Guide inquiry science e-module development for improving junior high school students’ scientific literacy

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Abstract. The first-grade students of SMP Negeri 9 in Jambi City experience difficulties in understanding science concepts, especially temperature and heat. Their ability to process numbers has also not been optimally developed. There is a need for teaching materials in the form of a learning module that is easily accessible for students to learn independently and better. This study aims to produce a product in the way of guided inquiry-based electronic learning modules to contain instructional materials and learning media that are easy to use and contextual, with a clear and understandable language and delivery. The development model used is the ADDIE model. The study result has been analyzed using the descriptive qualitative method. The development process has been carried out a prototype electronic learning modules with a science literacy load on the learning material presented. The individual test results and small group trials show that the electronic learning module is easy to use and easy to understand with an attractive design. Furthermore, the electronic learning module has a positive impact on improving learning and reading motivation and the ability to process numbers. It is an electronic module that potentially enhances students’ science literacy.

1. Introduction
Science is a learning process to understand many phenomena in nature systematically. Science is focused on knowledge as a product and provides enough space for students to develop their scientific skills. Science can also train students to solve problems and applied them in real life.

Improvement of science learning quality and collaboration between non-science subjects is one way to develop science literacy [1]. Science literacy can also define as another way to develop mindset, behavior and build up human characteristics to care and responsibility for themselves, people and nature, and the problems faced by modern society that rely on technology. Therefore, it can be inferred that science literacy is the basic knowledge that people must have in using knowledge and scientific skills when solving any problems in daily life.

Several factors significantly affect science literacy, including those stated by [2], namely reading skills, mathematics abilities, and educational facilities. Scientific terminology is knowledge of terms commonly used to study scientific research, practicum, and other scientific activities. This knowledge needs to be mastered by students because it is universal and is one factor supporting the development of science literacy[3]. This is in line with science communication, which also includes Scientific nomenclature, which influences students in conveying the ideas they think about solving the given
scientific problems. Besides, [4] added that the quality of learning, assessment, and textbooks used had a major effect on students' science literacy.

Based on the results of preliminary observations made at SMPN 9 Jambi City, it was found that several factors that influence science literacy are still not maximal. Among them is the limited access to science textbooks by students; this causes independent learning can not be achieved well. In addition, the ability to process numbers and the ability to understand scientific terms is not yet balanced with the reading skills of students. This is also due to the lack of scientific reading material that attracts reading interest.

Exposure to problems and facts that have been previously described, it appears that learning materials are needed that are easily accessible and used independently by students. Teaching materials that meet these characteristics are electronic modules. The electronic module developed must be able to accommodate the ability to read and count and improve cognitive, affective, and psychomotor aspects in a balanced manner. The electronic module aims to improve students' science literacy. Therefore the electronic module is developed based on the step of the guided inquiry learning model.

Modules are a form of teaching material, where according to [5] the module is a visual verbal-nonverbal-graphic message channel. Furthermore, [6] describes modules as teaching materials that are arranged systematically with language that is easy to understand according to the level of development, age, and knowledge of students to be studied independently and with minimal guidance. Electronic modules are superior in terms of flexibility in use and a more interactive display of the module, so the learning process is fun and easy.

The electronic module is presented in PDF format, based on ease of use. This was revealed by [7] that PDF files could be easily used only by using the software in the form of a PDF Reader, which can be downloaded for free and is easy to operate on various electronic devices. The use of learning media in PDF format has been widely used, one of which is in medical education, such as research conducted by [8], which has developed learning media in PDF format for the human body's anatomy.

The inquiry learning model is a learning model that can be used to train students to be accustomed to doing scientific methods in solving problems and carrying out science literacy while learning in the class [3]. One learning model that is naturally capable of facilitating science literacy development is the guided inquiry learning model[9]. Inquiry learning is focused on students as the center of learning. Students will ask questions, seek answers, and design research. This is done to answer existing questions so that there is a discussion between students and teachers. This study aims to determine development procedures, usage procedures, and the impact of using guided inquiry-based electronic modules.

2. Research Methods
The development of this guided inquiry-based electronic module is research that belongs to the type of research and development. Guided inquiry-based electronic modules are developed using the ADDIE (Analysis, Design, Development, Implementation, and Evaluations) development framework.

2.1. Analyze
The first step in this research is to analyze learning in schools. The analysis carried out in this study includes analysis of needs, analysis of the learning environment, and analysis of student characteristics. This stage aims to ensure that the product developed is following the requirements. Data at the analysis stage were obtained by conducting interviews with science teachers and giving an open questionnaire to 20 students representing all VII grade SMPN 9 Jambi City. The learning environment analysis is carried out to determine the learning environment conditions, existing learning materials, learning support facilities, and required resources. The study of student characteristics was carried out to get data regarding age, level of the learning experience, student learning abilities, learning styles, perceptions, perceived needs, and student personality.
Based on the analysis stage, it was obtained data that the limited access to science learning materials by students resulted in learning independence being difficult to achieve. Besides, there is a need for a learning process that can optimize learning outcomes in the cognitive aspect, where one of the causes is the ability to process numbers and understand scientific terms that have not been optimally developed. Students' average age is 12-13 years, where students like the audiovisual way of learning. Most students can understand well if the learning process combines discussion, demonstration, and lecture learning methods. Therefore, science teaching content is needed that helps students learn independently and are of interest to students for optimal learning outcomes. It aims to develop natural science literacy. The solution offered is to develop teaching contents in electronic learning modules that are easily accessible to students anywhere and anytime. Students’ ability to process numbers students still need guidance. This condition makes students have difficulty understanding the science concept that requires processing numbers, especially temperature and heat.

2.2. Design of electronic module
The design stage is the stage of designing the electronic science module based on pedagogical and non-pedagogical aspects. The electronic module is arranged based on the learning process with a guided inquiry model to improve students' science literacy skills. The design of the electronic module arrangement is the same as the module arrangement in general. According to [10], the module must consist of a title, a table of contents, an information map, a list of competency objectives, an initial test, a description of the material, an assignment, a summary, a glossary of terms, a final examination and an index.

This stage includes determining the required resources, the learning model used, defining the scope, structure, and learning message. A storyboard is also made as a guiding line to develop a
2.3. Development of an electronic module

The development stage is the step of realizing the electronic learning module design that was made in the previous stage. The electronic module that was developed contains scientific content about temperature and heat. The learning material's presentation is adjusted to the four science literacy content presented by [11]. Science as a body of knowledge is presented in the form of a description of the temperature and heat material, which is divided into seven units. Then, science's content as an investigative step is manifested in a learning unit that contains simple experimental steps. The display of simple experimental steps can be seen at Figure 3. Each learning unit is equipped with a learning video containing simple experiments that are easy for students to follow independently.

Figure 3. The display of simple experimental steps and QR Code Video
Science as the way of thinking is presented using guided inquiry learning steps to direct students in the independent learning process using modules. The electronic module material is also equipped with contextual examples to facilitate the relationship between science, technology, and society. These examples are presented in various forms, ranging from images, illustrations, and pictorial stories to learning videos that are presented using QR Code (Figure 3).

The learning module is presented in PDF format and can be accessed with electronic devices in the form of computers, tablets, or smartphones. Based on the analysis that has been done, this electronic module can operate properly using the Foxit PDF reader program. By using this program, the learning videos in the module can run well. In addition, students also find it easier to input text in the answer columns that have been provided. The program can be accessed for free on various electronic devices.

The electronic module display that has been designed is realized using Microsoft Word 2010 and Camtasia 2018. After that, the electronic module format has been changed from docx to pdf form. Then the module is tested and evaluated to see what parts are lacking and not working properly. The display some examples of electronic module layouts can be seen at Figure 4.

![Figure 4. The display some examples of electronic module layouts](image-url)

The development stage also includes the stage of validating the product that has been developed. [12] explains that product validation is the assessment of a product by experts. Three expert validators carry out the validation stage as conceptual validation, namely product design experts, content experts, and learning design experts. On the other way, the validation of practitioners was carried out by science teachers. The validation process is carried out using open questionnaires and interviews. Validation results are used as a reference for product improvement.

2.4. Implementation of the electronic module
The Implementation stage is the stage where the product that has been developed, validated, and has gone through a formative assessment is ready to be tested. Trials conducted are individual trials and small group trials. Data at the trial stage were collected using observation and deep interview methods. The implementation stage is a direct liaison between the developer and students as product users.
2.5. Evaluation of electronic module
The evaluation stage is the stage of evaluating the product being developed. According to [13], evaluation is an effort to ensure the quality of the product being developed is guaranteed. The evaluation carried out at each stage is called formative evaluation, and the results of the formative evaluation are used as material for product improvement or product revision. This aims to control and assess the quality of the processes and products developed so that the products developed are suitable for use in the learning process.

2.6. Data validation and Revision
The validation of the electronic learning module prototype can be carried out through validation steps, namely, expert validation and practitioner validation. Conceptual improvement input was obtained through expert validation. Meanwhile, to get input from a practical perspective is obtained through practitioner validation. Lecturers carry out expert validation at Jambi University. They have competencies in accordance with the validated aspects, while practitioner validation is carried out by science teachers at SMPN 9 Jambi City as learning implementers.

The learning design expert on the validation process gave positive responses to all aspects of the learning design in the science electronic learning module that has been developed. The science electronic learning module as a whole has fulfilled the aspects of the learning design used, including needs analysis, characteristics and learning environment, learning objectives, learning strategies, learning content, assessment instruments, and evaluation.

The validator's suggestions and comments are that questions need to be added to measure the initial abilities or prerequisite abilities that students must have before studying the electronic science module in the introduction. Besides, in the self-reflection section at the end of the learning unit, it is necessary to add questions about students' obstacles when studying the unit's material. According to [13][14], self-reflection is the act of describing itself about what has been felt, seen, and known to form new understandings or increase knowledge in learning and what to do next.

The product design validator assesses the feasibility of the science electronic learning module being developed on product appearance and effectiveness. The product design validator gave a positive response to the electronic science module being developed. The validator's suggestions and comments are that there was a need for improvement in the learning video's appearance. Then on the front cover of the electronic module.

The content expert provides suggestions for improving the writing of words and sentences in the instructions for using the electronic module, correcting sentences in the prerequisite ability section, and adding pretest questions to measure students' initial abilities. It is necessary to add a special section containing experimental steps to facilitate the psychomotor skills of students. Based on the content of validation results, the learning materials had been presented following scientific and contextual developments supported by facts, examples, pictures, concepts, and procedures on the subject of temperature and heat, which are presented accurately from relevant sources. Learning materials had been presented systematically, coherently, and well-integrated.

The development of the science electronic learning module requires practitioners' views and input as a bridge between the expert and the user's conceptual views in terms of product practicality. In developing the electronic learning module, the practitioner validator is one of the science teachers at SMPN 9 Jambi City. The validator gave a positive response to the electronic module being developed. The learning content was presented in this module is in accordance with the learning objectives to be achieved. The electronic module is also easy to use. The display of the electronic science module is also interesting. Of course, it will make students interested in using it and is equipped with contextual learning videos. In addition, the use of this electronic module will save time, effort, and cost.

3. Results and Discussion
The guided inquiry-based electronic module is developed by the development team, which consists of developers (researchers), supervisors, validators, and product users. In this study, the data taken is
qualitative data collected using a research instrument in an open questionnaire. According to \[14\][15], qualitative data is research data that is non-numeric, data in the form of text information, notes, or participant opinion reports. The instrument is said to be valid if it has been tested for validity. The validity test used for this research instrument was content validity.

This study's data collection techniques were observation, interviews, documentation, questionnaires, and daily journal. The data analysis technique used is the qualitative data analysis technique. The qualitative data analysis process is that data is reduced, data is presented, and conclusions are drawn. The suggestions from the validator are processed by correcting the deficiencies of the resulting Guided Inquiry-based Science electronic module draft.

3.1. One-on-One Trials

One-on-One trials are part of formative evaluation that aims to identify errors and improve product use procedures and obtain information on user reactions to materials and messages conveyed by-products. A good product needs to be tested to find out the opinions and input from the product's user side \[10\].

One-on-One trials focus on aspects of clarity, attractiveness, and shortcomings that can be seen immediately during the testing process \[15\]. The test subjects consisted of three students from seventh grade with various abilities. This aims to obtain product improvement data that is more varied according to the diversity of users.

Students' suggestions and comments regarding the electronic module being tested are still not used to use electronic-based learning materials, so students feel uncomfortable searching the page they want to read. Besides, the students who use smartphones to operate the electronic module have difficulty saving their work because the menu features on smartphones are different from those on computers. The corrective steps taken are adding a tutorial for smartphone users.

Based on the results of trials that have been carried out, it is known that students are not accustomed to using gadgets for the learning process. More students use gadgets for communication and entertainment purposes. This habit will undoubtedly affect the motivation and learning behavior of students. \[16\] This habit would cause computer anxiety, where doubts arise in using gadgets and technology effectively in learning. Learning environment factors and parenting styles have a positive effect on the formation of this behavior.

3.2. Small-Group Trials

Small group trials aim to convince students to use the electronic module independently without interacting with the instructor. Small group trials focus on aspects of product use's effectiveness and the potential for the product to be used by a broader range of users \[15\]. The small group trial subjects were ten students from seventh grade with various abilities. Overall, participants responded positively to product development. Students do not find it difficult to understand the material presented in the learning unit they choose because the sentences and grammar used are clear and easy to understand.

The module is also equipped with illustrations in comics and learning videos that make learning more fun and easy to understand. The use of images, illustrations, and appropriate language can add to the learning experience; as stated by\[5\], these three things make a big contribution to developing one’s knowledge.

A variety of exercises can help a lot in improving skills and understanding of the material that has been studied. Examples and illustrations that are current and contextual provide new knowledge for students. In addition, the module also provides a particular chapter on simple experiments; the steps of the experiment are presented in a clear format and sentences. A simple type of experiment is also unique and easy to follow. This makes students excited to try and want to add new experiences. This shows an increase in student interest in learning. Research conducted by \[17\] explained that interest in learning correlates with students’ mathematical literacy development. Students with high learning interests are superior in 4 of the seven components of literacy: the communication component, the reasoning and argumentation component, the strategy planning component, and the components using symbolic language, formal language, technical language, and arithmetic operations.
Presenting a variety of learning media and aiming to improve learning abilities and understanding also aims to facilitate the development of naturalistic intelligence and self-efficacy. This is in line with the opinion [18] that naturalistic intelligence and self-efficacy positively correlate with science literacy development. Therefore, the electronic science module aims to improve students' science literacy on the subject of temperature and heat.

3.3. Evaluation
The evaluation phase is carried out to minimize the weaknesses of the science electronic learning module that has been developed to make it better, easier to use, and in accordance with development objectives. The evaluation in this final stage is a summative evaluation, a comprehensive evaluation of the development process carried out, and the impact of using the electronic science module on students. Based on the results of expert validation, practitioner validation, individual trials, and small group trials, it was found that the electronic science module developed was feasible and met the requirements as a good learning module. The electronic science module is easy to use and can improve students' science literacy skills on the subject of temperature and heat. In the end, the science electronic learning module that was developed was in accordance with the desired expectations.

4. Conclusion
The development of more innovative and efficient teaching materials with simple resources is possible to increase students' understanding and abilities. The electronic module can help students learn independently, and it is easier to understand the concepts of temperature and heat. Besides, this can open up for more in-depth studies of the phenomena that occur in real life. Therefore, this module has the potential to increase science literacy.

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