by the characteristics of the e-bokartumban, which has a useful supporting component to facilitate the emergence of critical thinking skills (see Table 4).

Table 4. Indicators of Students' Critical Thinking Skills and E-bokartumban Components that Play a Role in Facilitating These Skills

No.	Indicators of Critical Thinking Skills	Media Components
1	Give a simple explanation	Evaluation questions, students discussion sheets
2	Build basic skills	Evaluation questions, students discussion sheets
3	Conclude	Evaluation questions, students discussion sheets
4	Identify terms and consider a definition	Evaluation questions, students discussion sheets
5	Set strategy and tactics	Evaluation questions, students discussion sheets

The data in Table 4 informs that students using e-bokartumban media practice to make simple statements, build basic skills, conclude, and so on, through various components of e-bokartumban media, namely in the evaluation/

assessment section and through several discussion activities provided. E-bokartumban also has various components that play an important role in growing various indicators of environmental care attitudes (see Table 5).

Table 5. Competency Indicators of Environmental Care Attitudes in Students and Components of the E-bokartumban Media that Facilitate the Emergence of These Attitude Indicators

No	Aspects and Indicators of Environmental Care Attitude	Media Components *)
1	Have thought that plants and animals have rights were equal to humans	Introduction to the materials
2	Have feelings/emotions about human actions that cause disaster	Introduction to the materials
3	Have thought that the environment is very fragile and easily disturbed balance	Student discussion sheets, materials
4	Have feelings and tendencies of behavior that the tendency of human beings there is a limit in controlling nature	Student discussion sheets, materials
5	Tend to take advantage of the source power of nature that has been used	Student discussion sheets, materials
6	Tend not to be arbitrary towards the environment	Student discussion sheets, materials
7	Have thoughts and attracted to environmental issues	Student discussion sheets, materials
8	Have emotional feelings about actions that can cause environmental damage	Student discussion sheets, materials

*) : The examples of the components of the e-bokartumban media are presented in Figures 2 and 3

In Table 5, column 3, various sections of the media are presented that are useful for strengthening various indicators of environmental care attitudes (column 2 of Table 5). The various components of the e-bokartumban media are very useful to familiarize students with various attitudes that lead to the formation of environmental care attitudes in students. The compo-

nents of the e-bokartumban media in question are the material components and student worksheets. Students' responses to learning using androwebic were obtained from questionnaires given at the end of the lesson. Information about students' positive responses to androwebic media is presented in Table 6.

Table 6. Student's Positive Response to Androwebic Media

Indicators of Androwebic Media	Score	Max. Score	Percentage (%)	Criteria*)
Affective consideration	755	840	89.88	Very good
Learning	1116	1260	88.57	Very good
Multimedia display	2308	2520	91.59	Very good
Navigation	1487	1680	88.51	Very good
Robustness	1507	1680	89.40	Very good
Average			89.59	Very good

*) Sugiyo (2015): very good: 81-100; good: 61-80; 41-60: enough/currently

Table 6 shows that students give positive responses to androwebic media with very good category. Positive responses to androwebic media were also obtained from teachers, through ques-

tionnaires. The positive responses of teachers to androwebic media with a very good category are presented in Table 7.

Table 7. Teachers' Positive Response to Androwebic Media

Indicators of Androwebic Media	Score	Max. Score	Percentage (%)	Criteria*)
Affective consideration	22	24	91.67	Very good
Learning	30	36	83.33	Very good
Multimedia display	64	72	88.89	Very good
Navigation	41	48	85.42	Very good
Robustness	42	48	87.50	Very good
Average			87.36	Very good

*) Sugiyo (2015): very good: 81-100; good: 61-80; 41-60: enough/currently

From the results in Tables 6 and 7 it can be stated that androwebic media received a very good response from students and teachers. This means that androwebic media a) attracts and motivates students/users (affective considerate), b) the material is appropriate to students and can make students interact with the media (learning), c) the media display (multimedia display) is good, d) navigation good media, and 5) this media is sturdy (resistant) to use, easy to access and the menu is easy to choose (robustness).

The problems in the discussion menu are related to daily events. For example, the work of the heart, normal and non-normal blood conditions and blood type. Those are all everyday things that students often experience. The availability of various menus on androwebic stimulates students' curiosity and encourages students to practice problem-solving (see Figure 1 and Table 2). Both activities require analytical thinking

skills so that students' skills are well trained. This statement is under the research of Prawita et al. (2019) and Sari et al. (2019), which states that the use of learning media that presents problems can improve students' learning outcomes and analytical thinking skills.

Comics help students learn by simplifying science concepts and making them easier to remember (Ozdemir, 2017). Comics also contribute to arousing students' enjoyment of science and the perception of success in science. Demirci & Zyürek (2017) state that the cartoon concept can effectively develop critical thinking skills. Colorful cartoons attract attention and encourage students' active participation in learning activities (think more actively). Indirectly, it plays an important role in helping to develop critical thinking skills. An active learning process is also very useful for improving students' critical thinking skills (Styers et al., 2018)

During the discussion stage in biology learning using Androwebic, students are trained to discuss and exchange ideas about problem solutions systematically and logically (Figure 1). Thus, students become trained to think analytically. Sari et al. (2019) proved that learning by actively involving students to solve problems improved analytical thinking skills and learning outcomes. Analytical thinking skills is one component of critical thinking skills (Facione 2015).

The teacher said that the androwebic media based on problem-based learning was very good, easy to use, up to date. The material presented was equipped with attractive visuals, ready to use anytime and anywhere with Android devices. Sung et al. (2016) stated that using android devices (smartphones) in learning was better and more effective than conventional learning.

In this study, comics are used to teach material about the circulation system, which is very complex and cannot be observed directly. The choice of comics to be used in Androwebic turned out to be very appropriate because it got an outstanding response from students and teachers (see Tables 6 and 7). This statement is in accordance with the statement of Morel et al. (2019), that comics are an excellent tool to help educators teach complex subjects and explain the occult world. Based on the above description, it can be stated that Androwebic media has an important role to train critical thinking skills.

In Table 3 it is presented that the average scientific attitude of students is in the very good category. It happened because, since the beginning of the learning using Androwebic, students are always motivated to learn and seek information independently. During the learning process assisted by androwebic media, students show a more caring attitude, respect, and conclude according to facts. During the learning process, students are also accustomed not to always feel right, dare to ask questions, dare to express opinions, be active in groups, and record complete observations. Students must solve discussion questions that contain contextual problems in the learning process. Every activity carried out during the discussion process positively contributed to scientific attitudes. This is what can encourage students to think analytically in solving problems. This is under the statement of Dwianto et al. (2017) that the application of learning media that presents contextual problems through discussion can positively contribute to students' formation of scientific attitudes.

Table 4 shows that the e-bokartumban media has components that facilitate each indicator

of critical thinking competence in this study. There are five stages of critical thinking with each indicator: 1) providing simple explanations, 2) building basic skills, 3) concluding, 4) identifying terms, 5) considering a definition, setting strategies and tactics (Kartimi & Liliyasi, 2012). These thinking indicators can be measured when students work on discussion sheets and evaluation questions on the media. Wiguna et al. (2019) and Damopolil & Kurniadi (2019) explained that students' learning outcomes increase after using android-based media. Based on the description above, it can be emphasized that the e-bokartumban has an important role in teaching or practicing critical thinking skills. Arista & Kuswanto (2018) stated that smartphones' media increases enthusiasm, interest, and motivation in learning activities. All of these things can increase students' independence and understanding of concepts.

From Table 5, indicators of environmental care attitudes use a scale adapted from NEPS. Indicators of the environmental care attitude are as follow: 1) Having the idea that plants and animals have the same rights as humans, 2) having feelings/emotions about human actions that cause disasters, 3) having the thought that the environment is very vulnerable and its balance is easily disturbed, 4) having feelings and behavioral tendencies that human tendencies have limits in controlling nature, 5) having behavioral tendencies to take advantage of used natural resources, 6) has a behavioral tendency not to be arbitrary towards the environment, 7) has thoughts and is interested in environmental issues, and 8) has emotional feelings towards actions that can cause environmental damage. All indicators of environmental care attitudes can be measured as long as students use the media when reading the material and during group discussions during the learning process.

Learning Biology (on plant diversity material) with e-bokartumban media makes a positive contribution to increasing students' environmental care attitudes. Environmental care attitudes are attitudes and actions that always try to prevent damage to the surrounding natural environment and develop efforts to repair natural damage (Yaumi, 2014). Environmental care attitudes can be shown by attitudes and actions that always try to prevent environmental damage and repair the natural damage (Mardikaningtyas et al., 2016).

Based on the description in the paragraph above, it can be stated that the use of android-based learning media is very effective in increasing student understanding. This statement follows the opinion of Sudarsana et al. (2019), which

states that the use of technology-based learning media can improve student learning outcomes. Junaedi et al. (2018) and Damopolil & Kurniadi (2019) found that applying android-based media can improve student learning outcomes. Learning that uses technology can increase student interest and learning outcomes (Sudarsana et al., 2019).

Positive response of students to the androwebic media used in biology learning were obtained from questionnaires given at the end of the lesson. Information about students' positive responses to Androwebic media is presented in Table 6. Table 6 shows the average score for each indicator that shows very good criteria. In some indicators, the student response rate shows the maximum score. Students are interested and motivated to learn with comics on the media. Besides being interested and motivated by comics, students also acknowledged that the material equipped with pictures on Androwebic media was beneficial and made it easier for students to learn because it had been summarized in a structured way. The problems in the Androwebic media also increase students' activeness in problem-based learning activities. In the learning process, students not only listen but also try, discover, and conclude. Therefore, students' understanding, analytical thinking ability, and scientific attitude will be higher.

In terms of appearance, Androwebic media received high points in very good criteria, showing that students are very interested in the appearance of Androwebic media. Androwebic media with pictures on every material detail provides the proper visualization. It makes it easier for students to understand abstract blood circulation material. Androwebic media also help students understand and discover concepts about the circulatory system. Appropriate learning media and students' character in learning can help students find concepts contextually. The media in question must be engaging, contain extensive learning resources, contain information whose presentation is accompanied by visual images. The use of a problem-based learning approach that is complemented by the use of learning media has been proven to be able to foster student interest and motivation to be more active in learning to create fun learning, understanding the material of the circulatory system will increase (Lee et al., 2015; Maulana & Sulistyoningrum, 2018). From the data in Table 7, it is known that

the average score for each indicators is 87.36%, with a very good category. The teacher said that androwebic media is very good, easy to use, and up-to-date. The material in these media is equipped with attractive visuals. It can be used anytime and anywhere on android devices. It is confirmed by Sung et al. (2016), which states that android devices such as smartphones are better and more effective than conventional learning. Students are more enthusiastic because the learning process is student-centered, while the teacher only directs and guides. This statement is under the findings of Ali (2019), which proves that student-centered learning will improve students' skills to understand the material and problem-solving skills. In such circumstances, the teacher directs and guides as necessary.

The responses of students and teachers in this section were obtained from the questionnaire, described by ten indicators. The descriptive data analysis on responses to e-bokartumban media shows that students and teachers each gave a response of 89.13% and 90.09% (very good category). The teachers stated that the e-bokartumban helped students build the concept of biodiversity. The teachers also positively responded to student activities in learning because it made students very enthusiastic during discussion. The teacher said that the E-Bokartumban media is an attractive, contemporary, easy to use, easy to carry media, and the material presented is evident. Thus, it can be emphasized that the e-bokartumban media is a perfect medium to use in learning and has excellent potential to train critical thinking skills and environmental care attitudes, as previously stated.

The description clearly states that Androwebic media can train students' analytical thinking skills by 92.68% and scientific attitude by 85.66%. Students and teachers positively responded to the android-based media. E-bokartumban also trains critical thinking skills and environmental care attitudes. E-Bokartumban is also responded positively by students and teachers by 89.13% and 90.09%, respectively. Thus, it can be stated that the androwebic and e-bokartumban analyzed in this study responded well by students and teachers and played an essential role in teaching skills and attitudes. This media has a vital role in teaching students' analytical skills, critical thinking skills and scientific attitudes, and environmental care attitude in learning biology.

CONCLUSION

From the discussion above, the following conclusions can be drawn. E-Bokartumban media shows an essential role in teaching students critical thinking skills and environmental care attitudes. Androwebic media shows a vital role in teaching students' analytical skills and scientific attitudes. The level of critical thinking skills, analytical skills, scientific attitudes, and environmental care attitudes of students after learning to use android-based media increased to good and very good. E-Bokartumban can teach students critical thinking skills and environmental care attitudes because it contains various components that can facilitate activities that are indicators of critical thinking skills and environmental care attitudes. Androwebic can be used to teach analytical skills and scientific attitudes to students. It contains various components that can facilitate activities that are indicators because they contain various components that can facilitate activities that are indicators of analytical skills and scientific attitudes. The learning activities carried out by students while learning to use the two android-based media include various activities that match the indicators of critical thinking skills, analytical skills, scientific attitudes, and environmental care attitudes. Students and teachers showed an excellent response to Androwebic and e-Bokartumban in Biology learning. Two types of Android-based media (Androwebic and e-bokartumban) in Biology learning have proven to have a vital role in teaching students critical thinking skills, analytical skills, scientific attitudes, and environmental care attitudes.

ACKNOWLEDGEMENTS

The authors would like to thank Prof. Dr. Enni Suwarsi Rahayu, M.Si., and Prof. Dr. Retno Sri Iswari, S.U., as the material expert validator, Dr. Budi Naini Mindiyarto, M.App.Sc., and Mohammad Fikri, S.Sn (Pusdatin Kemendikbud) as media expert validators. The latter have provided beneficial suggestions for improving this research. The authors also would like to thank Dr. Sigit Saptono, M.Pd (Coordinator of S2 Science Education study program) and Dr. Saiful Ridlo, M. Si. This research was supported by the Lembaga Penelitian dan Pengabdian Masyarakat Universitas Negeri Semarang, which has funded this research (the contract number of the funding letter: SP DIPA-023.17.2.677507/2020, 27-12-2019, following the Letter of Assignment of Research Implementation of UNNES DIPA Funds Year 2020, Number 166.23.4/UN37/PPK.3.1/2020, 23-04-2020.

REFERENCES

- Ali, S. S. (2019). Problem based learning: a student-centered approach. *English Language Teaching*, 12(5), 73-78.
- Amini, R. (2015). Outdoor Based Environmental Education Learning and its Effect in Caring Attitude Toward Environment. *Journal Pendidikan IPA Indonesia*, 4(1), 43-47.
- Arista, F. S., & Kuswanto, H. (2018). Virtual physics laboratory application based on the android smartphone to improve learning independence and conceptual understanding. *International Journal of Instruction*, 11(1), 1-16.
- Chung E. Y. (2019). Facilitating learning of community-based rehabilitation through problem-based learning in higher education. *BMC medical education*, 19 (1), 433.
- Damopolil, I., & Kurniadi, B. (2019). The development of android-based mobile learning supported by problem-based learning strategy for students' learning success. *International Journal of Scientific and Technology research*, 8(7), 190-193.
- Demirci, F. & Özyürek, C. (2017). The Effects of Using Concept Cartoons in Astronomy Subjects on Critical Thinking Skills among Seventh Grade Student. *International Electronic Journal of Elementary Education*, 10(2), 243-254.
- Dwianto, A., Wilujeng, I., Prasetyo, Z. K., & Suryadarma, I. G. P. (2017). The development of science domain based learning tool which is integrated with local wisdom to improve science process skill and scientific attitude. *Jurnal Pendidikan IPA Indonesia*, 6(1), 23-31.
- Eshun, E., & Amoah, C. A. (2018). Assessing the reasoning skills of biology students in selected senior high schools in the central region of Ghana. *International Journal of Scientific Research and Management (IJSRM)*, 6(04).
- Facione, P. A. (2015). Critical thinking: What it is and why it counts. *Insight assessment*, 2007(1), 1-23.
- Hasanah, S. I., Mustofa, R. F., & Ardiansyah, R. (2020). Correlation between Generic Science Skills and Scientific Attitudes on Learning Outcomes. *BIOEDUSCIENCE*, 4(2), 124-128.
- Junaedi, J., Irviani, R., Muslihudin, M., Hidayat, S., Maselena, A., Gumanti, M., & Fauzi, A. N. (2018). Application program learning based on android for students experiences. *International Journal of Engineering and Technology (UAE)*, 7(2.27), 194-198.
- Kartimi, K., & Liliyasi, L. (2012). Pengembangan alat ukur berpikir kritis pada konsep termokimia untuk siswa SMA Peringkat atas dan menengah. *Jurnal Pendidikan IPA Indonesia*, 1(1), 122852.
- Khasanah, A. N., Widoretno, S., & Sajidan, S. (2017). Effectiveness of Critical Thinking Indicator-Based Module in Empowering Student's Learning Outcome in Respiratory System Study Material. *Jurnal Pendidikan IPA Indonesia*, 6(1), 120425.
- Lee, S., Kang, E., & Kim, H. B. (2015). Exploring impact of students' learning approach oncol-

- laborative group modeling of blood circulation. *Journal of Science Education and Technology*, 24(2), 234-255.
- Mardikaningtyas, D. A., Ibrohim, I., & Suarsini, E. (2016). Pengembangan Pembelajaran Pencerminan Lingkungan Berbasis Penelitian Fitoremediasi untuk Menunjang Keterampilan Ilmiah, Sikap Peduli Lingkungan dan Motivasi Mahasiswa pada Matakuliah Dasar-Dasar Ilmu Lingkungan. *Jurnal Pendidikan: Teori, Penelitian, dan Pengembangan*, 1(3), 499-506.
- Maulana, H., & Sulistyoningrum. (2018). Implementation Mirror Technique 3D Objects for Interactive Learning Media "Circulatory System" Virtual Reality-Based. *Journal of Physics: Conference Series*, 1364, 012036.
- Morel, M., Peruzzo, N., Juele, A. R., & Amarelle, V. (2019). Comics as an Educational Resource to Teach Microbiology in the Classroom. *Journal of microbiology & biology education*, 20(1), 1-4.
- Mutakinati, L., Anwari, I., & Yoshisuke, K. (2018). Analysis of students' critical thinking skill of middle school through STEM education project-based learning. *Jurnal Pendidikan IPA Indonesia*, 7(1), 54-65.
- Nhat, H. T., Lien, N. T., Tinh, N. T., Hang, N. V. T., & Trang, N. T. (2018). The Development of Critical Thinking for Students in Vietnamese Schools: From Policies to Practices. *American Journal of Educational Research*, 6(5), 431-435.
- Özdemir, E. (2017). Humor in Elementary Science: Development and Evaluation of Comic Strips about Sound. *International Electronic Journal of Elementary Education*, 9(4), 837-850.
- Prawita, W., Prayitno, B. A., & Sugiyarto. (2019). Effectiveness of generative learning-based biology module to improve the analytical thinking skills of the students with high and low reading motivation. *International Journal of Instruction*, 12(1), 1459-1476.
- Pujiasih, P., Isnaeni, W., & Ridlo, S. (2021). Android-based e-booklet development to train students' critical thinking and attitude of caring for environment. *Journal of Innovative Science Education*, 10(1), 95-101.
- Purnami, W., Sarwanto, S., Suranto, S., Suyanti, R., & Mocerino, M. (2021). Investigation of Science Technology Ecocultural Society (STeCS) Model to Enhance Eco Critical Thinking Skills. *Journal of Innovation in Educational and Cultural Research*, 2(2), 77-85.
- Puspita, I., Kaniawati, I., & Suwarma, R. (2017). Analysis of critical thinking skills on the topic static fluid. *Journal of Physics: Conference Series*, 895, 012100.
- Puspitasari, E. D. T., Surjono, H. D., & Minghat, A. D. (2018). Utilizing web-based learning as 21st century learning media for vocational education. *International Journal of Engineering & Technology*, 7(4-33), 157-160.
- Putri, M. A., & Prodjosantoso, A. K. (2020). Improving Critical Thinking Skills and Scientific Attitudes by Using Comic. *Psychology, Evaluation, and Technology in Educational Research*, 2(2), 69-80.
- Rohmadi, M., & Nasucha, Y. (2015). Dasar-dasar penelitian bahasa, sastra, dan pengajaran. *Sura-karta: Pustaka Brilliant*.
- Sari, R., Perdana, R., Riwayani, Jumadi, Wilujeng, I., & Kuswanto, H. (2019). The implementation of problem-based learning model with online simulation to enhance the student's analytical thinking skill in learning physics. *Journal of Physics: Conference Series*, 1233, 012030.
- Seventika, S. Y., Sukestiyarno, Y. L., & Mariani, S. (2018, March). Critical thinking analysis based on Facione (2015)-Angelo (1995) logical mathematics material of vocational high school (VHS). In *Journal of Physics: Conference Series* (Vol. 983, No. 1, p. 012067). IOP Publishing.
- Styers, M. L., Van Zandt, P. A., & Hayden, K. L. (2018). Active Learning in Flipped Life Science Courses Promotes Development of Critical Thinking Skills. *CBE life sciences education*, 17(3), ar39.
- Sudarsana, I. K., Nakayanti, A. R., Sapta, S., Haimah, Satria, E., Saddhono, K., GS, D. A., Putut, E., Helda, T., & Mursalin, M. (2019). Technology application in education and learning process. *Journal of Physics: Conference Series*, 1363, 012061.
- Sugiyono. (2015). *Metode penelitian pendidikan*. Bandung: Alfabeta.
- Sujatmiko, Y.A., Isnaeni, W., Ridlo, S., & Saptono, S. (2021). The development of andro-webcomic media based on problem-based learning to improve analytical thinking ability and scientific attitude. In *Journal of Physics: Conference Series* (Vol. 1918, No. 5, p. 052023). IOP Publishing.
- Sukenda, Anjani, M., & Yustim, B. (2019). Learning Media for Biology Subject Based on Multimedia in Junior High School Level. *Universal Journal of Educational Research*, 7(4A), 43-51.
- Sung, Y. T., Chang, K. E., & Liu, T. C. (2016). The Effects of Integrating mobile Devices with Teaching and Learning on Students' Learning Performance: A Meta-Analysis and Research Synthesis. *Computers & Education*, 94, 252-275.
- Surjanti, J., Seno, D. N., Hadi, H. K., Maroah, S., Siswanti, Y., Muafi., & Isfianadewi, D. (2018). The role of m-learning on effective learning media in higher education. *International Journal of Civil Engineering and Technology*, 9(4), 77-85.
- Thomas, T. (2011). Developing First Year Student's Critical Thinking Skills. *Asian Social Science*, 7(4), 26-35.
- Wiguna, D., Irwansyah, F. S., Windayani, N., Aulawi, H., & Ramdhani, M. A. (2019). Development of android-based chemistry learning media oriented towards generic science skills. *Journal of Physics: Conference Series*, 1157, 042047.
- Williamson, B., Eynon, R., & Potter, J. (2020). Pandemic Politics, Pedagogies and Practices: Digital Technologies and Distance Education during the Coronavirus Emergency. *Learning, Media and Technology*, 45(2), 107-114.