The development of electronic modules with science literature through direct instruction of impulse and momentum materials

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Abstract. This research aims to produce an electronic module with scientific literacy through direct instruction on impulse and momentum materials and describe its feasibility. The specific objective of this study is to describe the validity, practicality and effectiveness of the electronic module. The research method used is research and development using the ADDIE model (Analyze, Design, Develop, Implement, Evaluate). The test subjects in this study were ten students at one of the senior high schools in Banjarmasin. The data were obtained through the electronic module validity sheet instrument, student response questionnaire sheets, and student learning outcomes tests. The results show that: (1) the electronic module is declared valid with a very high category, (2) the electronic module is declared practical in the good category, (3) the electronic module is declared effective with a gain score of 0.64 in the moderate category. In this study, it can be concluded that the electronic module with scientific literacy through direct instruction on impulse and momentum material is declared fit for use in learning.

1. Introduction
Science education is challenged to prepare quality human resources, which are proficient in science and technology, can think logically, critically, and creatively, and have scientific literacy to solve various daily life problems. PISA is an examination system initiated by the Organization for Economic Cooperation and Development (OECD) to evaluate the education systems of 72 countries around the world. Every three years, 15-year-old students are randomly selected to take a test of three essential competencies, namely reading, math and science. PISA measures what a student knows and what he does (application) with his knowledge. The latest results from PISA (Program for International Student Assessment) 2018 Indonesia were ranked 73rd out of 78 participating countries that participated and got a score of 371 to aspects of literacy, 379 to aspects of mathematics, and a score of 396 to aspects of science. However, it is still low compared with the score OECD average is 487 for a score of literacy and 489 for the score in mathematics and science.

Based on the results of PISA, it can be seen that Indonesia is low in literacy aspects. The research results of the Research and Development Institute of the Ministry of Education and Culture in researching the level of students' scientific literacy, many factors affect students' lack of scientific literacy. One of them is the lack of teaching materials in Indonesia compared to other countries in developing students' scientific literacy [1]. Similar to the OECD, one of the international institutions that evaluates student achievement is the IEA (International Association for the Evaluation of
Education Achievement) through the TIMMS study (Trends of International Mathematics and Science Study), surveying fourth-grade elementary school students and eighth-grade, junior high school students. This survey is conducted every four years. This survey was first conducted in 1999 and last conducted in 2019.

Based on the results of the preliminary studies, it was found that 63.24% of students did not know about scientific literacy, 77.94% of students were not interested and enthusiastic in learning, and 63.24% of students preferred electronic books to printed books. Obtained test results of class X students at one of the senior high schools in Banjarmasin that is 51.43% have not met the Minimum Completeness Criteria applicable at the school. It shows that the test of student learning outcomes is low. One of the reasons for this low level is students' incomplete understanding of learning when receiving information from the teacher. Everyone must have scientific literacy skills, including scientific knowledge, science process skills, and scientific attitudes [2]. Based on statistical analysis results, cognitive learning outcomes only affect 2% of scientific literacy (not significant) [3]. In this study, cognitive learning outcomes and scientific literacy stand alone. There is no significant relationship. Influence each other because each is influenced by several internal and external factors from the environment.

Many studies related to scientific literacy have been carried out, such as scientific literacy comics [4], scientific literacy in contextual-flipped classroom learning [5]. However, so far, there has been no scientific literacy research on impulse and momentum material. The material of impulse and momentum requires students to apply the concepts of momentum and impulse and the law of conservation of momentum in everyday life. This study uses electronic modules that can be accessed easily on various networks (wifi, 3G, and 4G), accompanied by videos, images, and links.

2. Method

The type of research conducted is research and development. Development research is a research method used to produce specific products and test the effectiveness of these products [6]. The purpose of developing the product is to solve the problem in the problem formulation. The research and development carried out is the development of e-modules for high school students. The steps of this research are to use the ADDIE model. ADDIE Model is a systematic instructional design model that includes five phases (Analyze, Design, Development, Implementation, Evaluation).

| Research Stage | Information |
|----------------|-------------|
| Analyze        | The analysis phase consists of two stages, namely, performance analysis and needs analysis. Performance analysis identifies and clarifies whether performance problems require solutions to organize training programs or improve work management. The second stage is to conduct a needs analysis. At this stage, the researcher considers a need to research and develop e-modules containing scientific literacy at one of the senior high schools in Banjarmasin. |
| Design         | The design phase is focused on dealing with and resolving the problems described in the previous analysis phase. The e-module is designed in such a way according to the previous problem analysis. At this stage, the design is based on scientific literacy relating to momentum and impulse material to make students more active in learning and interested in participating in learning activities, deepening material, adding to understanding and insight, and improving student literacy. |
| Development    | At this stage, researchers develop e-modules to foster scientific literacy. E-modules were developed covering the material concept of impulse and momentum, the law of conservation of momentum, and other types of collisions. At this stage, the e-module was also validated by three validators before being implemented. The aim was to determine the validity of the developed e-module. |
Research Stage

Implementation

At this stage, research and development product trials are conducted on a small scale to conduct a series of trials of the learning process. The implementation subjects in this research and development were ten class X MIPA, one of senior high school in Banjarmasin. The trial design used in this study compares the conditions before and after using the developed scientific literacy e-module (before-after).

Evaluation

This evaluation stage includes the feasibility of the e-module. The e-module is declared feasible if it has gone through validity, effectiveness, and practicality tests. Validity testing determines the level of conformity of the e-module with the concept of the material being taught, effectiveness to determine the extent to which the e-module can achieve the expected goals, and practicality testing to determine the extent of ease of use of the e-module.

The trial subjects related to the feasibility of the e-module being developed were ten students of class X MIPA 5, one senior high school in Banjarmasin, for the 2019/2020 school year. The subject of this research is the feasibility of the developed e-module. Feasibility e-module is the suitability of the e-module obtained from the validity, practicability and effectiveness developed. The validity of the e-module is the level of validity of the e-module, which is validated by three validators using a validation sheet. The practicality of the developed scientific literacy e-module is measured based on the student response questionnaires distributed when the e-module learning has been completed. The learning outcomes test (summative evaluation) is used to measure the achievement of student learning outcomes that indicate the level of effectiveness of the developed product and measure the achievement of learning outcomes in the form of mastery of the material. Data on test results on students’ learning outcomes were then analyzed by calculating the difference between post-test and pre-test (gain normality test)[7].

3. Results and Discussion

The developed electronic module contains scientific literacy on impulse and momentum material using the Flip PDF Professional application to present interesting electronic modules accompanied by videos, images and links to help students understand more easily in studying physics material. There are four categories for scientific literacy indicators in e-modules: science as a body of knowledge, science as a way of investigating), science as a way of thinking, and the interaction between science, technology, and society [8].

The validation of the Electronic Module containing scientific literacy through direct instruction on impulse and momentum material was carried out by three validators. The results of the electronic module validation consist of three assessment aspects, content, display and scientific literacy. The recapitulation of the validation results of the electronic module containing scientific literacy through direct instruction on impulse and momentum material is presented in Table 2. The results of electronic module validation are 86.29%, with a very valid category.

| No | Aspect            | Total score | Total score maximum | Percentage Validity |
|----|-------------------|-------------|---------------------|---------------------|
| 1  | Contents          | 158         | 180                 | 87.78%              |
| 2  | Appearance        | 134         | 156                 | 85.89%              |
| 3  | Science Literacy  | 184         | 216                 | 85.19%              |
|    | Category all aspects |           |                     | Very Valid         |
Based on the validation results of the electronic module, the validator consists of three aspects: review the content, look, and scientific literacy in the category of very valid to the category of reliability is very high. The characteristics of the module are self-instructional, self-contained, stand-alone, adaptive, user friendly, and consistent. The first characteristic of the electronic module is self-instructional, meaning that students can learn on their own, not depending on other parties. The second characteristic is self-contained, meaning that the content in the module contains all material (material, worksheets, evaluations) of one competency that students must learn. The third characteristic is stand-alone. The electronic module is said to be stand-alone. In the use of the electronic module, it can be used alone as a complete medium without using other media as a compliment. The fourth characteristic is adaptive, meaning that the electronic module is adapted to the characteristics of students. The fifth characteristic is user friendly. The electronic module meets the rules of being friendly to the user. The last characteristic of the electronic module is consistency. It is consistent in using fonts, spacing, and layout and must be the same and balanced. Electronic modules provide opportunities for students to be active in the process of teaching and learning activities.

The assessment of the scientific literacy aspect in the electronic module is categorized as very feasible. It is because it has fulfilled the aspects of science as a body, science as a way to investigate, science as a way of thinking, the interaction between science, technology and society. Based on scientific literacy, the electronic module presents facts, concepts, principles, laws, theories, models, describing how science is used in technology for society. The presentation of the contents of the electronic module is adjusted in the setting of the direct instruction model.

Direct instruction is a teacher-centred teaching model. The direct instruction model is a learning model to support student learning with the teacher as the centre of the learning process [9]. In addition, this learning model is also shown to help students learn basic skills and obtain information that can be taught step by step. So that this electronic module can be tested in the classroom because the developed electronic module is suitable for use as a guide for learning tools for students.

| Table 3. Results of student response questionnaires |
|---------------------------------------------------|
| Aspect                | Average Score |
| Benefit               | 3.38           |
| Efficiency            | 3.25           |
| Convenience           | 3.30           |
| Science Literacy      | 3.03           |

The practicality of the module was carried out by calculating the average score of the student response questionnaire distributed when learning with the electronic module had been completed [10]. A product is said to have high practicability if the product is practical and easy to administer [11]. There are two types of statements in these four aspects: positive and negative statements. Twenty-five statements exist in the questionnaire responses, both positive and negative statements in every aspect. Once the students learn the material contents contained in the electronic module, the learners complete a questionnaire response online using google form.

The convenience aspect based on Table 3 shows that the electronic module is in the practical category. It means that using an electronic module containing scientific literacy through direct instruction on impulse and momentum material is easy. This developed electronic module makes it easier for students in the learning process because it uses language, words, and phrases. Sentences, and appropriate paragraphs, this electronic module presents animations, videos, images and links that help make it easier for students to understand learning material. This electronic module is more accessible anytime and anywhere than printed books and is easily accessible on various networks. Research conducted in line with Mujizah, Wati, & Mahtari states that students can access electronic modules to be flexible to study independently [12]. The electronic module could be used anywhere because it combines print and computer media to present information in a structured, attractive manner high level of interactivity [13]. Students can teach scientific literacy skills through science subjects [14].
The learning outcomes test is used to measure the achievement of student learning outcomes that indicate the level of effectiveness of the developed product and measure the achievement of learning outcomes in the form of mastery of the material. Data on student learning outcomes test results were then analyzed by calculating the difference between post-test and pre-test (gain normality test). The effectiveness of the e-module is determined from the suitability of the gain score obtained. The results of the calculation of the normality gain test of the student are 23.25 for pre-test average, 72.7 for post-test average and 0.64 for N-gain score with medium category.

The effectiveness of electronic modules is calculated by the N-gain test, which consists of three categories, namely high, medium, and low. The calculation for the cognitive learning outcomes test on the value of each student was carried out by the N-Gain test, from ten students whose data was used in the study and took the pre-test and post-test. The pre-test is a test carried out before being given an electronic module. The Post-test is a test that is carried out after being given an electronic module. The learning outcomes test contains ten multiple-choice questions and six essays that students do. The average post-test scores of students after studying the developed electronic module give relatively good results. It indicates that there is an increase in the ability of students to solve physics problems. It is in line with the research of Zulkarnain, Kadaritna, & Tania, which states that academic ability is a factor from within students in understanding the material [15]. It shows with the results student's response after using module electronics in the process defender's horse. In addition to ability, motivation also affects the higher the motivation, the higher the academic achievement. From the results of the average value of the pre-test and post-test, the results of the N-gain test scores are in the medium category. These results show that the electronic module containing scientific literacy through direct instruction on impulse and momentum material is effectively used during the learning process. It is supported by research that uses the Normalized gain score to measure the effectiveness of the developed product [16].

Overall, students' cognitive abilities have increased compared to before being taught using the developed electronic module, based on the average pre-test and post-test scores. Analysis of learning outcomes tests that have been carried out shows that learning using this electronic module is effective because it can help students achieve learning objectives that direct students to undergo the learning process. The effectiveness is related to how product development can achieve specific goals [17]. This electronic module developed is effective because it is influenced by several factors in which it contains scientific literacy by the 2013 curriculum—appropriate links for strengthening learning materials.

4. Conclusion
This research produces an electronic module suitable for learning physics on Impulse and Momentum material with valid, practical, and effective ways to improve students' science literacy skills.

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