**DEVELOPMENT OF ELECTRONIC SCIENCE MODULE BASED ON INQUIRY TO FACILITATE ICT LITERACY**

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***Abstract* –** This development research aims to arrange products in the form of an electronic science module based on inquiry that can facilitate ICT literacy skills. The R&D model used is 4D. The product feasibility assessment is carried out by material experts and media experts. The feasibility assessment uses the assessment questionnaire sheet. ICT literacy assessment uses observation sheets and assessment questionnaires by students. The ability of ICT literacy is assessed based on aspects of accessing, integrating, managing, evaluating, creating, and communicating information. The product is declared as eligible with the 'very good' criteria to be used based on the assessment of the material experts and media experts. The results of wide-scale trials get the results that the ICT literacy ability of students can be facilitated in learning science using the electronic science based on inquiry The electronic science module product that was developed can facilitate ICT literacy of students with very good criterion criteria based on observational assessments and is vey good based on the results of filling out questionnaire sheets by students.

***Keywords – E-module, Inquiry, ICT literacy***

1. **INTRODUCTION**

The rapid development of information, communication and technology (ICT) in the 21st century has influenced the orientation of educational goals in Indonesia. Improving the quality of human resources (HR) capable of mastering 21st century skills, especially in the field of ICT is one of the educational goals to be achieved. [1] revealed that ICT literacy is one of the skills that must be owned by 21st-century society. The fundamental of changes that occurred in the 21st century have directly changed the existing learning system.

Efforts to realize human resources that master ICT skills can be started by getting used to the use of ICT devices in teaching and learning activities in the classroom. [2] explained that digital/ ICT literacy is one of the foundational principles in the framework of the 21st century learning that students need to master.

The results of the questionnaire about the application of ICT in learning with 32 respondents of science teachers showed the results that there have been many science teachers who use ICT devices while teaching. Science teachers have used media in the form of animation and learning videos, PowerPoint (PPT), and the internet. Although teachers have used ICT, there are still many students who have not been actively involved in using ICT during the learning process. [3] explains the use of ICT in Indonesia is at the middle level, but the achievement of ICT literacy is still lacking. Data from [4] shows that internet users in Indonesia reach 143.26 million people. Internet users by age range of 13-18 years old (students) reach 75.5%. This figure shows that the internet has become a primary need for young people in Indonesia.

The high number of internet users at the age of students should be directed to support the learning process. The activeness of students in utilizing ICT devices needs to be supported by learning resources that are also based on these technologies. The accuracy between the application technology, the learning process, and the content that is taught is influenced by the knowledge of education practitioners about these three things known as TPCK (technology, pedagogy, content, and knowledge). [5] introduced ICT-TPCK as a strand of TPCK. ICT-TPCK is explained as knowledge about affordance, pedagogy, content, learners, and context which is synthesized into an understanding of how specific topics that are difficult for students to understand or difficult to display by the teacher can be transformed and taught more effectively with technology which adds value.

The characteristics of learning content need to be known before applying learning resources based on information and communication technology. Vibration, wave, and sound material for class VIII is material content that has the potential to be integrated with ICT technology. The material contains a lot of competencies that students must master, but the allocation of time for learning is limited. Presentation of material with variations of animation and video for the material will also increase students' interest in learning. Based on the characteristics of vibration, wave, and sound material, one of the appropriate learning resources to develop is a module.

Modules in the electronic version (electronic module) can be one source of learning that has the opportunity to be developed to support ICT literacy. Modules have the advantage of supporting the process of independent learning, so students can be more active in using digital devices. The presence of e-modules can also be a supplement to the main learning resources in science learning in schools today, the 2013 Science Curriculum Student Book.

The advantage of e-module that can be considered is its ability to overcome the limitations of space and time. Science teachers often face limited time to study science but there is a lot of natural science material to be taught. E-modules can also be equipped with additional learning resources that are trusted for students.

The e-module that was developed did not only focus on facilitating ICT literacy of students, but also continued to consider the process skills that needed to be mastered through science learning. The 2013 curriculum advocates a number of student-centered learning models, one of which is the inquiry model. The selection of inquiry models is also based on aspects of the proper pedagogy for vibration, wave and sound material. The inquiry learning model is a learning model that begins with questions so that it can nurture the curiosity of students to continue learning.

The existence of appropriate teaching material supplements is expected to be one of the factors that support the learning process and mastery of ICT literacy. Analysis of the need, material characteristics, and potential supplement of teaching materials modules underlies researchers to develop an electronic science module based on inquiry for content, waves and sound. The e-module is designed to be accessible online using digital devices, such as laptops and smartphones.

1. **Literacy Review**
2. **Electronic Module**

E-module is a set of digital teaching materials that are designed systematically by utilizing multimedia to assist students' independent learning processes ([6], [7], & [8]). In principle, the print module with e-module is not much different. The fundamental difference between the two lies in the presentation, where e-modules utilize devices such as computers to display them.

E-modules can be developed with a learning management system (LMS) in Moodle. Moodle (Modular Object-Oriented Dynamic Learning Environment) is an open source LMS (free) with complete facilities that support an interactive e-module, such as the availability of chat features, discussion forums, quizzes, tests, assignments, and uploads and download.

1. **Inquiry**

[9] classifies inquiry from the lower level to the top into 4 groups, namely inquiry confirmation (confirmation inquiry), structured inquiry, guided inquiry, and open inquiry (open inquiry). [10] revealed that the inquiry applied in science learning for students needs to be given by considering teacher guidance appropriately because the learning model is based on constructivism prone to misconceptions that can actually make students confused and frustrated. [11] explain that the syntax of inquiry learning models consists of stages (1) identification and determination of the scope of the problem, (2) investigation planning and outcome prediction, (3) investigation to collect data, (4) data interpretation, (5) drawing conclusions, and (6) reflection.

1. **Electronic Science Module based on Inquiry**

The development of electronic science module based on inquiry is based on the existing module format. The module format is then adjusted to the Moodle format used. Adjustments are made to the e-module display with content that remains the same as the print module.

Table 1 Adjustment of electronic science module format

|  |  |
| --- | --- |
| **Module** | **E-module** |
| Cover page | Homepage |
| Student Identity | Log in |
| Table of contents page | Dashboard |
| Module contents page | Course, which contains:   1. Objectives of learning 2. Learning activities: 3. ‘Ayo kita mengamati sekeliling!’ 4. ‘Ayo kita selidiki!’ 5. ‘Ayo kita pelajari!’ 6. ‘Ayo kita kerjakan!’ |
| Summary | Summary |
| Bibliography | Bibliography |
|  | Other learning resources |

**D. ICT literacy**

ICT literacy is the process of utilizing information and communication technology to access, manage, integrate, evaluate, and create information that can be useful for the community while still considering the ethical values and legality in it. The strong influence given by the development of ICT in the world of education has made ICT literacy adapted in the assessment systems in various countries. Australia is a country that has developed the trend of ICT literacy assessment every three years since 2005.

Aspects and indicators of ICT literacy assessment based on sources from [3], [12], and [13] are as follows.

Table 2 Aspects and indicators of ICT literacy

|  |  |  |
| --- | --- | --- |
| **No** | **ICT literacy aspects** | **Indicators** |
| 1 | Accessing information | Access the website correctly |
| Use the account correctly when logging in |
| 2 | Managing information | Download file |
| Upload file |
| 3 | Integrating infromation | Uses many sources of information |
| 4 | Evaluating | Able to know the truth of information sources |
| 5 | Creating | Change information into graphical form, table, or other visual format |
| 6 | Communicating | Making information products |

1. **Research Method**

This research is a research and development (R&D) with 4D model. The 4D model consists of define, design, development, and disseminate stages. In the define stage, researchers determine the learning needs by conducting a needs analysis. The needs analysis is carried out in 5 steps which include front-end analysis, learner analysis, concept analysis, and specific instructional objectives.

The design phase is carried out after the researcher has performed a needs analysis. In the design phase, researchers design the electronic science module. The design phase consists of the criterion-referenced test constracting process, media selection, format selection, and initial design. The product that has been designed then enters the development stage. The development phase consists of an expert and developmental testing appraisal process. Electronic science module based on inquiry that have been tested for further distribution to science teachers and the results of their research are presented in seminar forums. The product dissemination stage and information about this product are called disseminate.

Trials at the development stage are carried out through limited scale trials and large scale trials. A limited scale trial was conducted to determine the readability of the product by students. The trial data was collected using a readability questionnaire with 9 respondents as students. A large scale trial was conducted in class VIII A at SMP N 6 Temanggung.

Data collection techniques were carried out using non-test techniques which used instruments in the form of questionnaire assessment sheets and observation sheets. Questionnaire evaluation sheets include product eligibility assessment sheets by experts, student readability questionnaire sheets, and student response questionnaire sheets related to ICT literacy.

The product eligibility assessment sheet is for media experts and material experts. Observation sheets are used to measure the effectiveness of ICT literacy during the learning process using the electronic science module. Analysis of product feasibility assessment by experts using the following criteria.

Table 3. Product eligibility assessment criteria

|  |  |
| --- | --- |
| **Interval** | **Criteria** |
| Mi + 1,5 SDi < M < Mi + 3,0 Sdi | Very good |
| Mi + 0 SDi < M < Mi + 1,5 Sdi | Good |
| Mi - 1,5 SDi < M < Mi + 0 Sdi | Bad |
| Mi - 3 SDi < M < Mi - 1,5 Sdi | Very bad |

information:

Mi = ideal mean = ½ (maximal score + minimal score)

SDi = Ideal Standard Deviation=1/6(maximal score-minimal score)

The ability of ICT literacy of students after participating in the learning process using electronic science module is known through observation techniques. The results of observations are calculated using the following equation.

Information:

NP = percent value

R = total score for each aspect

SM = the ideal score

[15]

The results of the percentage of ICT literacy skills of students through observer assessment at each meeting in the form of quantitative data. The data is then converted into qualitative data using the following scoring guidelines.

Table 4 Percentage of ICT Literacy Ability

|  |  |  |
| --- | --- | --- |
| **Mastery Level (%)** | **Value** | **Criteria** |
| 85 < X < 100 | A | Very good |
| 75 < X < 85 | B | Good |
| 65 < X < 75 | C | Adequete |
| 55 < X < 65 | D | Bad |
| X < 55 | E | Very bad |

(Source: adapted from [14])

The ability of ICT literacy is also assessed based on the results of the student questionnaire. The questionnaire contained 12 statements consisting of 7 positive statements and 5 negative statements. Data from students' self-assessment through a questionnaire is changed from qualitative data to quantitative with the following conditions.

Table 5 Conversion of student questionnaires

|  |  |  |  |
| --- | --- | --- | --- |
| **Positive Statement** | | **Negative Statement** | |
| Answer | Score | Answer | Score |
| Strongly agree | 4 | Strongly agree | 1 |
| Agree | 3 | Agree | 2 |
| Disagree | 2 | Disagree | 3 |
| Strongly disagree | 1 | Strongly disagree | 4 |

(Source: adapted from [16])

The quantitative data that have been obtained are then calculated using the following equation.

Information:

NP = percent value

R = total score for each aspect

SM = the ideal score

[15]

Student responses in the form of quantitative data are then converted into qualitative data using five scale interval data. Reference to changing the score is as follows.

Table 6 Criteria for ICT Literacy Capability

|  |  |
| --- | --- |
| **Percent value (%)** | **Criteria** |
| 0 – 20 | Very bad |
| 21 – 40 | Bad |
| 41 – 60 | Adequete |
| 61 – 80 | Good |
| 81 – 100 | Very good |

(Source: adapted from [16])

1. **RESULT AND DISCUSSION**
2. **Result**

The appraisal of the electronic science module based on inquiry involved 2 material experts and 2 media experts. The results of the electronic science module feasibility assessment according to media experts and material experts are as follows.

Tabel 7 The results of the electronic science module based on inquiry assessment by material experts

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Aspect** | **Actual score (X)** | | **Interval** | **Value** | **Criteria** |
| **Expert I** | **Expert II** |
| Content | 31 | 31 | |  | | --- | | 23,25 < X < 31 | | 15,5 < X < 23,25 | | 7,75 < X < 15,5 | | 0 < X < 7,75 | | A | Very good |
| Linguistic | 4 | 4 | |  | | --- | | 3 < X < 4 | | 2 < X < 3 | | 1 < X < 2 | | 0 < X < 1 | | A | Very good |
| Module characteristics | 4 | 4 | A | Very good |

The results of the assessment by the two experts on the electronic science module that was developed showed the value with **very good** criteria. Both material experts provide input and suggestions summarized in table 8.

Tabel 8 Comments and suggestions for improvement from material experts

|  |  |
| --- | --- |
| **Validator** | **Comments and suggestions for improvement** |
| Expert 1 | Fix the problem stem by not using question sentences |
| Fix the tables in the module |
| Improve writing sentences using capital letters correctly |
| Correct the supporting images that match the material |
| Change ‘Belajar 1’ to ‘Kegiatan Belajar 1’ |
| Expert 2 | It is recommended that each destination item contains 1 order/ goal to be achieved |
| Use effective sentences in writing learning objectives |
| Add time allocation information for activities in the module |
| Fix the apperception section |

Electronic science module based on inquiry were assessed by 2 media experts. The assessment is carried out using a product feasibility assessment sheet. Following are the results of the assessment from two media experts.

Tabel 9 The results of an electronic science module based on inquiry assessment by media experts

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Aspect** | **Actual score (X)** | | **Interval** | **Value** | **Criteria** |
| **Expert I** | **Expert II** |
| Display interface | 14 | 16 | |  | | --- | | 8,5 < X < 17 | | 8,5 < X < 12,75 | | 4,25 < X < 8,5 | | 0 < X < 4,25 | | A | Very good |
| Presentation | 13 | 13 | |  | | --- | | 9,75 < X < 13 | | 6,5 < X < 9,75 | | 3,25 < X < 6,5 | | 0 < X < 3,25 | | A | Very good |

The results of the assessment by the two experts on the electronic science module that was developed showed the value with **very good** criteria. Both media experts provide input and suggestions summarized in table 10.

Tabel 10 Comments and suggestions for improvement from media experts

|  |  |
| --- | --- |
| **Validator** | **Comments and suggestions for improvement** |
| Expert 1 | Modules require additional introductory sentences for each menu/ sub-menu |
| Fix links on additional learning resources that can go directly to relevant web pages |
| Menus/ sub-menus without dynamics in color and appearance making it less attractive |
| Ahli 2 | Pay attention in the placement of explanatory videos supporting learning, explanations should be separated from the material. |

The electronic science module based on inquiry after it has been corrected in accordance with the suggestions and comments of the experts, is then tested on a limited basis (readability test). Readability test uses 9 student respondents. The readability test results are presented in table 11.

Table 11 Readability Test Results of Electronic Science Module

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **No** | **Responden** | **Score** | **Interval** | **Criteria** |
| 1 | R1 | 49 | |  | | --- | | 52 < M < 64 | | 40 < M < 52 | | 28 < M < 40 | | 16 < M <28 | | Good |
| 2 | R2 | 57 | Very good |
| 3 | R3 | 57 | Very good |
| 4 | R4 | 50 | Good |
| 5 | R5 | 61 | Very good |
| 6 | R6 | 61 | Very good |
| 7 | R7 | 52 | Very good |
| 8 | R8 | 49 | Good |
| 9 | R9 | 48 | Good |
|  | Average | 53,8 | Very good |

The electronic science module based on inquiry that was developed was then tested on a large scale in class VIII A of SMP N 6 Temanggung. The results of the ICT literacy assessment through observations made in learning science in the class are as follows.

Table 12 Percentage of observations of ICT literacy in students

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **No** | **ICT Literacy Aspects** | **Percentage of observations per meeting** | | |
| **I** | **II** | **III** |
| 1 | Accessing | 85% | 94% | 96% |
| 2 | Managing | 77% | 81% | 84% |
| 3 | Integrating | 75% | 100% | 100% |
| 4 | Evaluating | 78% | 100% | 100% |
| 5 | Creating | 78% | 94% | 100% |
| 6 | Communicating | 78% | 84% | 94% |
|  | Average | 79% | 92% | 96% |

The ability of ICT literacy is not only assessed through observation, but also through student questionnaires. Following are the results of students' responses to their ICT literacy skills in learning.

Table 13 The level of ICT literacy ability is based on student questionnaire data

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **No** | **ICT Literacy Aspects** | **Percentage of observations per meeting** | | |
| **I** | **II** | **III** |
| 1 | Accessing | 75% | 80% | 84% |
| 2 | Managing | 63% | 69% | 76% |
| 3 | Integrating | 72% | 76% | 84% |
| 4 | Evaluating | 76% | 82% | 88% |
| 5 | Creating | 70% | 77% | 87% |
| 6 | Communicating | 70% | 80% | 87% |
|  | Average | 71% | 77% | 84% |

1. **Discussion**

This research is a research development by applying the 4D model. Electronic science module based on inquiry that can facilitate ICT literacy skills are the product of this research. The feasibility of an electronic science module is assessed by material experts and media experts, where each field consists of 2 experts.

The feasibility assessment by the material experts includes aspects of content, linguistics, and module characteristics. All three aspects were assessed with the **'very good'** criteria. Both experts provide suggestions and comments that serve as a reference for researchers to make improvements. Product revisions made based on suggestions and comments from material experts are in the writing section of the electronic science module.

Electronic science module is assessed from the aspect of interface appearance and presentation by media experts. Both aspects were assessed with the **'very good'** criteria. Product revisions are based on suggestions and comments given by media experts. The revisions made were in the homesite section as in Figure 1.



Figure 1. Revised homesite of e-science module section

Products that have been assessed for eligibility by experts are then tested on a limited scale (readability test). Readability test using 9 respondents scored 53.8 and included in the **'very good'** criteria. The score data shows that e-science module based on inquiry can be understood by students. Based on the results of the feasibility assessment by experts and readability tests on students, the e-science module based on inquiry can be used in large-scale trials.

E-science module based on inquiry is used in the process of learning vibration, wave and sound material in class VIII A of SMP N 6 Temanggung. The number of students is 32 children. Observer observes students during the learning process and assesses the effectiveness of their ICT literacy skills using existing observation sheets.

Figure 2 ICT literacy skills of students based on observational assessment

Observation assessment data is presented in the graph in Figure 2. Based on the graph data, **accessing** ability is well mastered by students because it gets a percentage of 85%. At the second and third meetings, the ability to **accessing** has increased with a percentage of 94% and 96%. This percentage is included in the criteria **very good**.

The ability to **manage** gets a percentage of 77%, 81%, and 84%. This value if converted according to table 4 is included in the **good** criteria. The ability to **integrate** gets a percentage of 75% or is included in the '**adequete**' criteria. This ability improved to **very good** at meetings 2 and 3 with a percentage value of 100%. The ability to **evaluate** obtains good criteria with a percentage value of 78%. Students show improvement for this ability at the next meeting to be **very good** with a percentage of 100%.

Ability to **create** a percentage of 78% or included in the **good** criteria. This ability increases to **very good** with the acquisition of a percentage of 94% for meetings 2 and 100% for meetings 3. The communicating skills of students are included in **good** criteria with a percentage value of 78%. This ability include to **good** criteria at meeting 2 with a percentage value of 84% and at meeting 3 became **very good** at a percentage of 94%.

The average percentage of aspects of ICT literacy in learners was based on observations of 79% at the first meeting, 92% at the second meeting, and 96% at the third meeting. The ability of ICT literacy in general increases from **good** to **very good** criteria. The ability of ICT literacy in addition to being assessed through observation, is also assessed through student questionnaire sheets.

Student questionnaire response data is presented in the graph in Figure 3. Based on the responses from students, it can be seen that the ICT literacy ability of students has increased at each meeting. The ability to **access** all three meetings is included in **good** and **very good** criteria with percentage values of 75%, 80%, and 84%. The ability to **integrate** is also included in the **good** and **very good** criteria by getting a percentage of 72%, 76%, and 84%.

Figure 3. ICT literacy skills of students based on a questionnaire

The manage ability is classifiedin **good** criteria with a percentage value of 63%, 69%, and 76%. The ability to **evaluate** is included in the **good** criteria with a percentage value of 76% in first meeting. In second and third meeting, **evaluating** ablity include in **very good** criteria with 82% and 88% percentage value.

The ability to **create** has increased in each meeting. This ability at meeting 1 and 2 was included in the criteria of being **good** at a percentage of 70% and 77%, then being **very good** at a percentage of 87%. **Communication** skills have increased in percentage gains, at the first meeting 70%, at the second meeting 80%, and at the third meeting 87%. The percentage value indicates the ability to communicate with students included in the criteria is **good** and **very good**.

The average percentage of ICT literacy facilitation aspects of students based on filling out questionnaires was 71% at the first meeting, 77% at the second meeting, and 84% at the third meeting. The overall ability of ICT literacy increased from the **good** criteria to be **very good**.

The results of the analysis of the ICT literacy observation sheet data shows that learning science by using e-science module based on inquiry can facilitate the ICT literacy skills of students. This is indicated by the results of observations on the learning process and assignments in the e-module which obtained **very good** criteria. The observations were reinforced by the results of completing the ICT literacy effectiveness questionnaire by students who were in **very good** criteria.

Analysis of the data that has been done shows that learning science by using e-science module based on inquiry can finance ICT literacy in students. The results of this study are consistent with research conducted by [17], [18], and [19]. The three studies found that science learning based on project based learning through e-learning can equip learners' ICT literacy.

1. **CONCLUSIONS**

The e-module product developed has received a very good assessment from media experts and material experts so that it is suitable for use in science learning. The e-science module based on inquiry that was developed can facilitate ICT literacy of students with very good criterion criteria based on observational assessments and is very good based on the results of filling out questionnaire sheets by students.

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