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Development of Interactive Learning Media as an Alternative to Improve Students' Conceptual Understanding and Motivation on the Temperature and Heat Topics

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Abstract: This study aims to develop and determine the feasibility of interactive learning media on the topic of temperature and heat. The type of research is Research and Development (R&D) with the ADDIE model. In this model, the stages include Analyze, Design, Develop, Implement, and Evaluate. However, this research is only up to the development stage. The subjects of this study were 20 students from one of the XI MIPA classes at Panjura High School. The interactive media was developed in the form of an android-based application with the topic of temperature and heat. The research data was obtained from the results of content and construct validation by the validator and then the feasibility test by the students. From the research that has been done, the average percentage of content or display validation is 82.2% including in the very valid category and the average percentage of construct validation is 93.1% including in the very valid category. For the feasibility test conducted by students, the percentage is 95.2% so it is included in the very feasible category. Based on the validation test and student feasibility test, it was found that interactive learning media can strengthen students' conceptual understanding and motivation in learning. The media developed is also easy to download and use and easy to operate. Suggestions for further research are applications that are made can be downloaded via the google play store, then the questions on the diagnostic test are easier than Quiz and not only the Android system but iOS as well.

INTRODUCTION

Physics is one of the sciences that is very closely related to human life. Physics if realized in technology will be beneficial for humans (Harefa, 2019). Physics is a subject that is part of science at the high school level (Kurniawan, Astalini & Sari, 2019). Physics covers the study of the universe from the largest galaxies to the smallest subatomic particles. In addition, Physics is the basis of many other sciences, including computer science, oceanography, seismology, and astronomy, medicine (Galaju et al., 2019). Physics should be studied using a more specific goal, namely to provide students with understanding, knowledge, and several skills for higher education levels and also to develop in science and technology. On that basis, learning material in physics cannot be

separated from mastering concepts and their application to problem-solving in physics as well as scientific work (Liza, 2021).

One of the purposes of learning Physics is to educate students to have the ability to apply concepts (Taqwa, Suyudi, & Faizah, 2022; Taqwa & Rahim, 2022; Taqwa, Sulman, & Faizah, 2022; Taqwa, Amalia, & Suyudi, 2022). Physics learning in schools is still considered not optimal when using learning methods and learning media (Sumiati et al., 2022). Physics learning that should be student-centered becomes the opposite, namely teacher-centered learning. Using a method that is often used by teachers, namely the lecture method, students are not accustomed to obtaining their own knowledge. Understanding the concept is one of the keys to success in studying physics. Physics is included as the subject that is most in demand but is often problematic for students in the realm of science (Guido, 2013).

Temperature and heat are a topic in physics subjects that are taught at the high school level in class XI. The material for temperature and heat according to the students is a difficult material. It is found that temperature and heat are very abstract materials so it has a low impact on students' conceptual understanding (Astiti & Yusuf, 2018). The difficulty of temperature and heat material is caused by several factors, including students' talents, interests, and motivations (Ma'rifah et al., 2016).

Understanding student concepts is the thoughts of students in conceptual understanding of physics so that students are able to restate, categorize objects based on certain properties, convey physics concepts in various representations, provide examples other than concepts that have been studied, apply certain methods and apply concepts. to solve everyday life problems in the physics learning process (Putranta & Supahar, 2019). There are factors that influence students' understanding of the concepts of temperature and heat, namely the concepts of expansion, heat, and temperature changes (Zahroh et al., 2021).

Based on previous research, it was stated that the results of the analysis of data from tests of 5 question numbers obtained the percentage of students' overall concept understanding was 54.76% indicating that students' conceptual understanding of temperature and heat was low (Risqa et al., 2021) and in Silaban and Utari's research. (Silaban & Utari, 2015) shows that the mastery of concepts from high school students in Medan city is still low in terms of weakness when answering questions about temperature and heat. In addition, research was conducted at SMA Singosari class XI that a test was carried out with the help of Quizizz, some students faced errors when understanding the concept of Temperature and Heat, including students who did not understand the expansion of bimetallic chips on automatic switches, assumed that specific heat was related to changes in temperature. objects, and also the inaccurate concept of heat transfer by conduction (Azizah et al., 2020). The occurrence of conceptual misunderstandings in the sub-concepts on the heat temperature material is the presentation of material and questions are often presented in the form of pictures and diagrams that are difficult for students to understand (Wulandari et al., 2018).

Motivation is an internal process that generates, guides, and sustains behavior over time. Each student has a different learning motivation. Therefore, all educators must

understand this so that learning activities are appropriate. (Bhakti et al., 2020). According to Sidik et al., (2021) the results of interviews and filling out questionnaires said that students have difficulty learning physics on the topic of heat temperature due to a lack of motivation to learn.

In activities in learning, the media is a very crucial part of shaping the activeness of students. Learning media is one of the factors that affect the quality of education. Learning media serves as a teacher's assistant to convey material in the learning process easily (Alfurqan et al., 2019). The basis for selecting learning is not based on the taste of the teacher but considers the suitability of the characteristics of the students, the peculiarities of the material, and also the character of the media itself (Ekayani, 2017). Teachers must adjust the majors taken in their lectures with the professions undertaken in order to be able to understand the factors and criteria in the selection of learning that will be used properly and appropriately.

Research from Setyaningsih et al., (2020) said that interactive learning media succeeded in increasing students' learning motivation by 70% of data in the experimental class when compared to the control class with an increase of 60% using only conventional methods. In addition, from a study, it was found that the difference in understanding of students' mathematical concepts with interactive multimedia was greater when compared to the understanding of concepts of students who took part in learning (Setyowati et al., 2020). In the learning media that has been developed by (Harahap & Siregar, 2020) it is said that learning motivation is 94.7% higher than using learning media on the internet. Meanwhile, according to (Muslichatun et al., 2021) there is an increase in the understanding of the experimental class that is given interactive learning media by 77.78% compared to the control class without interactive learning media which is only 66.66%. Based on the explanation that has been presented previously, this study aims to develop interactive learning media as an effort to improve students' conceptual understanding and motivation on the topic of temperature and heat.

METHOD

This study uses a research methodology "research and development" often referred to as Research and Development using the ADDIE research model. In this model, the stages include Analyze, Design, Develop, Implement, and Evaluate. However, research is only carried out until the development stage.

In this study, it was only carried out at the Develop stage. Implementation is the implementation of trials on products that have been developed for students which are carried out on a limited basis. In the first stage, namely Analyze, the development scenario and product specifications were developed and analyzed the performance and needs of students, teachers, teaching materials, and materials. The second stage is Design, in this stage, the product design is developed. The next stage is Develop, which is the development of products that have been designed and product validation carried out by the validator. Then the Develop stage also conducted trials with representatives of students to provide an assessment on the questionnaire sheet as an assessment of the product being developed. This research did not reach the Implement and Evaluate stage

because it was only carried out for the results of the feasibility analysis of the final product.

The research was conducted in one of the classes in SMA Panjura Malang class XI with a specialization group in Mathematics and Natural Sciences. This study has a subject with 20 students who are taking the material temperature and heat.

Data collection techniques in this study were carried out using two-level tests, including expert tests and small group tests. In the expert test, the trial was carried out with media experts and material experts. Expert test to evaluate product quality based on material design and presentation. Small group testing tests the product to some extent. Small group tests were conducted on several students.

Learning media validation sheets and questionnaires were instruments in this study. The media validation sheet is the instrument used at the product testing stage by several experts as the feasibility of the media that has been developed. While the response questionnaire with questions filled out by students in small groups.

This study uses a Likert Scale for the preparation of the validation test questionnaire for material experts and media experts as shown in Table 1 (Muhammad et al., 2020).

Table 1. Likert Scale

Option	Score
Strongly disagree	1
Disagree	2
Doubtful	3
Agree	4
Strongly agree	5

The calculation in the validator response questionnaire analysis is done by calculating the number of scores obtained and then calculating the percentage (Tanjung & Faiza, 2019). After obtaining the percentage of the results of the validity of the product validity results are categorized into several criteria as shown in Table 2 (Andriyani et al., 2020).

Table 2. Media Eligibility Criteria

No.	Score Percentage	Validity Level
1	< 25	Very unworthy
2	26 – 50	Not feasible
3	51 – 75	Feasible enough
4	76-100	Very worthy

The Guttman scale is used to compile a feasibility test questionnaire of the product with two choices, namely "Yes" and "No". Students who answer "Yes" means that students agree with the questions asked in the questionnaire and vice versa. The Guttman scale is 1 for “Yes” and 0 for “No” (Astuti & Ulfah, 2019). The score given by the student is then calculated as a percentage. The average value obtained from the results of the responses made by students, these feasibility results are categorized according to the criteria in Table 3 (Dwiningsih & Rahma, 2018).

Table 3. Media eligibility criteria

No.	Score Percentage	Validity Level
1	< 20	Sangat tidak layak
2	21 – 40	Tidak layak
3	41 – 60	Cukup layak
4	61 – 80	Layak
5	81 – 100	Sangat Layak

RESULT AND DISCUSSION

Analyze Stage

At this stage, an analysis was carried out by means of online interviews with one of the physics subject teachers in class XI Mipa SMA Panjura to obtain information about the problems that became the background of the development of interactive learning media to improve understanding of concepts and learning motivation. From the results of online interviews, information was obtained that in the learning process the use of learning media was still limited to books, modules, youtube, and power points. So it is necessary to develop interactive learning media to stimulate students' motivation and understanding of concepts.

Interactive learning media is made using the Flutter platform or software. Flutter is a framework for developing applications that have been developed by Google to create applications on the iOS and Android operating systems (Krisnada et al., 2019). Because flutter has advantages, namely ease of operation, speed of access, and completeness of access (Hakim et al., 2019), as well as good animation.

Design Stage

In the design stage, the interactive media design is carried out as shown in Fig. This interactive media has four main menus, the menus include Competence, Diagnostic Tests, Materials, and Quiz. This interactive media is made on an android basis with apk format. The developed interactive medium for temperature and heat has the following product specifications. The media developed is in apk format, so it can be run on Android-based devices. On the first page, there is a biodata and password, so that not everyone can access it. There are Temperature and Heat materials that are in accordance with the Basic Competencies that are displayed sourced from the 2013 Curriculum. There is also a Diagnostic Test so that students understand the initial understanding before reading the material and will understand how much students understand after reading the material by filling out the Quiz. In the material, there are interesting pictures and animations, and there are also examples of 10 questions. In its use, it does not require to connect to the internet (Offline) so it can be accessed even if there is no data package.

Development results

The results of the products that have been developed starting from the initial page display are shown in Figure 1. On this page, there are two Text Fields that must be filled in to enter the next page, namely the menu page. The name will be filled with the full

name while the password will be filled with the numbers that have been given in the user manual.

Figure 1. Application start page

The next page is a menu page that displays four menu options in order according to the number above the menu. The four menus consist of Competence, Diagnostic Test, Material, and Quiz as shown in Figure 2.

Figure 2. Application menu page

On the Competence menu, there are Basic Competencies (KD) of Temperature and Heat in accordance with the 2013 Curriculum.

In the Diagnostic Test menu, there are 16 questions in the form of true or false statements with one point, the question is one point. This diagnostic test has the aim to identify students' concepts before reading the material in the application. The test menu is shown in Figure 3.

Figure 3. Diagnostic test page

Furthermore, on the material menu, there is a choice of material from Temperature and Heat then by pressing the button. In the last menu, namely the Quiz menu, there are 15 multiple choice questions with a deadline of 3 minutes or 240 seconds with the time mark at the top. Students who answer will immediately come out with incorrect or correct answers after answering 15 questions, the correct answer score will come out from the Quiz with a total of quiz questions.

Develop Stage

In this phase, the validation process is carried out by material and media experts, namely physics lecturers and high school teachers. Validation by material and media experts includes content validation and constructive validation. Based on the validation, a revision was made.

Three aspects that are assessed in material validation include: Content Aspect which consists of the suitability of the material displayed with Basic Competencies, material according to the cognitive level of students, material concepts in accordance with the truth of physics theory, the material provided is comprehensive and appropriate for students, and The last is supporting images and animations according to the material presented. Aspects of the Diagnostic Test consist of language in which questions are easy to understand and do not cause double meaning, the questions given are in accordance with the material concepts of the truth of physics theory, and diagnostic questions can explore students' initial conceptual understanding. For the Quiz Aspect which consists of the language used in the questions that are easy to understand and do not cause double

meaning, the questions given are in accordance with the material concepts of the truth of physics theory, and the questions on the quiz are appropriate for the student level.

Based on the results of the research, quantitative data obtained from the validation test on the content of the developed interactive media are shown in Table 4.

Table 4. Content Validation Test data results

No	Aspect	Average of Score Percentage	Validation Category	
1.	Content	86,7%	VeryValid	No Revision
2.	Diagnostic tes	80%	Valid	Slight Revision
3.	Quiz	80%	Valid	Slight Revision
Average		82,2%	Very Valid	No Revision

The results of the validator's assessment related to content can be seen that in general, the content of interactive media has been developed with an average validity of 82.2% which means it is very feasible so there is no need for revision. Suggestions from the validator are improvements to competencies, especially indicators of achievement of basic competencies and concept maps that must be changed.

There are five aspects that are assessed in content validation, including the Display aspect or layout consisting of layouts, button navigation, then the composition of the colors used, and the selection of fonts (letters). The next aspect is the language consisting of the language used is communicative, clear, and does not have multiple meanings. Furthermore, the Image and Animation Aspect consists of the suitability of images and animations, as well as images and animations that are presented in an attractive and clear manner. The fourth aspect is Usability, which consists of the functions of the buttons running well, and their easy use. The last aspect is Android and Installation consists of Installing applications on Android which is not complicated and easy to do than using the format that is currently popular.

From the validation test on the developed interactive media constructs shown in Table 5.

Table 5. Data Result of Validation

No	Aspect	Average Score	Validation Category	
1.	Display/layout	86,7%	Very Valid	No Revision
2.	Language	88,9%	Very Valid	No Revision
3.	Picture and animation	93.3%	Very Valid	No Revision
4.	Usability	96,7%	Very Valid	No Revision
5.	Android and Installation	100%	Very Valid	No Revision
	Average	93,1%	Very Valid	Very Valid

The results of the validator's assessment related to the interactive media construct can be seen that the interactive media assessment has been developed with an average validity of 93.1% which means it is very feasible so there is no need for revision. As for suggestions from the validator on the display after the initial display to make it attractive. Based on the validation there is a suggestion from the validator. The results of the revised product suggestions are shown in Figures 4 and 5.

Figure 4. Revised Indicators of Achievement of Basic Competencies (IPKD)

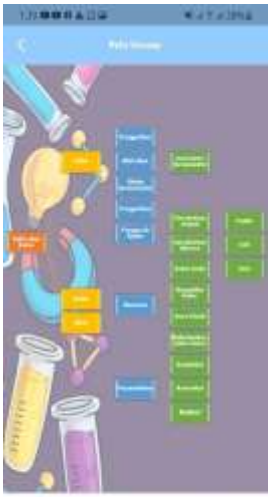

Figure 5. Revision of Concept Map

Then a small group trial and an online field trial were conducted. The results of the group trial were the readability test of the product being tested on 21 students of class XII MIPA in one of the Panjura High School classes as a response. This readability test is to determine the feasibility of the media that has been developed. At this stage students as respondents were asked to try the application with installation instructions on youtube, and instructions for use in the form of photos, after which students filled out a questionnaire via a google form, all of which were sent in class groups. The results of the feasibility test are shown in Table 6.

Table 6. Feasibility Test data results

No	Aspects	Average Score	Validation Category
1	Display/Layout	100%	Very Feasible
2	Language	98,3%	Very Feasible
3	Images and Animation	92,5%	Very Feasible
4	Usability	87,5%	Very Feasible
5	Motivational Aspect	97,5	Very Feasible
Average	95,2%	Very Feasible	

The results of the feasibility test of interactive media can be seen that in general, the content of interactive media has been developed with an average validity of 95.2% which means it is very feasible to use. As for suggestions from respondents in the quiz, the time is too fast.

The advantage of the learning media developed is that students can download applications easily, even though there is still no permission from Google Play. The use of the application is easy and even if there is no internet connection it can be used. Made with interesting animations and pictures so that it can increase student learning motivation. There is a concept map in the Competency so that students understand what is being learned on the topic of temperature and heat and the material is made interesting, there is also a Diagnostic Test that will show values so that they understand how much students understand the concept before reading the material then after reading the material students can also measure how much the student's understanding of the concept through the Quis will show the value as well. The advantage of this application is that it can be used in landscape and portrait views on Android. The drawback with this interactive learning media is that according to the validator, the questions on the material are already interesting but it is better to make them more interesting with moving animations and also the questions on the existing diagnostic tests can be made easier than the questions in the Quiz later from The research subject for the feasibility test said that the time in Quiz seemed faster or less long for the song and also they said they developed media could not be downloaded through the Playstore and could only be used for Android users, for iOS it could not.

According to Junedi & Sari, (2019) it is said that participants' mathematical understanding can be improved by providing concept maps in the learning process. In physics, mathematics has an important role in building students' understanding (Sulam, et al, 2020). A diagnostic test is a tool to determine the level of understanding of students' concepts (Vellayati et al., 2020). Based on this, students become in accordance with the interactive media that have been made, there is a concept map in the "Competency" menu and there is also a "Diagnostic test" menu so that students will understand the understanding that has not been understood then will read the material in the "Material" menu. According to research by Putri et al., (2021), interactive media with an attractive appearance and not boring can increase students' learning motivation. In accordance with this interactive media has been designed as attractive as possible to increase students' learning motivation during a pandemic. According to (Nurrita, 2018) said that learning media can motivate students not only with elements of art but also make it easier to learn subjects so that students' motivation or enthusiasm for learning can increase. This is

important because a good understanding of the concept must be achieved by students (Rivaldo, et al., 2019; Rivaldo, & Taqwa, 2019; Taqwa, et al., 2019; Saputri, et al, 2019; Taqwa, & Faizah, 2016; Taqwa, Hidayat, & Sutopo, 2016). Like this interactive media, students can learn the material easily with the buttons. Based on the results of the feasibility test by students, it was found that the interactive media developed received a positive response from students.

CONCLUSION

An application was developed as an interactive learning medium, which can be used via Android with various menus to support or improve understanding of concepts and students' learning motivation. But there are still some shortcomings, namely, the questions contained in the diagnostic test are too difficult compared to the Quiz questions and also still cannot be downloaded via the Playstore and cannot be used for iOS users.

The results of the study indicate that a media that is claimed to be valid and feasible for learning physics has been developed. According to the data that has been obtained in the content validity test with an average of 82.2% with very feasible criteria, construct validity test with an average result of 93.1% with very feasible criteria and feasibility test with an average result of 95.2% with very feasible criteria.

Based on the results of the study, it was found that in interactive learning media, the questions on the diagnostic test were even easier than Quiz and could not be downloaded via the Playstore and could only be used for Android users, for iOS it could not. The appearance of the material is made even more interesting with moving animations.

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