

# **DEVELOPMENT OF ELECTRONIC MODULES BASED INKUIRI ON PHYSICS LESSON MATERIALS OF TEMPERATURE AND KALOR IN SECONDARY SCHOOL**

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## **Abstract**

Physic electronic module inquiry-based in the main subject of temperature and heat valid, practical and effectiveness to the learning result for senior high school were successfully developed. The research method used development research with the Hannafin and Pack model and Tessmer evaluation. Stages performed in this study include the planning stage, the design stage, and the development stage. In the evaluation phase using Tessmer's evaluation, which consists of 5 stages: self-evaluation, expert evaluation, one to one evaluation, small group evaluation and field test. The subjects of the study were students of science class XI Muhammadiyah Senior High School 3 Palembang. The validity of this electronic module is assessed by four experts namely material experts, media experts, software experts and design learning experts. Expert or validator results obtained by 0.78 from material experts, 0.82 from media experts, from software experts 0.87, and 0.75 from design learning experts, so that developed electronic modules are valid and can be tested as suggested. The practicality of electronic modules can be seen from the quantitative assessment of learners from one to one evaluation trial consisting of 3 (three) students who have high ability, moderate and low. Then a small group evaluation trial consisting of 9 (nine) students. The average result of the quantitative assessment of the practicality of the electronic module is examined in one-to-one evaluation and small group evaluation of 0.84 with very high category, so it can be concluded that practical module is very practical in learning. The effectiveness of this electronic module is apparent from the learning outcomes which show an increase with N-gain of 0,66 which is included. This shows that physics electronic modules inquiry-based on temperature and heat materials that have been developed have effectiveness to learners' learning outcomes.

**Keyword:** Physics Electronic Module Inquiry-Based, Temperature And Heat

## **PRELIMINARY**

The whole process of education, especially in schools, is inseparable from learning activities, learning activities are the most important activities in education, therefore learning is very important. Learning is a process of change that changes behavior as a result of interaction with the environment in fulfilling the needs of his life (Slameto, 2010).

Physics is the fundamental science that becomes the backbone for the development of science and technology (Supiyanto, 2004). Physics is also an empirical study, meaning anything that is known about the physical world and the principles relating to its behavior is studied through observation (observation) of natural phenomena (Sutarto, 1998). Marjorie.dkk (2018), "Physics curricula should inculcate creative thinking and critical analysis in students". Based on what Marjorie said, the physics curriculum should be instilled with creative thinking and critical analysis on the students. In learning physics itself learners sometimes have difficulty to participate actively, think creatively, and can

analyze. Some of the causal factors are the planting of inadequate material concepts, the readiness of learners in receiving the subject matter, the lack of learning strategy to explain the learning, answer the questions, or the exercise problems, and the lack of utilization of the latest technology so as to get less satisfactory learning outcomes . Learners expect that educators are able to develop teaching materials that can help learners become motivated and actively to learn, thus causing learning outcomes to increase.

The development of a good electronic physics module will provide benefits for learners, such benefits can provide convenience to learners to understand the concepts of physics, and relate learning physics in everyday life, and can be used as a variety of teaching materials that can encourage learners to learn independently, creatively, and effectively in the process of learning to achieve mastery of competence, so that learners' learning outcomes in accordance with the expected.

Research conducted by Sugiyanto et al (2013), states that the E-module based flip book maker get a positive assessment because learning materials become very easy to understand by students, in addition to the operation of the module is very easy. In line with the above research Adriani (2014), reported that the learning media that is able to accommodate learners in his research is electronic module (E-module). Utilization of E-module will be maximal if packed with the appropriate learning, one of them is with guided inquiry learning. This guided inquiry-based e-module is valid with mean percentage of 88.1% so that this guided inquiry-based e-module is suitable for use as an alternative teaching material at school. The result of t-paired t-test analysis shows that the significance value  $(0,000) < 0.05$  so that  $H_0$  is rejected, it is concluded that the use of E-module has significant effect on critical thinking ability, mastery of concept and scientific attitude of learners.

From previous research that said that E-module can help in learning hence researcher try to do development by using electronic module in process of learning, to be in accordance with goal of independent student and active in learning so that can yield result of learning which is desired then digunakan is form of learning one of them is by inquiry. Inquiry comes from word to inquire which means participating, or engaging in asking questions, seeking information, and conducting investigations.

Sularso.dkk (2017) "Inquiry as a way of studying scientific problems in a real-life context inquiry-based learning is effective for improving learning outcomes, student enthusiasm in following practice activities, and student attitudes in learning". Inquiry learning aims to provide ways for students to build intellectual skills (thinking skills) related to thinking processes. According to Hardianti.dkk (2017) "In inquiry learning, learners have more personal experience of the process of the scientific quest for knowledge so that it gives them the meaning of perception and causes their science process skills to grow", he said that in learning inquiri learners will have a more personal experience in the process of scientific knowledge seeking so as to give them meaning, perception, and cause the ability of their scientific processes to flourish.

According to Hussain (2011) "Student inquiry is defined as a versatile activity that involves making observations, posing questions, examining books and other sources of information to see what is already known; planning investigations; reviewing what is already known in light of the student's experimental evidence; using tools to gather,

analyze and interpret data; proposing answers, explanation, and predictions; and communicating the results".

In physics learning alone, temperature and heat materials are very possible for teachers to use inquiry-based electronic modules. Bellarmine (2014) "Information and Communication Technologies (ICT) in education is a welcome development / revolution but not without some limitations or restrictions", that ICT in education is the future and a revolution without limitation. Media with electronics can help students improve understanding, present data attractively and reliably, facilitate interpretation of data, and condense information (Asnawir and Usman, 2002). In the study of physics itself a lot of material that is abstract is needed illustration and depiction, one of which is how to explain the process of heat transfer by factors that affect the occurrence of such displacement by conduction, convection, and radiation.

The development of a good electronic physics module will provide benefits for learners, such benefits can provide convenience to learners to understand the concepts of physics, and relate learning physics in everyday life, and can be used as a variety of teaching materials that can encourage learners to learn independently, creatively, and effectively in the process of learning to achieve mastery of competence, so that learners' learning outcomes in accordance with the expected. In relation to the above view, the main objective of this research is to develop inquiry-based electronic modules in physics subjects of temperature and heat in high school. The formulation of the problem in this research is how to develop the inquiry-based electronic module on physics subjects of temperature and caloric material in high school that is valid, practical and effective.

Based on the description above, the goal to be achieved in this research is to produce physics-based electronic module inquiry on physics subjects of temperature and caloric material in high school that is valid practical and effective. Benefits that can be gained for learners is a new experience in learning, so that the understanding of the concept of learning is increasing, for teachers to be one of the learning media that can help create an active, creative, and innovative learning, especially in physics learning. For this research school is expected to add teaching materials in the form of modules that can facilitate the quality of learning and improving the quality of learning in schools so that ultimately can provide the quality of achievement of good learning goals. For other researchers it can be reference material and reference for other relevant research.

## **LITERATURE REVIEW**

Learning is a life-long process (Khodijah, 2014). A person is considered to have learned something if he can show changes in his behavior. Learning is a form of growth or change in a person expressed in new ways of behaving thanks to experience and practice, new behaviors such as from not knowing to know, new insights, and new awareness in a person as a social being (Zainal, 2002).

It is said that learning is a conscious effort undertaken by the individual in behavioral change through practice and experience involving cognitive, affective, and psychomotor aspects in order to attain certain goals (Aunurrahman, 2010). Learning is the work done by educators or other adults to make learners can learn and achieve maximum learning outcomes (Khodijah, 2014). From the opinion of some experts above, it is concluded that learning is an important process in the life of each person and is a change that occurs within a person in behavior change through practice and experience.

In learning humans interact through images and symbols, then humans enter the second world in communication ie human beings have the ability to communicate through writing (Stevany, 2014). Ruffi (2015) "Applying the traditional approach to learning is not necessarily wrong. But ideally a good learning process puts a lecturer as a learning manager ". Humans are increasingly developing and creating a variety of technologies to existing technology at the moment, all of these knowledge make progress especially in the learning process. The development of information and multimedia technology has spawned Computer Assisted Learning (CAL), which is computer programs that can be used as teaching aids that help teachers in explaining and helping students to more easily understand the subject matter (Cecilia, 2004).

Physical learning studies issues related to natural phenomena and various problems in everyday life. Natural phenomena can be viewed from the object, the problem, the theme and the scene. Physical learning requires investigative activities either through observation or experimentation, as part of scientific work involving process skills based on scientific attitude. In addition, physics learning develops curiosity through findings based on direct experience made through scientific work (Sutrisno, 2006). Collette and Chiappetta (1994) state that "science is essentially a body of knowledge, a way of thinking, and a way of investigating" "A more precise statement of the essence of science is as a product to substitute the claim of science as a body of knowledge, science as an attitude to substitute scientific statements as a way or way of thinking, and science as a process to substitute scientific statements as a way of investigating ("a way of investigating").

Through scientific work, students are trained to utilize facts, build concepts, principles, theories as the basis for analytical, critical and creative thinking. In physics learning, students can master at least four things, master the concepts of physics, skillful use of thinking skills and motor skills, have positive attitudes as those of physicists, able to apply the concepts of physics and have the thinking skills to solve problems daily.

Teaching materials are all forms of materials used to assist teachers / instructors in carrying out teaching and learning activities in the classroom, one of which is a module. A module is a systematic and compelling teaching material that includes material, method and evaluation content that can be used independently. Suharjono, said that the module is the material that is compiled and presented in writing in such a way that the reader is expected to absorb the material itself, with the aim as self-learning material of students (Kunandar, 2011). Sudarmin (2016), The contents of a module should be complete, either viewed from the pattern of dish, let alone the contents. "The module is compiled based on problem analysis, requirements analysis, then validates against the validation of content, language and display module substance additives based ethnoscience."

Modules are usually used as self-study materials. In addition, the module can contain learning objectives, materials, activities to achieve the objectives and evaluation of the achievement of learning objectives. Along with the development of the current module era can be combined with ICT, therefore from a form of instructional materials in the form of modules related to electronic, that is electronic module.

The electronic module can be defined as a form of presentation of self-study materials structured systematically into the smallest learning unit to achieve a particular learning objective, presented in an electronic format, in which each learning activity in it is linked to links as navigation that enables participants students are more interested in

learning, with the presentation of video, animation, and audio to enrich the learning experience of students (Salsabila, 2013). Electronic modules that can be accessed by learners have different benefits and characteristics. If viewed from mafaatnya electronic module alone can make the learning process more interesting, interactive, can be done anytime and anywhere and can improve the quality of learning.

In the development of this electronic module using base inquiry. Hiararqi of inquiry is an approach to instruction that systematically promotes the development of intellectual and scientific process skills by addressing inquiry in a systematic and comprehensive fashion. Stages of hiararqi of inquiry are intended to facilitate teachers in applying inquiry gradually and continuously by observing students' intellectual abilities (Wenning, 2011). Hiararqi of inquiry is a pedagogical pedagogical hierarchy associated with the inquiry process (Wenning, 2005). Wenning (2005) grouped five sequences in implementing activities berinuirri namely discovery learning, interactive demonstration, inquiry lesson, inquiry lab, and hypothetical inquiry.

The development of this module uses the Hannafin and Peck Models, a model consisting of three phases of the requirements analysis phase, the design phase, and the development and implementation phase (Hannafin& Peck, 1988). In this model, assessment and repetition need to be executed in each phase.

In the manufacture of electronic modules based on inquiry on the physics of temperature and heat material is needed some software supporters to make it, which include Adobe Flash CS6 and Adobe Photoshop CS3

## **RESEARCH METHODOLOGY**

Type of research used in this research is research development. According to (Sugiyono, 2010), research development is a research method used to produce a particular product and test the effectiveness of the product. This research will develop physics-based in physics module in class XI

In this development study, researchers used the Hannafin and Peck development model. Hannafin and Peck's development model is a product-oriented development model. Hannafin and Peck Procedures are the requirements analysis phase, the design phase, and the development and Implementation phase.

In the phase of the needs analysis activities include identifying the needs in developing physics-based electronics module inquiry, determine goals, view knowledge and target proficiency, prepare the need for the manufacture of electronic modules based on inquiry. The design phase aims to identify and document. Documenting the point is to produce a storyboard form that includes learning activities based on learning needs. And in the phase of development and implementation of activities carried out generate flowcharts, then tested, and assessment of the product. The results of this assessment and testing process will be used in the adjustment process to achieve the desired media quality.

To obtain the necessary data in this study conducted data collection through (1) walkthrough; (2) interviews; and (3) the questionnaire, and 4) the test of learning outcomes, the evaluation using Tassmer's evaluation to obtain the data of the researchers obtained validation data from the opinion of media experts, material experts, design learning experts and software experts. Interviews were conducted on preliminary study

activities to teachers and students, and tests were used to determine students' learning outcomes after using electronic physics modules

## **RESULTS AND DISCUSSION**

Researchers have successfully developed a valid, practical, and effective inquiry-based electronic module that has effectiveness on student learning outcomes. This is in line with research conducted Ditama (2015) which shows that the use of electronic modules are made using Adobe flash software that includes an interesting animation will facilitate students in learning the subject matter. Hadiya (2015) in his research on learning with problem-based modules developed already meet the valid, practical, and effective criteria of learning outcomes, and this can significantly increase student learning interest, and, according to Eka (2015) based on electromechanical module using Macromedia Flash 8 on Fluid material results obtained by the use of learning media can provide a positive response to learning.

In this research development research with reference to the development model of Hannafin and Peck so that generated electronic module based physics inquiry. This research has been conducted in SMA Muhammadiyah 3 Palembang and involve students of class XI IPA 2. This research uses development research approach with development model from Hannafin and Peck.

Stages undertaken in this development form the stage of needs analysis, design, development and implementation. The data collection instances used in this study, ie walkthrough, interview, questionnaire, and learning result test. The developed electronics module is valid. Validation results from the validator in addition to comments and suggestions are used as a reference to revise the electronic module products that have been developed. The average result of the assessment of the four aspects of material aspect, media aspect, software aspect, and instructional design. The result is the number of 0.78 from the material experts, 0.82 from the media expert, from the software experts 0.87, and 0.75 from design learning experts. The average of the results of the expert's assessment of 0.80, the validation results stated that the electronic module on the temperature and heat material is feasible to be used in the learning after various revisions are made.

Electronic modules that have been developed are then tested for practicality and have been declared practical, it is obtained after performing the stage one-to-one evaluation and small group evaluation. In one-to-one evaluation is seen from the questionnaire to 3 (three) students while in small group evaluation performed on 9 (nine) students. Thus the average result of the quantitative assessment of the practicality of the electronic module dilihat on one-to-one evaluation and small group evaluation of 0.84 with very high category, so it can be concluded practicality of the module is very practical electronics practical tested and used in learning that is categorized very practical for learners use.

Electronic modules that have been developed also have effectiveness to learners' learning outcomes. This is seen from the results of the initial test students obtained averaged 40.83 while the final test of students using electronic module obtained 79.50, while the average results of learning outcomes of learners to obtain N-gain score of 0.66 are included in the medium category.

When viewed from the comparison of high, medium and low value criteria can be seen in the following figure:

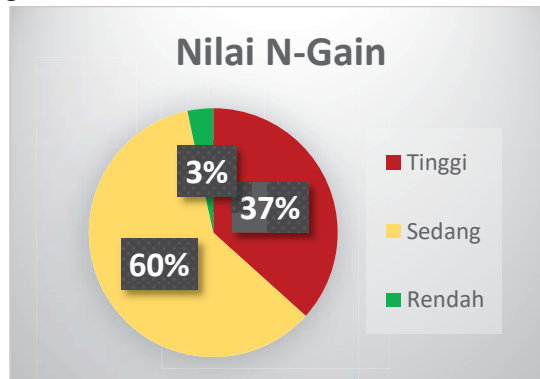


Figure Diagram Comparison Learning Results Students Based on N-Gain Value Criteria

Learning outcomes on learners based on N-gain is with a high percentage rate obtained 37%, medium 60% and low 3%. The recapitulation result is categorized moderately with an N-gain value of 0.66 based on the N-gain value criterion if  $0.3 < N\text{-gain} \leq 0.7$  is categorized as being.

## CONCLUSIONS AND SUGGESTIONS

Based on the results of research that has been done on the development of physics-based electronic module inquiry on temperature and heat materials, it can be concluded as follows:

The developed electronics module is valid. Validation results from the validator in the form of comments and suggestions are used as a reference to revise the electronic module products that have been developed, also in the form of a quantitative assessment of electronic modules that have been developed. The average result of the assessment of the four aspects of material aspect, media aspect, software aspect, and instructional design. The result is the number of 0.78 from the material experts, 0.82 from the media expert, from the software experts 0.87, and 0.75 from design learning experts. The average of the results of the expert's assessment of 0.80, the validation results stated that the electronic module on the temperature and heat material is feasible to be used in the learning after various revisions are made.

Electronic modules that have been developed have been practical, it is obtained after the stage of one-to-one evaluation and small group evaluation. In one-to-one evaluation is seen from the questionnaire to 3 (three) students while in small group evaluation performed on 9 (nine) students. Thus the average result of the quantitative assessment of the practicality of the electronic module dilihat on one-to-one evaluation and small group evaluation of 0.84 with very high category, so it can be concluded practicality of the module is very practical electronics practical tested and used in learning that is categorized very practical for learners use.

The electronic modules that have been developed have effectiveness to the learners' learning outcomes. This is seen from the results of the initial test students obtained averaged 40.83 while the final test of students using electronic module obtained 79.50,

while the average results of learning outcomes of learners to obtain N-gain score of 0.66 are included in the medium category.

The suggestions that can be given are as follows:

1. For other researchers, it is expected to develop an in physics-based physics-based electronics module on other materials or lessons and, and to develop more effective and structured evaluation questions.

2. For educators, it is advisable to be able to develop a physics-based electronics module inquiry in the field of study that is facilitated to facilitate the delivery of materials in the learning process

3. For the school, it is expected that this physics-based in physics-based electronics module is used as teaching material on physics subject in class XI and it is better to improve the quality of learning

4. For students, it is expected to use the physics-based electronics module inquiry in order to facilitate learning independently and provide a positive response to the learning media to get better learning outcomes

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