IJOEM

Indonesian Journal of Elearning and Multimedia
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Development of Android-Based Interactive Learning Media with SAC Integrated PBL Model on Temperature and Heat Materials

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Article Information:
Received October 16, 2024
Revised January 23, 2025
Accepted January 27, 2025

Keywords:
Development; Learning Media; Smart Apps Creator; Problem Based Learning; Critical Thinking Skills

Abstract

This study aims to develop interactive learning media based on android integrated with PBL model to improve students' critical thinking skills. Interactive learning media based on android developed with SAC based on PBL model is one type of interactive multimedia teaching material containing images, texts, and videos that are systematically arranged according to PBL model syntax which is useful for improving students' critical thinking skills. The purpose of this study was to evaluate the feasibility and benefits of using interactive learning media products based on android as a tool to help students of class XI SMA N 2 Lhokseumawe in studying temperature and heat material. The ADDIE paradigm is used in this development research to refer to the research and development (R&D) approach. The subjects of the study were physics teachers and students of SMA N 2 Lhokseumawe. The results of the study are as follows: 1) Media validation obtained a percentage of 82.5% with the category "Very Feasible", then validation by material experts obtained a percentage of 81.67% with the category "Very Feasible". 2) As many as 87.54% of students' answers (small scale) fell into the category "Very Practical". 3) The teacher's answer obtained a percentage of 98.32% in the "Very Practical" category, while the large-scale student answers obtained a percentage of 86.7% in the same category. This proves that the media developed by the researcher is declared feasible and practical to be used as teaching materials in the learning process.

A. Introduction

Physics is a science that teaches students related to natural events, which helps them understand what they are learning and overcome environmental problems (Khoir et al., 2020). Of course, effective, efficient, interactive, and high-quality teaching materials have transformed through the evolution of learning made possible by information technology (Muhibullah & Zamhari, 2022). The widespread use of android technology is used by all ages, from adults to young people who go to school, namely the impact of technological advances. Current educational methods allow children to learn independently thanks to advances in science and technology. In addition to relying on technology, 21st century industries have also experienced rapid progress in the field of science, including physics (Anwar et al., 2023).

Physics is a science that teaches students related to natural events, which helps them understand what they are learning and overcome environmental problems (Marzuki & Desnita, 2023). Nonetheless, physics is considered a challenging subject in school. As Octafianus et al. (2022) says that even if students do not feel Motivated to learn more, physics remains one of the subjects they find difficult and boring. In addition, the concepts learned in physics classes have real-world applications and include environmental phenomena.

How to Cite : Miranda, A., Nanda, N. N., Tulus, T. S., Syafrizal, S., & Widya, W. (2025). Development of Android-Based Interactive Learning Media with SAC Integrated PBL Model on Temperature and Heat Materials. *IJOEM Indonesian Journal of E-Learning and Multimedia*, *4*(1), 43–51. https://doi.org/10.58723/ijoem.v4i1.323
ISSN : 2830-2885
Published by : Asosiasi Profesi Multimedia Indonesia

These ideas encourage students to use critical thinking skills to come up with accurate, precise, and tangible solutions. In the 21st century, the ability needed is critical thinking (Putri et al., 2024). As Mahdarani et al. (2023) has been pointed out, critical thinking, creativity, communication, and problem-solving skills are traits that need to be acquired and honed by students in the 21st century.

Higher thinking skills such as critical thinking have been linked to developments in society, science, morality, mental health, and cognitive capacity (Hardianto et al., 2023). To solve a problem in a way that is consistent with reality, students must be able to think critically. Critical thinking is the ability to present arguments in a clear and unbiased way. Thus, from elementary school to high school, children need to be trained and prepared with critical thinking skills (Dewi et al., 2023).

In the observation and interview with the physics teacher at SMA N 2 Lhokseumawe, information related to the low critical thinking ability of students was found. The findings of interviews with physics teachers at SMA N 2 Lhokseumawe, which indicates that many students still have difficulty in analyzing and presenting arguments on a given topic, became the basis for the statement that students lack critical thinking skills. As according to Berjamai & Novianti Davidi (2020) a number of factors indicate low and lack of critical thinking skills among students, including poor classroom management, easy use of teaching methodologies, and lack of survey-based learning opportunities. The researcher found from the results of the interviews that the applicable learning process is still mostly instructor-centered and that students have never been taught tactics or learning materials that can improve their critical thinking skills. This is due to the fact that most teaching methods still use lecture and question and answer sessions, which hinders the direct participation of students and makes physics teaching passively (Nazira et al., 2024). As stated by Zohrani et al. (2018), students who get education through lectures cannot become curious and interested in the subject matter being discussed.

One of the efforts is to develop creative learning materials, efforts can be made to stimulate students' interest and encourage the development of their critical thinking skills in physics classes. Teachers can use learning media as a powerful and efficient tool to channel messages from sender to recipient or from teacher to student to attract students' ideas, emotions, concerns, and interests into the learning process (Ni'mah & Zutiasari, 2023). It goes without saying that having a role model that supports and encourages students' critical thinking skills is essential in the use of media in the classroom. In addition, choosing the right learning model is very important in developing students' critical thinking skills.

PBL is a useful teaching strategy that can help students develop their critical thinking skills. According to Efrain et al. (2021), one of the learning models that can support students' critical thinking skills is the PBL model, which provides students with the opportunity to see signs of a problem and teach them how to think critically. Because the steps in this learning model encourage students to be actively involved in the process of presenting problems, developing ideas, and using critical thinking skills to find correct and real answers based on their understanding of the natural phenomena of the presentation of the problem, so that they can develop critical thinking skills student. In addition, how media is used in education is also influenced by technological advances. Learning media is closely related to technological advances as a tool to support the learning process and achieve learning goals, according to Khoir et al. (2020).

To find out how to create android-based interactive learning materials with SAC based on a realistic and useful PBL model, researchers are interested in conducting research by producing this kind of material. SMA N 2 Lhokseumawe has never used this learning resource. The researcher's observations revealed that SMA N 2 Lhokseumawe has adequate facilities, and students are allowed to bring smartphones to help the learning process and facilitate the further implementation of this research. It is hoped that this research will support the improvement of future learning developed by teachers. Based on the description above, academics are interested in researching "Development of Android-Based Interactive Learning Media with SAC Based on PBL Model on Temperature and Heat Materials" as a means to overcome these problems.

B. Research Methods

Research and development (R&D) with the ADDIE model is the method used. The ADDIE development model includes 5 stages: (1) Analysis, (2) Design, (3) Development, (4) Implementation, and (5) Evaluation. Android-based interactive learning media with SAC based on PBL model on temperature and heat material, namely the final product of the research. Development techniques are outlined in the following scheme.

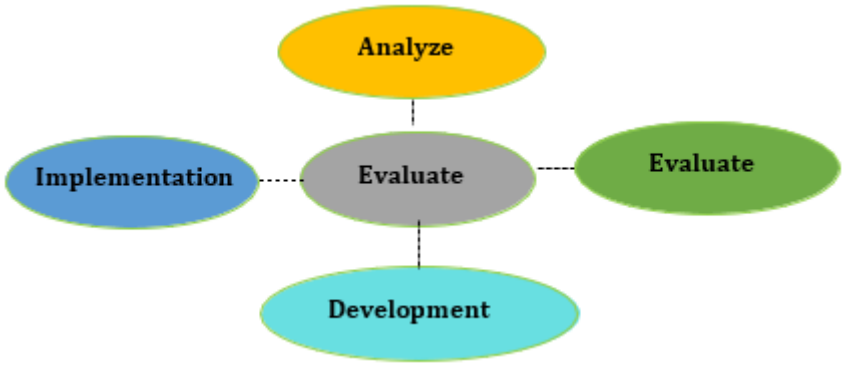


Figure 1. ADDIE Development Procedure

With PBL and SAC learning approaches, interactive learning materials for Android are developed. The population is all grade XI students who are registered at SMA N 2 Lhokseumawe. The population is all participants who are being studied (Sugiyono, 2019). As part of a large-scale trial, a sample of 25 students from grade XI 1 participated in the study. Purposive sampling, or the use of a sampling strategy that considers certain criteria when conducting research, is the one used for sampling (Sugiyono, 2019). A sample of students who are randomly selected through a lottery. This initial sample only used test subjects or limited trials with a total of 5 students. The research period was carried out for two weeks, from August 2 to 16, 2024. The research location is at SMA N 2 Lhokseumawe.

A questionnaire is a tool used to collect data, by asking respondents to research a written statement or a series of questions about the problem being discussed. In this study, a direct questionnaire with the Likert scale with the definition of the scale first introduced by Rensis Likert was used to express opinions with various answer options such as agreeing to disagreeing with the statement (Thoburn, 2022). The questionnaire used was given to material and media experts, teacher practitioners and students.

Descriptive statistics are used to analyze quantitative and qualitative data. Both quantitative and qualitative data are collected, and descriptive statistics are used for analysis. The usability of the product and the results of the feasibility test are evaluated using quantitative data. Meanwhile, qualitative data to check suggestions or inputs from product feasibility testers and practicality, which is the basis for revising and improving the resulting product. The response index is calculated using a rating scale as shown in table 1:

Table 1. Assessment Score (Sugiyono, 2019)

Score	Category
5	Very Practical/very feasible
4	Practical/feasible
3	Quite Practical/Quite Decent
2	Less Practical/Less Feasible
1	Impractical/unworthy

Calculate the percentage with the following formula:

$$\text{Validation Percentage} = \frac{Total\ score\ of\ data\ collection\ results}{total\ critiary\ score} x100\%$$

Meanwhile, for the assessment of feasibility and practicality criteria that state that the developed product is feasible and practical to use, it can be seen in the table that uses the Likert scale as a guide for the assessed category. As presented in Table 2.

Table 2. Rating Scale Assessment Category (Sugiyono, 2019)

Percentage Score (%)	Category
0 – 20%	Impractical/unworthy
21– 40%	Less Practical/Less Feasible
41 – 60%	Quite Practical/Quite Decent
61 – 80%	Practical/feasible
81 – 100%	Very Practical/very feasible

C. Results and Discussion

The findings are an interactive learning tool for Android that is produced using SAC and is based on the PBL approach. One physics teacher at SMA N 2 Lhokseumawe tested the practicality of this media after being validated by two validators. The following are the stages of media development:

1. Analyze

The analysis stage is the first step in the study and development of the ADDIE model. The analysis part of this study was carried out to obtain information as a reference for the development of android-based interactive learning media generated with SAC using the PBL model. This step involves problem analysis, student needs analysis, and material analysis. The investigation in this study began with observations and interviews with teachers as well as a number of students at SMA N 2 Lhokseumawe, and found that the problem was the students' lack of critical thinking skills and their interest in challenging physics materials. Because they have never used learning strategies or media that actively involve students in the learning process, students' critical thinking skills in evaluating arguments are still lacking. Involve students in the learning process in a way that makes it seem foreign to them. It is known that SMA N 2 Lhokseumawe has never applied the PBL learning paradigm into the classroom and has only ever used printed books as a learning medium. But it only makes use of the direct teaching model and written text. Students who learn through the lecture method cannot develop interest and curiosity towards the subject matter being taught, claims (Zohrani et al., 2018). Learning objectives (TPK) and learning outcomes (CP) in the autonomous curriculum for grade XI of high school are followed in the analysis of this development.

The author will develop Android-based interactive learning media using PBL-based SAC with the aim of improving students' critical thinking skills. This will be based on an analysis of problems, needs, and materials. Students can participate in their education and not just concentrate on their teachers when interactive media is used in the teaching and learning process (Hidayatullah, 2024).

2. Design

Using the PBL model syntax, a comprehensive media design (storyboard) is created during the design stage. To attract students' interest in the media that will be used in the classroom or for independent learning anytime and anywhere, especially in physics lectures, product design is made as attractive as possible:

1) Collection of Background, Fonts, Images, and Animations that will be included in the smart apps creator desktop application
2) Compiling media with reference to the independent curriculum which consists of containing the profile of Pancasila and learning objectives from, and instructions for the use of android-based media and learning stages.
3) Preparing learning materials according to the stages of the PBL learning model
4) Finding and compiling problems as problem orientation from PBL syntax
5) Include pre-designed evaluation questions
6) Adjusting the font shape and image layout in the media
7) Export Files into android-based learning media with SAC based on PBL model
8) Specify the name of the apk i.e. "MARBERKIS" (let's think critically)
9) Specify the apk icon and export the file in the form of apk
10) Sending apk to android and media can be installed on each student's android

3. Development

The development stage is the moment when the previously planned concepts and designs are transformed into real learning products and are ready to be implemented through multiple tests by validators. Here are the validation halil from the experts:

1) Media expert validation

The validation was carried out by media experts, namely physics education lecturers at Malikussaleh University. Through the validation of media experts, validators can assess the feasibility of the design aspect, the color aspect, the language aspect, and the feasibility of the learning model aspect. The following are the results and percentages of media validation results, namely:

Table 3. Media Expert Validation Results

No.	Aspects of Validator Assessment	Average	Percentage %	Criterion
1.	Desaign	4	80%	Highly Worthy
2.	Language	4	80%	Highly Worthy
3.	Color	4,5	90%	Highly Worthy
4.	Learning Model	4	80%	Highly Worthy
	Average Amount	**4,1**	**82,5%**	**Highly Worthy**

From the results of the validation, learning media is very feasible to be used from several aspects, namely: design, language, color, and learning model. Each aspect received a very high percentage with the category "Very Worthy".

2) Validation of Material Experts

The validation was carried out by material experts, namely physics education lecturers at Malikussaleh University. As for the results of the material expert validators above, the following are the results and percentages of material validation results, namely:

Table 4. Material Expert Validation Results

No.	Aspects of Validator Assessment	Average	Percentage %	Criterion
1.	Curriculum	4	80%	Highly Worthy
2.	Content of the material	4	80%	Highly Worthy
3.	Interaction	4,3	86,66%	Highly Worthy
4.	Evaluation	4	80%	Highly Worthy
	Average Amount	**4,07**	**81,67%**	**Highly Worthy**

Based on the results of the validation of learning media materials, it is very feasible to be used in the learning process from several aspects, namely: curriculum aspects, material content aspects, interaction aspects, and evaluations. Each aspect received a very high percentage in the category of "Very Feasible". The learning media is said to be feasible because it gets a number of per-aspect scores with very good criteria. As said by (Hidayah et al., 2023) a media can be said to be very feasible if the achievement of the results of the expert questionnaire gets good or very good eligibility qualifications.

After the media product is tested for feasibility, the media product is revised according to the validator's suggestions and comments. Then in the next stage, android-based interactive learning media products with PBL-based SAC are tested for practicality. The following are the results of the practical test of android-based learning media products with PBL-based SAC.

1) Results of teacher practitioner assessment

The practicality test was carried out by 1 physics teacher at SMA N 2 Lhokseumawe. The following results and percentages of respondents for physics teachers, obtained:

Table 5. Results of Teacher Response Questionnaire Aspects

No.	Response Aspects	Average	Percentage %	Criterion
1.	Content of the material	5	100%	Very Practical
2.	Curriculum	4,6	93,3%	Very Practical
3.	Ease	5	100%	Very Practical
4.	Accessibility	5	100%	Very Practical
Average Amount		**4,9**	**98,32%**	**Very Practical**

Based on the results of the practitioner test, it was reviewed from several aspects, namely: material content, curriculum aspects, facilitation aspects, and assistance. Each aspect obtained a very high percentage with the criterion of "very practical".

2) Student response results (small scale)

A limited trial was carried out to find out the responses and responses of students. Test the product with a student response questionnaire. Student responses were taken from 5 students in grade XII 1 at SMA N 2 Lhokseumawe. The results of the 5 respondents above were obtained as a total percentage, namely:

Table 6. Results of Student Response Questionnaire Aspects (Small Scale)

Amount	Total Score	Maximum Score	Average score	Percentage %	Criterion
5	394	450	4,4	87,54%	**Very practical**

From the results of the questionnaire in table 6 above, seen from the overall aspect of practicality, a very high percentage was obtained with the criteria of "very practical" media. Learning media is said to be practical if you get a qualification with good questionnaire results. As (Irawan & Hakim, 2021) argues that a media is said to be practical when viewed from assessments and comments from both teachers and students..

4. Implementation

At the stage of implementing media that has been tested for feasibility and practicality and then implemented to students in the experimental class in the learning process, the researcher will use the PBL methodology to teach the resulting learning media products in collaboration with SAC in the experimental class at SMAN 2 Lhokseumawe. The results of the product practicality test based on the student response questionnaire (large-scale) are:

5. Student response results (Large Scale)

Students fill out a response questionnaire because they have used Android-based interactive learning media with PBL-based SAC during the learning process. The proportion of the overall results of the student response test is:

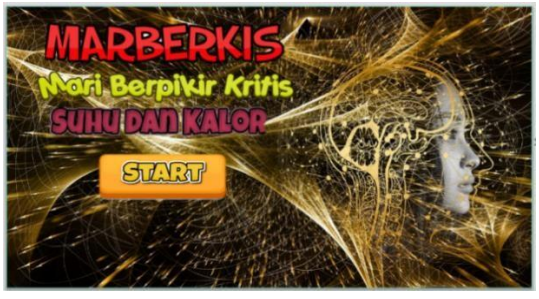
Table 7. Percentage of Total Student Response Test Results (Large Scale)

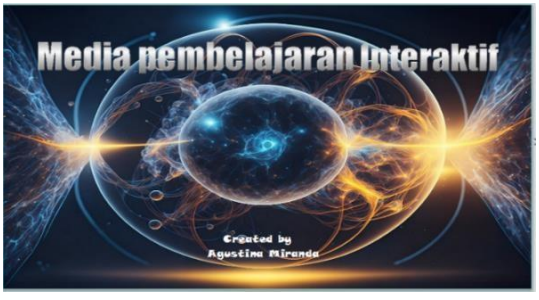
Amount	Total Score	Maximum Score	Average score	Percentage %	Criterion
25	1.951	2.250	4,3	86,7%	Very practical

From the results of the students' responses, judging from the overall practical aspect, a very high percentage was obtained with the criteria of "very practical" media.

6. Evaluation

At each stage, an evaluation is carried out to ensure that the developed product meets specifications. Physics students and teachers reported good results and comments after the product was developed and used in class XI Science 1 SMA N 2 Lhokseumawe. In physics education, this learning resource is seen as useful and easy to use. Thus, it is concluded that android-based interactive learning media with SAC based on the PBL model for temperature and heat materials has been developed and completed effectively, resulting in a final product that can be used.





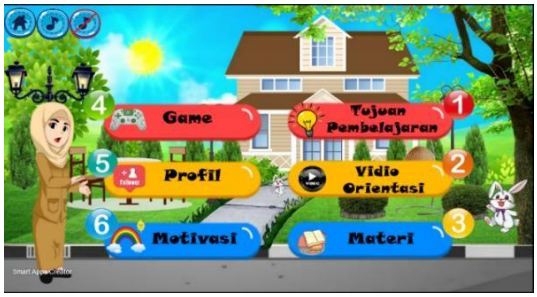


Figure 2. Results of Android-Based Interactive Learning Media Development with SAC Based on PBL Model

The methodology and development (R&D) used in this study uses the ADDIE model. ADDIE's development approach has five phases of research: (1) analyze, (2) design, (3) development, (4) implementation, and (5) evaluate. The product developed in this study is an android-based interactive learning media with SAC that uses the PBL methodology. In the first stage, the analysis, the researcher examined various problems that existed at SMA N 2 Lhokseumawe. The design stage is when researchers begin to design android-based interactive learning media that will be developed, starting with background creation, images, and buttons for the application, followed by the design of content or learning scenarios, teaching materials, and evaluation tools in the form of exam questions for the Android-based interactive learning media.

In the development stage at this step, the researcher validates the product with experts. The results of validation from material experts that produce assessments with "very feasible" criteria are used in learning with a proportion of 81.67%, showing that the material and learning objectives to be achieved are in accordance with what is taught. Media validation produces results that meet the "very feasible" criteria. The learning media is considered feasible because it receives a number of scores per aspect with excellent criteria. According to (Hidayah et al., 2023), a medium can be considered very practical if the findings from the expert questionnaire produce good or excellent qualifications.

The material is modified after product validation in accordance with the suggestions and inputs from the validators. Furthermore, a small-scale trial to determine the feasibility of the media was carried out with physics teachers of SMA N 2 Lhokseumawe and students. In the "very practical" criterion, the results of the teacher's practicality test showed an average score of 4.9 with a percentage of 98.32%, while the results of the limited scale test of students showed an average score of 4.4 with a percentage of 87.54%. Implementation stage of grade XI 1 high school students at SMA N 2 Lhokseumawe apply media that has been assessed as practical and feasible into the learning process in the classroom. Students obtained an average score of 4.3 with a percentage of 86.7 and the criteria of "very practical" for their responses after using Android-based interactive learning media designed according to the syntax of the Problem Based Learning (PBL) model. In the eyes of educators and students, this media is seen as useful (Irawan & Hakim, 2021).

The last stage is the evaluation stage, which is completed at each stage of development carried out by the researcher. The evaluation stage is carried out with the aim of producing products that are appropriate and useful in learning. So, through this stage, media items that meet the needs of students are obtained.

D. Conclusion

These findings yield some interesting things. First, expert validation of the resulting media products shows that the media is very suitable for use in physics learning. Second, the practical test by asking teachers and upper-class students to fill out a questionnaire shows that the media produced is very practical to use for student learning media.

E. Acknowledgment

The author would like to thank the Rector of Malikussaleh University, the Dean of the Faculty of Teacher Training and Education, Malikussaleh University, the Study Program Coordinator, the First and Second Supervisors, the Media Experts who checked and validated the learning media, the material validators, the principal of SMA N 2 Lhokseumawe, the Principal of SMA N 2 Lhokseumawe, the Fellow Teachers at

SMA N 2 Lhokseumawe, especially the teachers of SMA N 2 Lhokseumawe in the Physics Education Study Program who always participated and in helping researchers collect research data.

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