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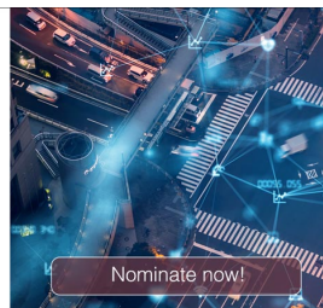


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The development of andro-webcomic media based on problem-based learning to improve analytical thinking ability and scientific attitude

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Abstract. The research aimed to describe the validity, practicality, and effectiveness of Andro-Webcomic media based on problem-based learning as a learning media to improve students' analytical thinking ability and scientific attitudes. The development design used was Research and Development (R&D) and used the ADDIE model, limited to the ADD (Analysis, Design, Development) stage. At the product development stage, small-scale trials are carried out, which this phrase was limited to 9 students of class XI MIPA at one of the high schools in Jepara. The instruments used were validation sheets, test sheets, observation sheets for students' scientific attitudes, student and teacher questionnaire responses. The results of this study indicate that: (1) the validity of the Andro-Webcomic media is 95.58%; (2) effective in improving analytical thinking of 88.89% with an n-gain score of 67% and a scientific attitude of 87.19%; (3) practicality based on student responses of 98.39% and teacher responses of 97.36%; (4) media component that supports improving competencies is on the webcomic and investigation menu. Based on the research results, it can be concluded that the Andro-Webcomic media is valid, practical, and effective in improving students' analytical thinking ability and scientific attitudes.

1. Introduction

Biology learning seeks to equip students with various abilities to make students understand the relationship between biological concepts and use scientific methods to solve their problems. In developing problem-solving skills, learning is needed that can train students to think analytically. The ability to think analytically is a basic ability that students must possess to analyze, assess, evaluate, compare, and differentiate abstract concepts. The indicators of analytical thinking include differentiating, organizing, and connecting [1]. Students who can think analytically will be more active in the learning process, independent in doing practicum, active discussion, and exchanging opinions in solving problems [2-3].

The learning causes the low level of students' thinking ability in the classroom [4]. That statement is supported by the results of observations at one of the high schools in Jepara, which stated that learning activities such as biology experiments, observation, and reading had not developed students' ability to analyze or describe a problem into a more superficial part. This indicates that students' analytical thinking and students' scientific attitudes are still low [5-6].



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Students' thinking ability in learning is primarily determined by the learning strategies used by the teacher. One of the strategies is a learning model. One learning model that presents real problems as a context for students to learn analytical thinking is problem-based learning [6, 7]. Problem-based learning is a practical approach to teach analytical thinking processes with problem-oriented situations, including learning how to learn [8]. Problem-based learning is also good enough to measure students' ability to solve problems [5].

Students' understanding of the circulatory system material will be better if implemented using a problem-based learning model so that students can analyze the available problems. There are limitations to the problem-based learning model. The context of the problem is presented in textbooks and other media that make the learning process uninteresting in school, so it requires learning media that is more attractive to students.

Based on the existing problems, it is necessary to have media that can visualize the context of problem-based learning in form of pictures, short discussions, and simple structures that focus on one goal. Andro-Webcomic is a form of media that can be used in the learning process and available for mobile phones with the Android operating system [9]. Learning using Andro-Webcomic media based on problem-based learning is expected to improve students' analytical thinking and scientific attitudes.

2. Methods

The type of research used to research and development (R&D) [10]. This study's development was carried out using the ADDIE development design developed by Dick & Carry, 1996 [11]. This model consists of five steps: analysis, design, development, implementation, and evaluation. However, this study was limited to the ADD stage. In the analysis stage, a needs analysis was carried out. The instruments in the analysis stage were the interview sheet and a questionnaire on students' and teachers' needs regarding learning media. At the design stage, activities were carried out to formulate learning objectives, select learning media, and design product concepts. It was done by collecting material, making products, making product measurement instruments, validating small-scale trials, and revisions at the development stage. Instruments at the development stage were validation sheets for media experts and lecturers of material experts, pretest and post-test questions on analytical thinking, observation sheets for scientific attitudes, and student and teacher response questionnaires.

At the development stage of the small-scale trial phase, this study used Andro-Webcomic media, which was conducted at one of the high schools in Jepara in the school year 2020/2021, using one group pretest-posttest design [10]. This research's data analysis was the analysis of Andro-Webcomic characteristics, validity, effectiveness, and practicality tests. The product effectiveness was carried out in a small-scale trial phase involving nine students of class XI MIPA. For product, practicality testing involved nine students of class XI MIPA and teachers of biology subjects.

Analysis of the Andro-Webcomic media's validity results based on problem-based learning obtained from the calculation of the percentage of expert validation results. Analysis of teaching practicality with Andro-Webcomic media based on problem-based learning media obtained from the average student and teacher response results. The analysis of the Andro-Webcomic media's effectiveness based on problem-based learning obtained from the average of observations of students' scientific attitude results, the calculation of the gain score from the pretest and post-test values carried out at the beginning and the end of learning.

3. Results and discussion

In the analysis stage, the results of interviews with teachers and questionnaires on students' needs for learning media. The interviews with three biology teachers of class XI senior high school showed that students' ability to understand biology learning was not evenly distributed. In addition, the teacher admits that the media used by the teacher is still underdeveloped.

The results of a questionnaire distributed as many as 102 students in high schools in Jepara in class XI MIPA showed that 84.3% of students used smartphones during the learning process, and 82.4% of students spent more time playing with smartphones than studying. Out of 102 respondents, only five

respondents stated that they did not own a smartphone. 32.9% of students admitted to using smartphones since elementary school, 41.8% admitted to using them since junior high school, and 25.3% since high school. In addition, 84.3% of students also use smartphones for communication, 77.5% looking for information, 52% listening to music, 43.1% playing games, and 37.3% viewing videos. This shows that the consumption of smartphone use by students is relatively high. As many as 92.9% of students are interested in using webcomics used in the learning process. As many as 76.5% of students are motivated when the learning process uses smartphones.

This development produced an Andro-Webcomic media based on problem-based learning on the circulatory system material, which had been uploaded to the Google Play store and given to students for the learning process in the classroom. The Andro-Webcomic media based on problem-based learning application consists of several features, including application icons, splash screen, cover page, display menus on the homepage, sub-menus (introduction to circulatory system material, KI, KD & indicators, learning activities, references), and learning activity sub-menu which contains problem-based learning steps equipped with webcomics and discussion questions.

Before the Andro-Webcomic media based on problem-based learning that had been designed was tested on the development stage, the product would be validated first by a material expert lecturer. This validation aimed to obtain the feasibility of Andro-Webcomic media based on problem-based learning on circulatory system material. There were three indicators of validity which include subject matters, affective considerations, and learning. The results of the validation are shown in the following Table 1 below.

Table 1. Result of material validation in andro-webcomic media based on problem-based learning.

No	Indicators	Score Obtained	Max. Score	Percentage (%)	Criteria
1	Subject matters	47	48	97.92	Very good
2	Affective considerations	8	8	100	Very good
3	Learning	20	20	100	Very good
Average				98.68	Very good

Table 1 shows that the developed media obtained a score with a percentage of 98.68% and obtained a very good category so that the media is considered worthy of being tested, but before it was tested, the Andro-Webcomic media based on problem-based learning developed had to be validated by a media expert.

Media expert validation was carried out by media expert experts from the Ministry of Education and Culture's Pusdatin. According to Alessi & Trollip, there are four media assessment indicators based on the media assessment criteria, including Auxiliary information, multimedia display, navigation, and robustness. The results of the media validation are shown in the following Table 2 below.

Table 2. Validation results of andro-webcomic media based on problem-based learning.

No	Indicators	Score Obtained	Max. Score	Percentage (%)	Criteria
1	Auxiliary information	11	12	91.66	Very good
2	Multimedia Display	22	24	91.66	Very good
3	Navigation	16	16	100	Very good
4	Robustness	16	16	100	Very good
Average				95.58	Very good

The data shows that Andro-Webcomic media based on problem-based learning on circulatory system material developed has a score of 95.58% in the very good category. From these data, the media is declared worthy of being tested.

After the product had been developed in the form of Andro-Webcomic media based on problem-based learning and validated by experts, then the media was applied in learning or called a small-scale

test to test the media's effectiveness that had been developed using one group pretest-posttest design [10]. The trials in this study were conducted on a small scale involving nine students. The effectiveness of Andro-Webcomic media was measured based on the student's cognitive learning outcomes obtained from the students' pretest and post-test scores presented in Table 3 below.

Table 3. Student pretest and post-test values by applying andro-webcomic media based on problem-based learning on circulatory system material.

Information	Pretest score (n=9)	Post-test score (n=9)
Maximum score	46.67	90.00
Minimum score	13.33	73.33
Average	26.30	80.37
Number of students completed	0	8
Number of students not completed	9	1
Classical completeness %	0	88.89

From Table 3, it can be seen that there is a significant difference between pretest and post-test, in which the pretest results show an average value of 26.30 where the average value is still below the KKM, which has not reached a value of 75. While in the post-test, the average value is 80.37, where the value has exceeded the KKM, which has exceeded the value of 75.

The n-gain test was carried out to determine the increase in student learning outcomes before and after being treated by applying the Andro-Webcomic media shown in Figure 1 below.

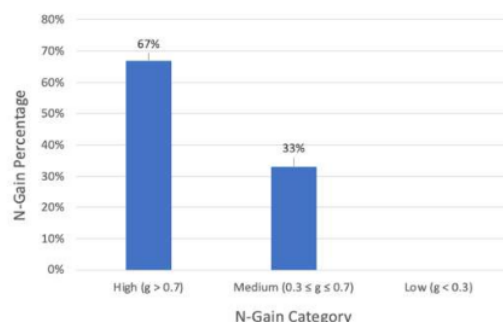


Figure 1. The results of the N-Gain test

From Figure 1, it can be seen that 67% of students obtained the high n-gain category while 33% of students obtained medium n-gain category. These data indicate that learning using Andro-Webcomic media on circulatory system material effectively improves students' analytical thinking. This is following the research results [12], which stated that learning using technology could increase student interest and learning outcomes. This is also supported from research [13] that learning using Android-based media could improve student learning outcomes.

In the Andro-Webcomic media, there are also discussion questions that contain problems in everyday life that can spur students' curiosity so that students have more memory and easier to understand the material that was previously considered difficult to understand. This is followed by research [13-14] that learning that presented contextual problems effectively improved student understanding and learning outcomes. Besides that, according to research [15] which stated when students could reflect on contextual learning in learning tools with everyday life, students' cognitive, affective, and psychomotor learning outcomes would increase.

In the learning process, students were also actively involved in discussions. Thus, students become trained to think analytically. This is following the research statement [16] that learning by involving students actively to solve problems could improve analytical thinking and student learning outcomes.

Students' scientific attitudes can be obtained from observations using student scientific attitude observation sheets. There were five aspects of students' scientific attitudes observed, which are presented in Table 4 below.

Table 4. Results of the assessment of students' scientific attitudes

No.	Indicators	Σ Score	Max score	Value (%)	Criteria
1	Curiosity	93	108	86.11	Very good
2	Respect for data/facts	89	108	82.41	Very good
3	Flexibility in thinking	93	108	86.11	Very good
4	Open-minded and cooperate	195	216	90.74	Very good
5	Perseverance	95	108	87.96	Very good
Average				87.19	Very good

Table 4 shows the average effective learning outcomes of students' scientific attitudes are in the very good category. This is because students from the beginning of learning have learned and looked for information independently to affect students' scientific attitude.

In the learning process, students had to solve discussion questions that contain contextual problems, where during the discussion process, they could contribute to the formation of scientific attitudes. This can encourage students to think analytically in solving problems, following the statement of research [17] that applying learning media that presented contextual problems through discussion could make a positive contribution to the formation of students' scientific attitudes.

The practicality of Andro-Webcomic media is obtained from student responses as users are given at the end of the lesson, as shown in Table 5.

Table 5. Results of student responses to andro-webcomic media based on problem-based learning on circulatory system material.

No	Indicators	Score Obtained	Max. Score	Percentage (%)	Criteria
1	Affective consideration	71	72	98.61	Very good
2	Learning	105	108	97.22	Very good
3	Multimedia display	215	216	99.53	Very good
4	Navigation	141	144	97.92	Very good
5	Robustness	141	144	97.92	Very good
Average				98.39	Very good

Table 5 shows the average percentage of 98.39%, which falls into the very good criteria. The media display indicator gets the highest points. It shows that students were very interested in the appearance of Andro-Webcomic media. Media based on problem-based learning can make students discover concepts contextually. Learning media can increase student interest and motivation to be more active in learning to improve learning outcomes [17-19]. The practicality of Andro-Webcomic media is also obtained from the teacher's responses which can be seen in Table 6.

The whole Table 6 gets an average of each aspect of 97.36%, which is included in the very good category. The teacher also 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 [20], which stated that Android devices such as smartphones in learning were better and more effective than conventional learning.

Table 6. Results of teacher responses to **andro-webcomic media based on problem-based learning** on circulatory system material.

No	Indicators	Score Obtained	Max. Score	Percentage (%)	Criteria
1	Affective consideration	8	8	100	Very good
2	Learning	11	12	91.66	Very good
3	Multimedia display	23	24	95.83	Very good
4	Navigation	16	16	100	Very good
5	Robustness	16	16	100	Very good
Average				97.36	Very good

4. Conclusion

The **Andro-Webcomic media based on problem-based learning** developed is very feasible in the learning process on circulatory system material with a validity percentage of 95.58%. The application of **Andro-Webcomic based on problem-based learning** is effective and practical for use in circulatory system material. The effectiveness aspect got a score of an increase in analytical thinking of 88.89%, with an n-gain score of 67% and a scientific attitude of 87.19%. The practical aspects are based on student responses of 98.39% and teacher responses of 97.36%.

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