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DEVELOPMENT OF PHYSICS LEARNING MEDIA BASED ANDROID USING CODULAR TO IMPROVE STUDENT LEARNING OUTCOMES ON TEMPERATURE AND HEAT MATERIAL

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ABSTRACT

Research was conducted due to the lack of interesting learning media, making students' interest in physics subjects to study physics low and resulting in unsatisfactory student learning outcomes. This research aims to develop android-based learning media using kodular as a learning media to improve student learning outcomes on temperature, expansion and heat material for high school class XI. This research is a Research & Development (R & D) study using the ADDIE model which consists of stages (Analyze, Design, Development, Implementation and Evaluation). The subjects of this research were students of class XI SMA The results of material expert validity have a percentage of 91.11% with a very valid category and media expert validity has a percentage of 90% with a very valid category. The results of practicality by students in small groups of 87.95% (very practical), medium groups of 85.54% and limited groups of 94.75% (very practical) and in the effectiveness test obtained the results of the gain score of the difference between the pretest and protest scores showed an average in the small group of 0.7707, medium group 0.7777 while in the limited group of 0.8348 in the high category. Based on this information, it is concluded that the android-based student learning media using codular to improve student learning outcomes on temperature, expansion and heat material at SMAN 5 Medan developed by researchers get results that are feasible to use with valid, very practical and effective categories.

PENDAHULUAN

INTRODUCTION

The era of the Industrial Revolution 4.0 is now a widely discussed issue, including in Indonesia. Globalization in Indonesia has entered the Era of Industrial Revolution 4.0 and makes it easier for people to do activities with more effective and efficient time. The revolution paradigm that continues to develop periodically is initiated by advances in science and technology as a supporter of the renewal. The world of education in the development of the revolutionary era continues to be required to improve its system (Cholily, Putri, & Kusgiarohmah, 2019: 1-2) The right education system brings progress to a country. In the era of industrial revolution 4.0 educational institutions are in an ideal position to help grow an ideal and superior workforce. Students can access unlimited available information, making it an option for virtual learning and connect easily as it is integrated to various platforms. In addition, learning in the era of revolution 4.0 can implement blended learning and case-based learning.

Education 4.0 is a plan to expand access and relevance to support the realization of smart education through improving and equalizing the quality of education and utilizing technology to realize world-class education so that students have 21st-century skills that refer to global competency standards that prepare young people to enter the world of work and the reality of life in the 21st century. Education in the 21st century is characterized by digitalization in various aspects of life, including in the field of education known as the

super highway in obtaining information and using technological media. (Hasibuan & Prastowo, 2019: 32). Attendance, source books, assignments, evaluations and many other aspects that utilize technological advances (Sujana & Rachmatin, 2019: 2). Technological advances and easy access to information should be able to facilitate teachers in explaining the material, so that it is in accordance with the concept of education in the 21st century, namely student-centered learning. Education is no longer centered on a reciprocal or two-way relationship between students and teachers, but on the network as the center, directly contacting other students with different sources of information; not only domestically, but also abroad. And in the 21st century the teacher is only a facilitator in connecting or being a contact person between students' prior knowledge. This encourages the development of more individualized learning methods and concepts, student independence and personal knowledge acquisition methods will be well implemented. This is what is called the era of education 4.0 (Teknowijoyo & Marpelina, 2021: 179-180). In the era of education 4.0, technological developments, especially in the digital world, have opened up new opportunities to create more interactive and interesting learning media.

Based on the results of observations at SMA Negeri 5 Medan that researchers have done in class XI MIPA with a total of 72 students which shows that 82.98% of students say that physics is a difficult lesson and always leads to formulas, and students have difficulty connecting understanding in everyday life so that it results in physics learning outcomes from students who are less than optimal. The KKM value at SMA Negeri 5 Medan is 78, but the student learning outcomes obtained by students are still below the KKM with an average score of 53.55. From the results of the teacher interview said that the superior XI Mipa class reached 75% of the KKM score, while the regular class only reached 40%. When learning physics with Temperature, Expansion and Heat material, the media used by teachers is limited to books and technology in the form of projectors and Microsoft PowerPoint. However, the media is only in the form of images that tend to be boring. The lack of interesting learning media makes students' interest in physics subjects to study physics low and results in unsatisfactory student learning outcomes.

Temperature, expansion, and heat are physics topics that require a deep understanding. These concepts are often difficult to understand without good visual and interactive illustrations. This results in students not fully understanding the material that has been delivered by the teacher. One way to utilize technology is through the use of kodular, an application development website used to create learning media. The kodular application can be installed on students' devices and they can use it to improve learning outcomes. Students today are more familiar with technology and digital media. So, with new innovations in learning media such as kodular, the learning atmosphere will be more interesting.

By using codular-based media, learning media creators can combine elements such as video, interactive simulation more easily. By presenting codular-based media learning for students, students will be more motivated and involved in physics learning. Meanwhile, teachers have the opportunity to create a creative, innovative learning atmosphere to improve student learning outcomes. Therefore, the development of appropriate learning media can help students overcome this difficulty.

Learning media

The word media comes from Latin which literally means intermediary or introducer. In a teaching and learning perspective, media is an information carrier from teacher to student to achieve effective learning. More specifically, the definition of media in the teaching and learning process tends to be defined as graphic, photographic, or electronic tools for capturing, processing, and reconstructing visual or verbal information. There are five components in the definition of learning media. First, as an intermediary for messages or materials in the learning process. Second, as a learning resource. Third, as a tool to stimulate student motivation in learning. Fourth, as an effective tool to achieve complete

and meaningful learning outcomes. Fifth, as a tool to acquire and improve skills. The five components collaborate well and will have implications for the successful achievement of learning in accordance with the expected targets. Based on the five components that have been described, learning media is everything that is used as an intermediary or connector from the information provider, namely the teacher to the recipient of information or students which aims to stimulate students to be motivated and able to follow the learning process as a whole and meaningful (Hasan & et al, 2021: 27-29).

According to Daryanto, in essence, the teaching and learning process is a communication process, delivering messages from the introducer to the recipient. Messages in the form of content or teachings that are poured into communication symbols both verbally and nonverbally (Gunawan & Ritonga, 2019). In the learning process, the media has a function as a carrier of information from the source (teacher) to the receiver (student).

In simple terms, Azhar (2011) groups learning media into several types, namely:

1. Visual media, namely the type of media used that relies solely on the sense of sight, for example print media such as books, journals, maps, pictures, and so on.
2. Audio media is a type of media that relies solely on hearing, for example tape recorders and radio.
3. Audio visual media are films, videos, TV programs, and so on.
4. Multimedia, namely media that involves several types of media and equipment in an integrated manner in a learning process or activity (Pagarra & et al, 2022: 26).

Android

Android is an operating system for Linux-based mobile devices that includes an operating system, middleware and applications. One of the creators of Android is Andy Rubin, who is now often referred to as the "Father of Android." In 2005, Google officially bought Android. So since then, Android development has been completely in Google's hands until now. However, Google still releases source code openly, so Android is included in open source software (Verawati & Comalasari, 2019: 619). The various opinions above can be concluded about the meaning of Android, namely, android is an operating system owned by Google where the operating system is based on Linux which is designed for Smartphone phones and is Open Source. Where this Open Source platform is intended for developers to create their own applications for use by various mobile devices (Safitri & et al, 2021: 4-5).

Kodular

Kodular is a site that provides a means to create android applications with the idea of drag-drop block programming. According to Setiawan (2020) block programming is the main feature in Kodular, with this feature there is no need to type program code manually (Safitri & Hayuhantika, 2023: 1254). The advantages of this codular application are that it has features that are more complex and more components than other application sites. In addition, it can also create android applications that are more effective and efficient, and many features of advertising media as a money-maker. Besides that, there are also some shortcomings that must be known, namely the maximum application size limit is around 10 MB, it is not common to make android launcher, widget, and theme applications, and the use of this application must be online or connected to the internet (Djuredje & et al, 2022: 34)

Users can create apps for Android using Kodular and publish them on the Google Play Store. Applications created with Kodular can be business, educational, and entertainment applications. Kodular is especially useful for beginners or teachers who

want to create mobile apps without having to understand complex programming languages. It has great potential to be a tool that helps grow the mobile app industry. By using Kodular, users can create apps quickly and easily without having to understand programming languages. Thus, Kodular is a very useful application for beginners who want to create mobile applications (Putra & et al, 2023: 19). Kodular is an opensource platform for creating Android applications using web-based block programming. Kodular has the advantage of being able to test/try applications that have been made directly without having to export the application first (Kristi & Dewi, 2021: 13). Creating Android applications using Kodular with the aim of anticipating when there are errors that start from making Android applications to using Android applications in production.

Learning Outcomes

Student learning outcomes are one of the measuring tools to see how far students can master the subject matter that has been delivered by the teacher. There are definitions of learning outcomes from different learning experts. According to Nana Sudjana, learning outcomes are competencies or skills that can be achieved by students after going through learning activities designed and implemented by teachers in a particular school and class (Nurrita, 2018: 175). According to Bloom (1964) the definition of learning outcomes includes cognitive, affective, and psychomotor abilities. The cognitive domain is knowledge (knowledge, memory), comprehension (understanding, explaining, summarizing, example), application (applying), analysis (decomposing, determining relationships), synthesis (organizing, planning, forming new buildings), and evaluation (assessing). The effective domain is receiving, responding, valuing, organization, characterization. The psychomotor domain includes initiatory, preroutine, and routinized. Psychomotor also includes productive, technical, physical, social, managerial, and intellectual skills (Wirda & et al, 2020).

Temperature, Expansion and Heat

Temperature is a quantity that indicates the degree of hotness or coldness of an object. The unit of temperature in SI is Kelvin (K). The tool used to measure temperature is a thermometer (D' Gamma, 2013: 69). Thermometers are made based on the basic properties of a material that changes regularly with temperature. When the thermometer is touched to the substance being measured, the temperature of the thermometer will gradually change towards the equilibrium temperature with the temperature of the substance. The change in thermometer temperature will cause a change in the scale designation on the thermometer. In the end, the temperature of the measured substance is equal to the scale shown by the thermometer at the time of thermal equilibrium between the substance and the thermometer (Nugraha, S.Si. & Sulaiman, S.Si., 2014: 61).
Types of ThermometersBased on the thermometer properties of substances
Thermometer properties of substances

Type	Working Principle
Liquid thermometer	The occurrence of changes in the volume of a substance, namely the volume of the substance will expand/increase when heated and will shrink/decrease when cooled. Changes in volume indicate changes in temperature.
Bimetal thermometer	There is a difference in the length of two different types of metals pressed together when heated / given a change in temperature. The difference in

	the length of the metals indicates the change in temperature.
Resistance thermometer	A change in temperature in an obstacle (metal wire) will change the resistance value. Changes in resistance are used to indicate temperature.
Thermocouples	The occurrence of the difference in the expansion of the two specified metals will produce GGL (electromotive force). GGL is used to indicate temperature.
Gas thermometer	The change in temperature is indicated by the pressure change/pressure increase due to the gas being heated at a fixed volume.
Pyrometer	The amount of radiant energy emitted by an object indicates its temperature.

Based on the use of thermometers

Uses of thermometers

Type	Usability
Body thermometer/clinical thermometer	Used to measure body temperature. The thermometer scale ranges between 35℃ – 42℃. Normal human body temperature is 37℃.
Wall thermometer	To measure room/space temperature. The thermometer scale ranges −50℃ – 50℃.
Maximum-minimum thermometer/Six-Bellani thermometer	To measure the maximum temperature during the day and the minimum temperature at night.
Rod thermometer	To measure the temperature of objects. Thermometer scale ranges−10℃ – 110℃.

Based on the liquid filling of the thermometer

Liquid filling thermometers

Type	Filling Substance
Mercury taximeter	Uses mercury as a temperature indicator. The reading scale of the thermometer is between −39℃ – 357℃.
Alcohol thermometer	Uses alcohol as a temperature indicator. Scale reads−114℃ – 78℃.

Expansion

In general, objects will expand when heated. Knowledge of the expansion of substances is very useful in various everyday problems, for example:

a. rail joints are spaced;
b. distance between the bridge body and the road;
c. a long oil pipe with a coil;
d. rivets are preheated when they are to be installed;
e. railroad wheels are preheated when they are installed;
f. window glass installation should be spaced;
g. bimetal for automatic switches, thermostats, and bimetal thermometers (Daton & et al, 2007: 166).

There are three types of expansion, namely:

Solid expansion

There are three types of expansion in solids, namely:

Length expansion

A solid will expand in length when heated if the width and thickness of the solid are negligible in relation to its length. For example, a needle or a piece of metal wire will expand in length when heated.

Volume expansion

If the length, width and thickness of a solid cannot be ignored, then when heated the solid will experience volumetric expansion. The volumetric expansion of a solid meets the following mathematical equation.

Expansion of gas

Gases also experience volumetric expansion, but the volumetric expansion of gases is greater than the volumetric expansion of liquids for the same temperature increase. In addition, gases can experience pressure expansion at a fixed volume. Gas expansion fulfills Boyle's law, Charles' law, Gay-Lussac's law and the law of pressure.

Heat

Heat is a form of energy associated with the movement of atoms, molecules and other particles that make up a material. Heat is a form of energy that can be transferred. When two objects are touched, the heat will move from the object with the higher temperature to the object with the lower temperature (Nugraha & Sulaiman, 2014: 63). Heat can be generated from chemical reactions (such as combustion), nuclear reactions (such as fusion reactions in the sun), electromagnetic dissipation (such as in electric stoves) and mechanical dissipation (such as friction).

Heat Transfer

Heat is energy that propagates due to temperature differences. Heat tends to move from a place with a higher temperature to a place with a lower temperature (D'Gamma, 2013: 71). Heat can move by conduction, convection, and radiation.

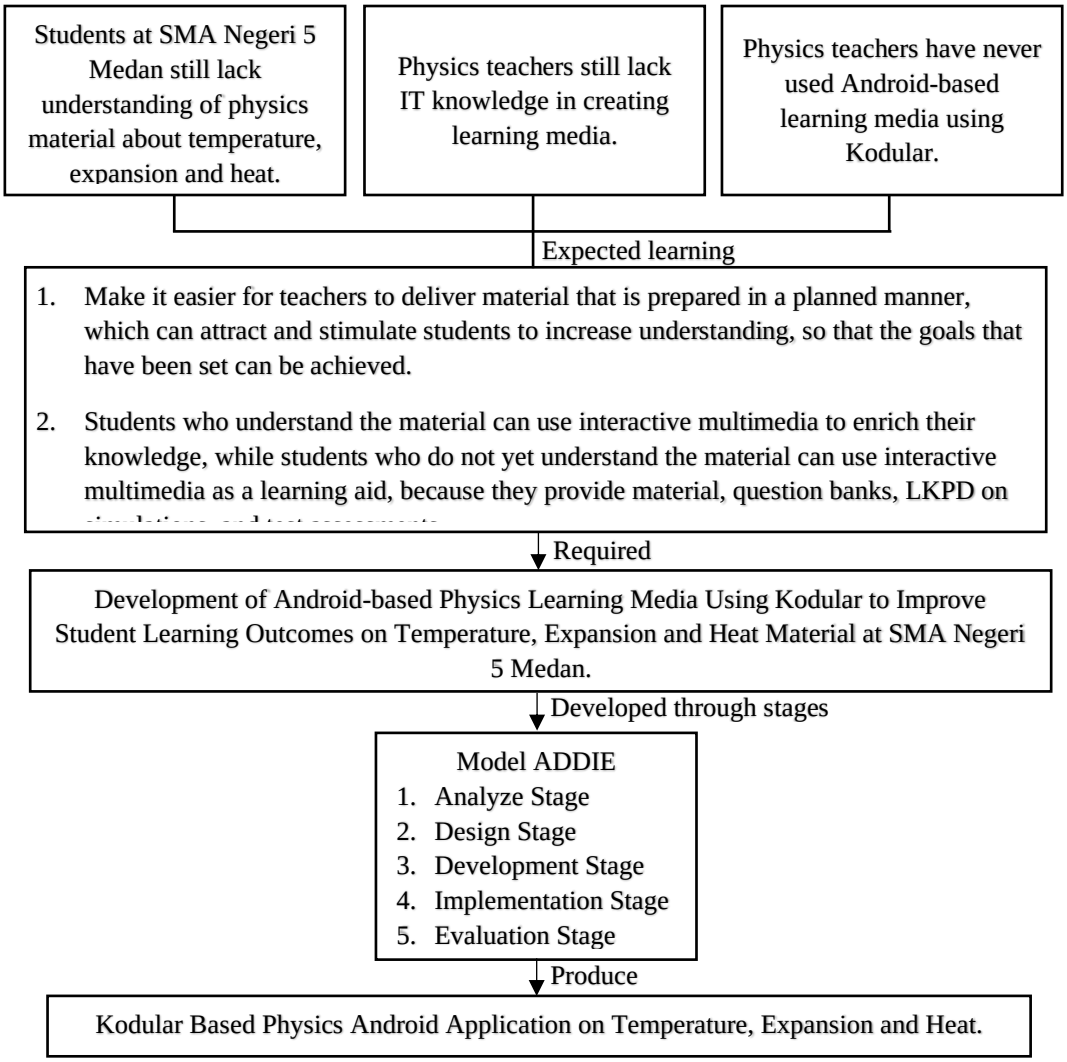
Convection

Convection heat transfer is a heat transfer through a medium that is accompanied by the transfer of particles of the medium. Example: As much water as one pot is heated, at first the water particles at the bottom of the pot become hot and will move (flow) up to the surface, while the water particles on the surface move (flow) down to the bottom to get warmed up. And so on, until all parts of the water become hot.

Radiation

Radiant heat transfer is a transfer of heat without going through a medium, in the form of electromagnetic waves. Example: The radiant heat (energy) of the sun can reach the earth, even though outside the earth's atmosphere there is a vacuum. Stefan-Boltzmann's Law: "The total energy emitted by a perfectly black surface in the form of heat radiation per unit time, per unit surface area is proportional to the fourth power of the absolute temperature of the surface."

Framework



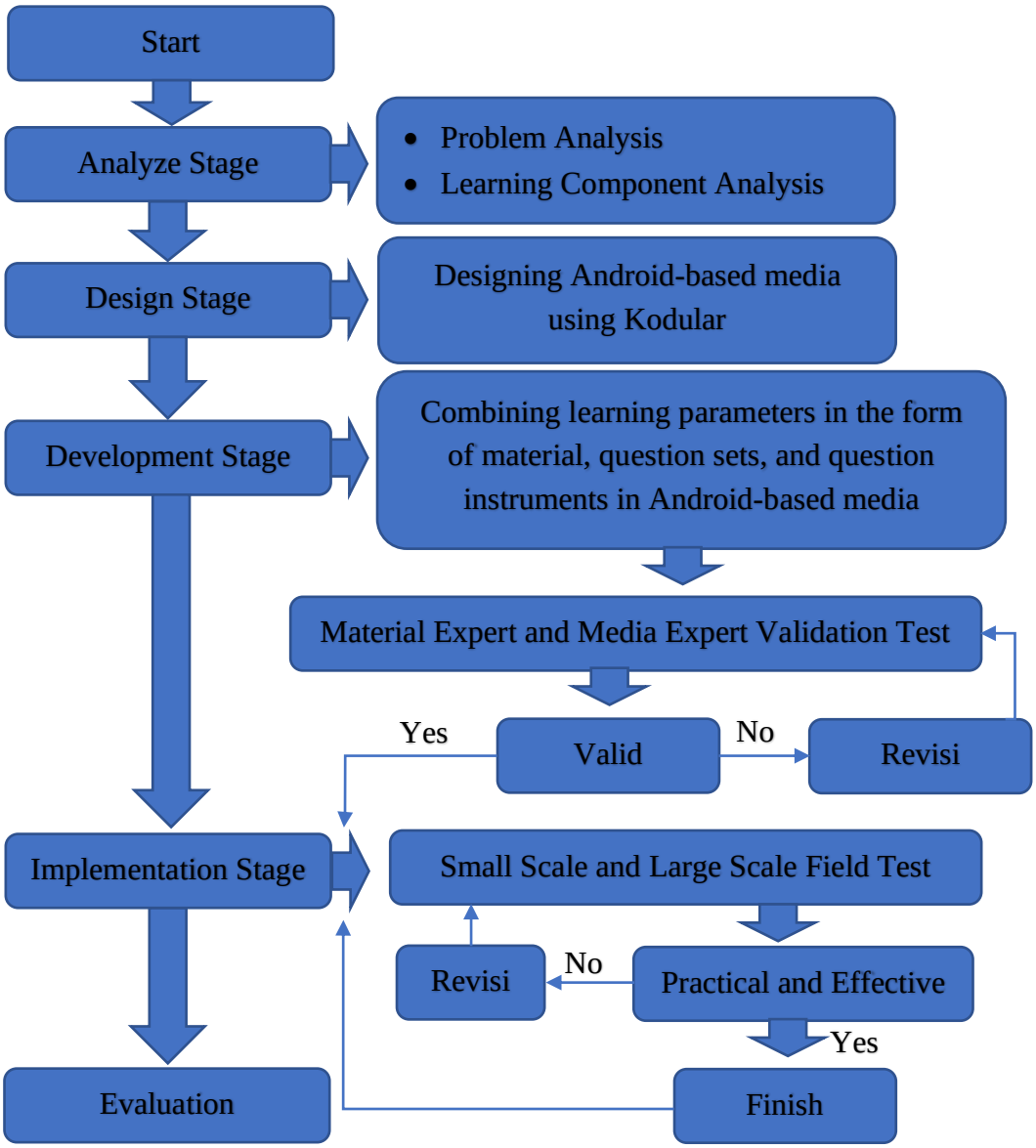
METHOD

This research was be conducted on class XI MIPA students of SMA Negeri 5 Medan on the material of Heat Semester II in the 2023/2024 school year. The time of this research was conducted from April to May 2023. In this study, the population was class XI students of SMA Negeri 1 Medan in the 2023/2024 school year.

This research uses the Research and Development (R&D) method, which is a process used to develop and validate educational products. Ibrahim, dkk (2023) research and Development (R & D) is a method or step to create new products or develop and perfect existing products and is used to test the effectiveness of these products. Several methods are used when carrying out R&D, namely methods: descriptive, evaluative and experimental.

The result of the research and development in the form of a learning software product is codular media. Codular media is an interactive multimedia media that can be accessed by students through the internet network. Android-based physics learning media using kodular to improve student learning outcomes on temperature and heat material at SMA Negeri 5 Medan. The development model used in this research is ADDIE (Analysis, Design, Development, Implementation, and Evaluation).

The procedure in developing android-based physics learning media using kodular to improve student learning outcomes on heat material at SMA Negeri 5 Medan is adjusted to the ADDIE development model, namely: (1) Analysis, (2) Design, (3) Development, (4) Implementation, and (5) Evaluation. The stages of the ADDIE development model are described as figure.



ADDIE Development Stage

The stages of developing android-based physics learning media using kodular to improve student learning outcomes on heat material at SMA Negeri 5 Medan can be explained as follows:

Analysis

Needs analysis is conducted through field studies and literature studies. The analysis stage includes two activities, namely:

a) Problem Analysis

At the problem analysis stage, observations and interviews were conducted with teachers and students at SMA Negeri 5 Medan to obtain information about the problems

that arise in learning activities, especially in physics learning and identify possible solutions used to overcome problems in order to facilitate the learning process.

Based on the results of observations at SMA Negeri 5 Medan that researchers have done in class XI MIPA with a total of 72 students which shows that 82.98% of students say that physics is a difficult lesson and always leads to formulas, and students have difficulty connecting understanding in everyday life so that it results in physics learning outcomes from students who are less than optimal. The KKM value at SMA Negeri 5 Medan is 78, but the student learning outcomes obtained by students are still below the KKM with an average score of 53.55. From the results of the teacher interview said that the superior XI Mipa class reached 75% of the KKM score, while the regular class only reached 40%. When learning physics with Temperature, Expansion and Heat material, the media used by teachers is limited to books and technology in the form of projectors and Microsoft PowerPoint. However, the media is only in the form of images that tend to be boring. The lack of interesting learning media makes students' interest in physics subjects to study physics low and results in unsatisfactory student learning outcomes.

One way to utilize technology is through the use of kodular, an application development website used to create learning media. The kodular application can be installed on students' devices and they can use it to improve learning outcomes. Students today are more familiar with technology and digital media. So, with new innovations in learning media such as kodular, the learning atmosphere will be more interesting. By using kodular-based media, learning media creators can combine elements such as videos, interactive simulations more easily. By presenting kodular-based media learning for students, students will be more motivated and involved in physics learning. Meanwhile, teachers have the opportunity to create a creative, innovative learning atmosphere to improve student learning outcomes. Therefore, the development of appropriate learning media can help students overcome this difficulty.

Analysis of learning components

The learning component analysis stage includes analyzing basic competencies, learning objectives, analyzing learning situations, analyzing students and analyzing learning content. The activity of analyzing lessons is to carry out activities to select subject matter that is considered to have power (strength) or essential material, and also think about how the acquisition of concepts occurs so that young students are absorbed and understood.

2) Design

The design stage includes:

a) Structuring the framework of the codular learning media structure
b) Determining the systematic presentation of material, illustrations and visualizations.
c) Writing the initial product draft of modular learning media and making story boards.
d) Making content for, material, LKPD, and simulations related to temperature and heat material.

3) Development

Product design that has been prepared, developed based on the following stages:

a. Researchers combine the materials that have been collected in accordance with the manufacture of media, then re-correct the development results before being validated. If it is appropriate then the product is ready to be validated.
b. Making validity instruments for media experts, material and learning experts and questionnaires for students.
c. Codular learning media design validation conducted by media experts, material and learning experts. Validation is carried out to obtain assessments and suggestions.
d. Input from experts is corrected, but if there are no revisions from experts and get a good predicate, then the product continues to the implementation stage.

4) Implementation

Implementation or delivery of learning materials is the fourth step of the ADDIE research and development model. Implementation is a step to apply the developed product. After revising the product at the design and development stage, it is declared feasible then the product is implemented in the classroom or conducts a summative evaluation.

Codular learning media trials were carried out with summative evaluation stages (one-to-one trial, small group trial, and field trial). The research conducted by the researcher aims to find out whether the codular learning media developed can be said to be feasible or not, it also aims to improve the product, so that the product developed can be refined.

5) Evaluation

The evaluation stage aims to analyze the media at the implementation stage, whether there are still deficiencies and weaknesses or not, if there are no revisions, then the media is suitable for use. More details about the development procedure are presented in the form of Table.

Development Procedure Concept

Stages of Development	**Activities**
Analysis (problem analysis and learning components)	• The basic competencies are analyzing and conducting temperature and heat experiments in technology. • The media used in learning are only print-based media (textbooks) and Power Point. • Teachers do not utilize technology, even though students are familiar with and able to operate the internet well. • The wifi network at school is available but has not been utilized properly in the learning process..
Design	• Codular learning media product design is the preparation of systematics, presentation of material, illustrations, visualization and design of evaluation tools.
Development	• Based on the results of the product design, at this stage the appropriate products (materials, tools) are made. • Validate the product with experts.
Implementation	• Start using the new product in a real learning or environment. • Conduct a summative evaluation
Evaluation	Evaluation in research is carried out at each stage of the ADDIE model through giving post-test tests to determine the effectiveness of the

	media. If there are revisions before and after implementation, improvements are made, but if there are none, all ADDIE model activities are completed.

RESULTS AND DISCUSSIONS

The development research aims to produce products in the form of android-based media. The android-based media developed is a codular media. The android-based media developed presents an introduction; material about temperature, heat and expansion; simulation; question bank and evaluation of learning outcomes tests.

The model used in this research is the ADDIE type development research model which consists of five stages, namely Analysis, Design, Development, Implementation and Evaluation. The data obtained in the development research are media validity data (material and media experts), practicality data through response questionnaires (teachers and students), effectiveness data through students' post-test scores (small and limited groups), and data on improving learning outcomes through students' pretest and post-test scores (small and limited groups). The data obtained in the development process were analyzed to answer the problem formulation, namely regarding validity, practicality, effectiveness and improvement of learning outcomes to see the effect of using android-based media developed using codular. The process to produce quality interactive multimedia follows the ADDIE instructional design model which consists of 5 stages.

The results of research and development of android-based learning media include product results and student responses to android-based learning media which are solutions to current problems. Android-based learning media that has been developed and is in accordance with development procedures, can be said to be feasible, practical, and effective and can be well received by students and teachers. The research model in developing android-based learning media uses the ADDIE research model. The ADDIE procedure consists of five stages, namely the analysis, design, development, implementation, and evaluation stages.

Validity of Android-Based Learning Media

Validation of android-based learning media is carried out so that the products developed are valid and suitable for use. The validation used in development research is content and construct validation. Content validation is carried out by material experts while media validation is carried out by media experts on android-based physics learning media.

The results of material validation refer to Table 4.3. shows that android-based physics learning media obtained an average of 91.1% with a very valid category. Revisions made to produce valid android-based physics learning media are Adding indicators of competency achievement, sample questions and making images more appropriate and numbering images so that they can be seen clearly. The results of material validation that have been in accordance with the material experts are validated to media experts using media validation sheets.

The results of the assessment of the validity of android-based physics learning media by media experts refer to Table 4.6. shows that of all the criteria assessed, the average validity is 90% with a very valid category. There are no revisions made to produce android-based physics learning media, only some suggestions suggested by media experts are the questions given must be clear and understandable by students. Validation results based

on data that has been described by media and material experts are in the range of 81.00% < P ≤ 100.00% with a very valid category.

The android-based physics learning media that has been assessed by validators has been improved both in terms of content and in terms of media so that it is feasible to use in the teaching and learning process. Valid android-based physics learning media used in the learning process can improve student learning outcomes about physics concepts. Media applications in physics learning result in a significant increase in students' knowledge (Cubrilo, 2014).

Practicality of Using Android-Based Physics Learning Media

The valid android-based physics learning media is used by students to determine the level of practicality of using the developed product. The level of practicality is reviewed from the usability and ease of students in using the developed product. Student responses in practicality are also needed in the use of android-based physics learning media. Practicality data collection by giving questionnaires to students was carried out three times, the first trial involved 14 students, the second trial involved 24 students and the third test involved 34 students. The results of trial I showed that the web-based interactive multimedia developed was in the very practical category with an average of 87.9% while the results of trial II obtained an average of 85.5% with a very practical category and the results of trial III obtained an average of 94.7% with a very practical category. The results of the overall analysis related to the practicality of using android-based physics learning media show that android-based physics learning media is very practical to use in the learning process.

The practicality of using android-based learning media is a combination of several aspects, namely making it easier for students to understand temperature, expansion and heat material, attracting students' interest in learning about temperature, expansion and heat material to be clearer because it is equipped with videos and simulations and students have no difficulty in operating android-based physics learning media. The physics learning media developed is practical, interesting, easy and provides benefits when used in the learning process (Putri, 2018).

Effectiveness of Android-Based Learning Media

The effectiveness of the android-based learning media developed is carried out related to formative evaluation. Evaluation carried out at the development stage is to measure the effectiveness of a media. The level of effectiveness is expressed on a numeric scale based on certain criteria. The effectiveness of android-based interactive multimedia is reviewed from the consistency between the curriculum and the product developed and the learning objectives achieved. Consistency is seen from student learning outcomes in small groups, medium groups and limited groups after using android-based physics learning media.

The post-test results of small group, medium group and limited group students after using android-based physics learning media are consistent in achieving learning objectives with a minimum classical completeness of 85%. The classical completeness obtained in the small group attended by 14 students was 85.7% with an average of 87, the medium group attended by 24 students was 87.5% with an average of 86.4583 and in the limited group attended by 34 students obtained classical completeness of 94.1% with an average of 88.7. A media is declared effective if the students' learning completeness is ≥85% classically so that the media is declared effective and can be used in the field trial and has met the criteria for very good effectiveness.

The results of the effectiveness that have been carried out obtained a relationship between the level of effectiveness with the criteria for android-based physics learning media in the aspects of ease, clarity, suitability, appearance and attractiveness, because students who state that the media is easy, clear, appropriate and interesting to use reach the KKM value. Riasti (2016) that there is a relationship between the level of effectiveness with

interactive learning media criteria in the aspects of convenience, usefulness and attractiveness.

Improvement of Student Learning Outcomes Using Android-Based Physics Learning Media

Analysis of gain score data was carried out to see the effect of using android-based learning media on temperature, expansion and heat fluid material using Hake's normalized gain test (1999). The results of the gain score difference between the pre-test and post-test scores obtained an average gain score in the small group of 0.7 with a high category, in the medium group 0.7 and in the limited group of 0.8 with a high category. The increase in student learning outcomes is due to the use of attractive android-based physics learning media so as to improve student learning outcomes. The use of media in the learning process has been done before, including Zulhelmi et al, (2017) concluded that the use of interactive learning media in learning can improve students' critical thinking skills with a gain score in the high category.

The results of the development of media products through 5 stages, namely analysis, design, development and evaluation, obtained that android-based physics learning media on temperature expansion and heat material meet valid, practical and effective indicators. Multimedia that has quality can be used as an alternative learning resource, especially on temperature, expansion and heat material.

Disadvantages of Android-based Physics Learning Media Developed

In the operational work of android-based physics learning media developed by researchers there are some shortcomings such as not supporting Ios devices. So, there are some students who cannot download physics learning media applications based on android.

CONCLUSIONS

The conclusion of the research and development of android-based physics learning media is as follows:

1. Material experts stated that this android-based physics learning media is feasible or valid. android-based physics learning media is declared feasible with the assessment of all criteria according to material experts and obtained an assessment with a percentage of 91.1% (Very Valid).
2. Media experts stated that this android-based physics learning media is feasible to use or valid. Android-based physics learning media is declared feasible with the assessment of all criteria according to media experts and obtained an assessment with a percentage of 90% (Very Valid).
3. Students' assessment states that android-based physics learning media using kodular is practical to use during learning. This is because the results of the practicality of student responses in small classes are 87.9%, medium classes are 85.5% and limited classes are 94.7% declared very practical.
4. There is an increase in student learning outcomes by using android-based physics learning media in the learning process with a gain value in the high category in the small class 0.7, medium class 0.7 and limited class 0.8

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