

VALIDITY OF ICT BASED ON INTEGRATED STEM EDUCATION TEACHING MATERIALS TO IMPROVE DATA LITERATURE AND TECHNOLOGY PHYSICS STUDENTS

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ABSTRACT

The development of the 21st century demands changes in resources of human of “broad insight, critical thinking, and literacy” to deal with the development of 21st century education. Conditions in the field found that STEM, data literacy and technology had not been implemented, and the average score of students in physics learning had not been implemented. One solution that can be conducted is to develop ICT materials of teaching on work and energy based on STEM Education. This study aims to determine the validity of ICT-based business and energy teaching materials to integrate STEM Education to improve data and technology literacy of high school students. The research conducted includes development research using the development model of Plomp. The development model of Plomp is carried out until the design and prototype stages, namely determining the validity of the product carried out by experts on the product being developed. The results of the study obtained that the assessment of teaching materials was valid on five components based on data analysis using Aiken, V obtained the results for material substance with a value of 0.77, visual communication display with a value of 0.78, learning design with a value of 0.78, software usage with a value of 0.63 and STEM assessment with a value of 0.74. Based on this validity assessment, it can be concluded that ICT-based business and energy teaching materials integrate STEM Education to improve data literacy and valid high school students' technology so that they can be applied to students in learning

Keywords: Validity; STEM Education; Data Literacy and Technology; work and Energy.



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I. INTRODUCTION

Development To deal with the development of 21st century education, human resources must possess broad perception, critical thinking, and literacy. 21st century education is a century where science, technology and information dissemination are developing very rapidly. 21st century education allows human resources to reduce intense competition in the development of science, technology development, and information dissemination. Among these skills is the ability to think critically in analyzing, evaluating, and finding solutions to problems encountered. Human resources must have high quality and have comparative, innovative, competitive, and collaborative capabilities so that they can easily absorb new information, have reliable capabilities in adapting. On the other hand, in the world of 21st century education, literacy skills are no less important. Literacy skills help students in managing information in the digital world which is marked by the era of the revolution of industrial 4.0. Efforts to improve this ability are in line with educational goals and the revised 2013 curriculum.

The 2013 curriculum is an improvement from the KTSP curriculum. According to the 2013 curriculum, learning is student-centered, requiring that learners independently examine the course materials. In addition, the 2013 curriculum also requires students to develop hard and soft skills. These abilities must be possessed by students in facing and competing in the revolutionary era. The revised 2013 curriculum is in accordance with the

learning objectives which also require students' literacy skills. The literacy needed in the revolution era includes student data and technology literacy. Data and technology literacy is an individual's ability to communicate, collaborate and think critically about information obtained through technology and understand the working principles and application of technology.

Facing the demands of the times, ICT-based materials of teaching are needed integrated with STEM education. It can aid students in comprehending the subject and how it applies to technology and lead to the curiosity of students in designing technology with the concepts being studied so that students have broad insights [1]. In this instance, it indicates that instructional materials should be focused on environmental issues, the use of technology using STEM education, and the development of kids' critical thinking, creativity, innovation, and problem-solving skills in addition to their character development. Learning using STEM education also provides experiences through project-based learning activities that aim to practice problem solving skills in real life in order to develop experience, and life skills [2].

Information and technology of communication utilization (ICT) can improve the quality of education, including physics learning, by opening wide access to knowledge and providing quality education. Entering the era of information and communication technology at this time, the importance of using ICT in learning activities is felt to increase the expected quality of learning. The evolution of information technology follows that of theory, communication, and technology that facilitates the practice of educational tasks. Web-based learning and computer-based learning (CBI) (e-learning), Computer Assisted Learning (CAI) is a form of using ICT that needs to be implemented in today's world of education.

Based on data obtained in the field, found problems in learning physics in schools where there are problems with low student learning outcomes in physics learning, especially in work and energy materials, the unavailability of ICT-based materials of teaching in schools, and the low ability of students' data literacy and technology in physics learning. One solution that can be done to solve problems that occur in schools, especially in learning physics is to develop materials of teaching on ICT-based work and energy materials to integrate STEM to improve data and technology literacy skills of high school students.

Materials of teaching play an important role in the process of learning [3]. Materials of teaching are all forms of materials used to assist educators in carrying out the process of teaching activities. Materials of teaching are essentially all resources (including information, tools, and texts) that are organized in a systematic way to show a full list of skills that students will master and utilize during the learning process with the intention of planning and monitoring the application of learning [4]. Through material of teaching the teacher will be easier to complete the process of learning and deliver the material being taught, and can help students to more easily accept the material presented by the teacher and can supervise the process of students in obtaining information in learning. The main role of materials of teaching is to make learning more interesting, practical, realistic, and meaning-full [5]. So, the role of materials of teaching is as a support in the learning process so that the learning competencies to be achieved can be fulfilled.

ICT-based materials of teaching have an important role in helping the learning process, especially in learning Physics. ICT-based materials of teaching are a set of materials that are systematically arranged and can be mastered by students which are summarized in electronic form [6]. ICT-based materials of teaching can also be interpreted as materials of teaching published in digital format, containing writing, images that can be read through computers or other digital devices.[7]. This ICT-based teaching material is designed to help learning in the classroom and can store value from the activities carried out by students [8]. ICT-based materials of teaching have a role to help students increase their interest in learning and make it easier for students to learn independently [9]. The presence of ICT-based materials of teaching can facilitate teachers and students in the learning process. Teachers are expected to be able to make ICT-based materials of teaching that can support the achievement of student competencies.

ICT-based materials of teaching are developed by integrating STEM Education. STEM is a combination of science, technology, engineering and mathematics [10]. STEM itself can be defined as an interdisciplinary application of knowledge designed to provide students with a broad learning experience that is related to the real world [1]. STEM education is education that links and integrates STEM subjects, namely science, technology, engineering, and mathematics with the aim of creating problem-based learning in everyday life. With this STEM education, students can practice and apply the knowledge learned in school with phenomena in the real world [11]. Through STEM education, students will have a logical, systematic, and critical mindset [12]. The importance of integrating STEM education in the learning process affects the education quality. The integration of STEM education can produce a new generation that is able to develop the competencies they already have [13] and apply their knowledge directly to the problems they face in everyday life [2]. The integration of STEM education in the

learning process can also encourage students' literacy skills and students' interests to expand their interest in the STEM field [14].

Based on the explanation above, in responding to the challenges of the 21st century, researchers have developed ICT-based materials of teaching that integrate STEM education into data literacy and technology for high school students. This purpose of the study is to determine the validity of ICT-based work and energy materials of teaching to integrate STEM education into the new literature of high school students so that the developed materials of teaching are suitable for use and tested more broadly in further research.

II. METHOD

This research is a learning media development research using research and development (R&D) methods. The research and development method is a method used to produce a certain product and test the validity and effectiveness of using the product [15]. Development is research that aims to produce a product in research. This research was conducted to determine the validity of the product that has been developed.

The research was carried out through the Plomp 2013 development model. In this research, the product produced is validity of ICT-based work and energy materials of teaching to integrate STEM education into the new literature of high school students.[16] The research phase of the 2013 Plomp model consists of the preliminary research phase, the design and prototype phase and the assessment phase. This research is focused on the prototype phase or development phase where this research will determine the validity of validity of ICT-based work and energy materials of teaching to integrate STEM education into the new literature of high school students.

This research begins with the preliminary research stage, at this stage a needs analysis in learning physics in schools is carried out through questionnaires distributed to teachers and students. After obtaining the problems and needs of teachers in schools, then the development of materials of teaching on ICT-based work and energy materials is carried out STEM education improves data and technology literacy of high school students as a solution to problems found in the field. After the product is developed, it is continued by testing the validity of the product to test the feasibility level of the product that has been developed. This is done so that the product is suitable for use in the field as materials of teaching on ICT-based work and energy materials by integrating STEM education with the aim of improving students' data and technology literacy skills in learning physics.

The statistical test used in this study is a product validity test as a measure of the validity of a product being developed, a product is said to be valid if the product is in accordance with the specified validity assessment component.[3] A data is said to be valid if it has great support for the total score. The validity analysis in this study was carried out through a validity assessment sheet using a Likert scale given by experts, namely 3 physics lecturers, Faculty of Mathematics and Natural Sciences, Padang State University. Validity analysis was conducted on 5 components consisting of "components of material substance, visual communication display, learning design, software usage and STEM assessment". The results obtained from the assessment of the validity of the experts were analyzed using the V'Aiken equation in Equation 1.

$$V = \frac{\sum s}{[n(c-1)]} \quad (1)$$

$$S = r - lo \quad (2)$$

Information:

lo = The lowest validity value (value = 1)

c = The highest validity value (value = 4)

r = Value given by validator

In this study, a Likert scale was used to assess the validity of the developed product which was analyzed using the V'Aiken equation. The value of V'Aiken obtained is large or equal to 0.6, then the ICT-based STEM integrated materials of teaching are said to be valid and suitable for use in the learning process. And for a small value of 0.6, ICT-based STEM integrated materials of teaching are said to be invalid and not yet feasible to be implemented in the learning process. The results obtained from the V'Aiken results can be categorized in Table 1.

Interval	Category
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$\geq 0,6$	Valid
<0.6	Invalid

(Source: Febriandi [28])

III. RESULTS AND DISCUSSION

Result

Based on the research that has been done, has developed a teaching-materials on ICT-based work and energy materials integrate STEM education improve literacy data and technology for high school students. The display of the developed materials of teaching can be seen in Figure 1.

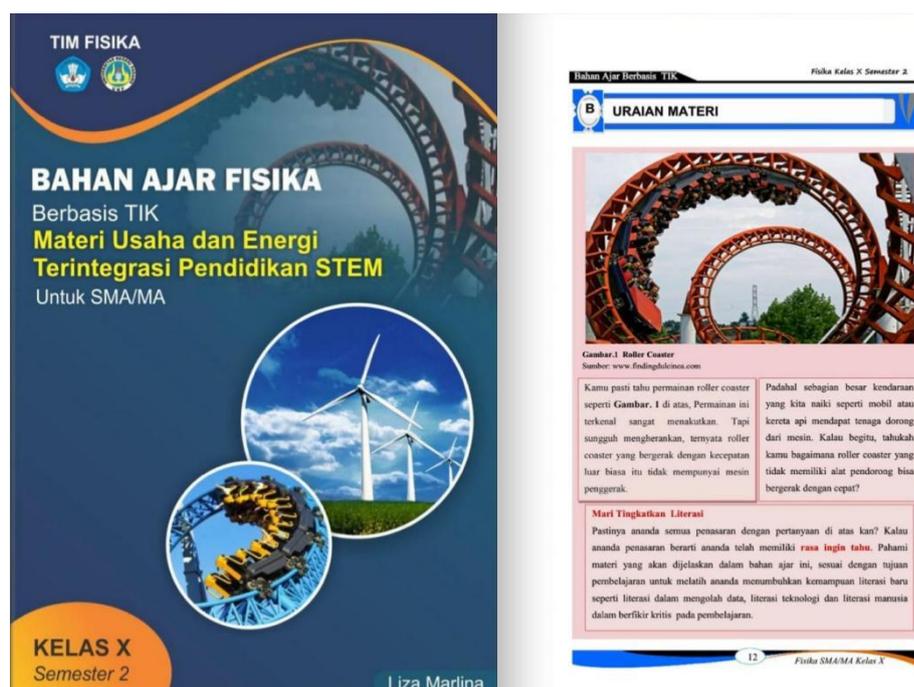


Fig. 1. Display of *ICT* materials of teaching on work and energy based on STEM Education to improve data literacy and technology of high school students

The results of the validity analysis in this study have been carried out on 5 component consisting of “component material substance, visual communication display, learning design, software usage and STEM assessment”.

The results of the first validity test are at component material substance. Component material substance consists of 4 sub components consisting of; 1) truth (N1), 2) material coverage (N2), 3) contemporary (N3), and 4) legibility (N4). The results of the validity assessment on component the substance of the material can be seen in Figure 2.

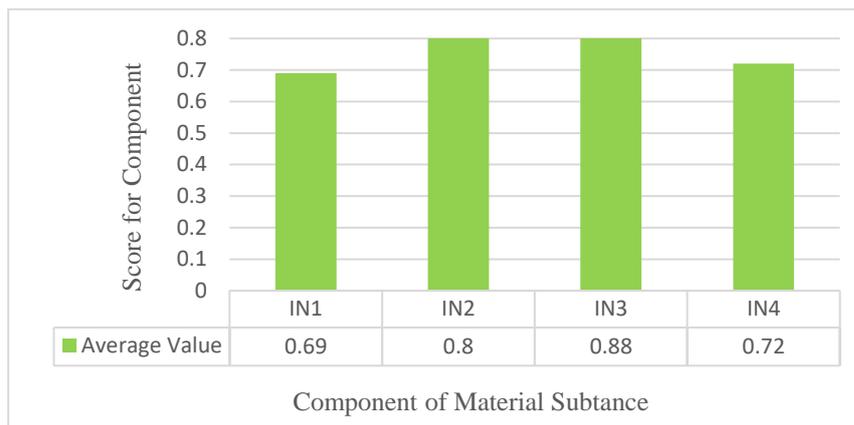


Fig.2. Validity Score of Material Substance Component

Based on the validity test results in Figure 2, it is known that the results for all components of the substance of the material are obtained with values greater than 0.6. The results of the assessment show that the highest validity value is obtained in indicator 3 with a value of 0.88, while the lowest validity value is in indicator 1 with a value of 0.69. This shows that ICT-based work and energy materials of teaching integrate STEM education to improve data literacy and technology for high school students that have been tested valid on the substance component of the material.

The second validity test result is the visual communication display component. The visual communication display component consists of 6 sub components consisting of; 1) Navigation (N1), (2) Letters (N2), (3) Media (N3), and (4) Color (N4), (5) Animation (N5), (6) Layout (N6). The results of the validity assessment on the visual display of communication component can be seen in Figure 3.

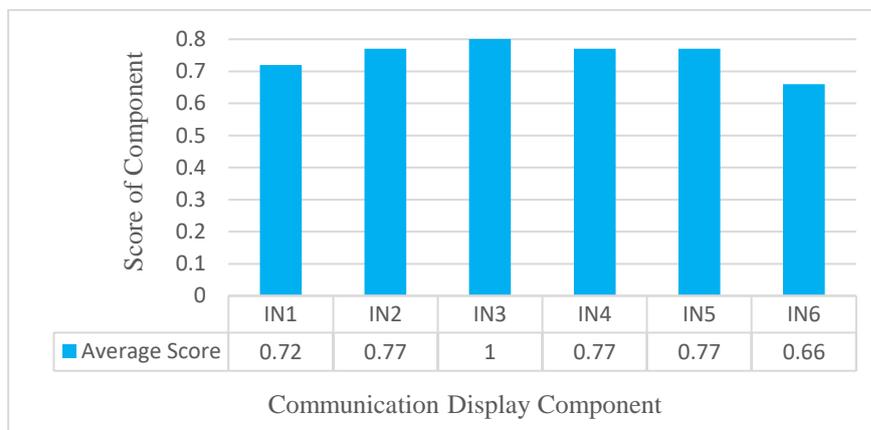


Fig.3. Validity Value of Visual Communication Display Component

Based on the validity test results in Figure 3, it is known that the results for all components of the visual communication display are obtained with values greater than 0.6. The results of the assessment show that the highest validity value is obtained at indicator 2, indicator 4 and 5. with a value of 0.77, while the lowest validity value is at indicator 6 with a value of 0.66. This shows that ICT-based work and energy materials of teaching that integrate STEM education in improving data literacy and technology for high school students have been tested valid on visual displays of communication.

The third validity test result is the instructional design component. The learning design component consists of 9 sub components consisting of; 1) Title (N1), (2) KI and KD (N2), (3) Learning Objectives (N3), (4) Material (N4), (5) Sample questions (N5), (6) Exercises (N6) , (7) Work steps (N7), (8) Compiler (N8), and (9) Reference (N9). The results of the validity assessment of the learning design components shown in Figure 4.

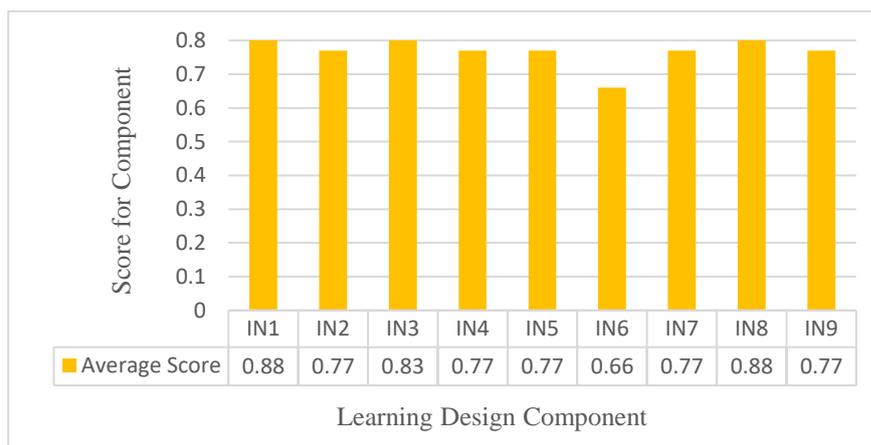


Fig.4. Validity Score of Learning Design Component

Based on the validity test result in Figure 4, it is known that the results for all components of the instructional design are obtained with values greater than 0.6. The results of the assessment show that the highest validity value is obtained in indicator 1 and indicator 8 with a value of 0.88, while the lowest validity value is obtained at indicator 6 with a value of 0.66. This shows that ICT-based work and energy materials of teaching that integrate STEM education in improving data literacy and technology for high school students have been tested to be valid in the learning design component.

The results of the validity test to fouris on the use of software components. the usage software component consists of 3 sub components consisting of; 1) Interactivity (N1), 2) Supporting Software (N2), and 3) Originality (N3). The results of the validity assessment on the use of software components can be seen in Figure 5.

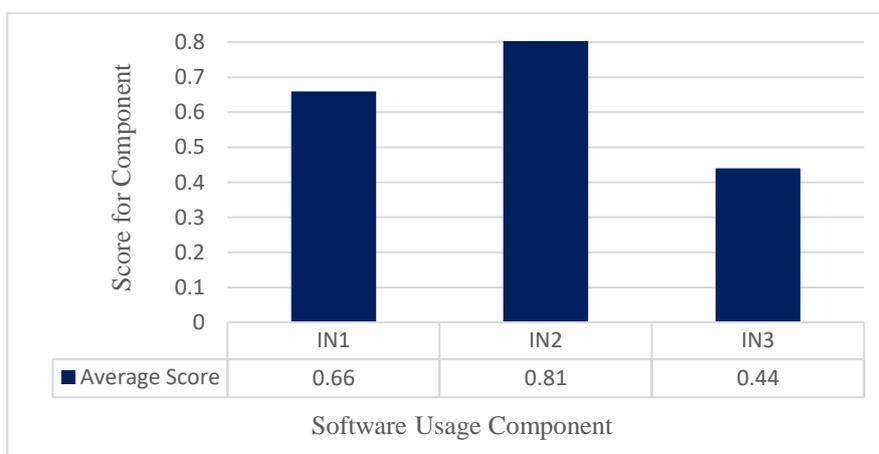


Fig.5. Validity Score of Software Usage Component

Based on the validity test results in Figure 5, it is known that the results for all components of the software usage are obtained with values greater than 0.6. The results of the assessment show that the highest validity value is obtained in indicator 2 with a value of 0.81, while the lowest validity value is in indicator 3 with a value of 0.44, so improvements are needed. This shows that ICT-based work and energy materials of teaching that integrate STEM education in improving data literacy and technology for high school students have been tested valid on the software component of use.

The validity test results to fouris on the STEM assessment component. the STEM assessment component consists of 4 sub-components consisting of; 1) Science (N1), 2) Technology (N2), 3) Engineering (N3), and 4) Mathematics (N4). The results of the validity assessment on the STEM assessment component can be seen in Figure 6.

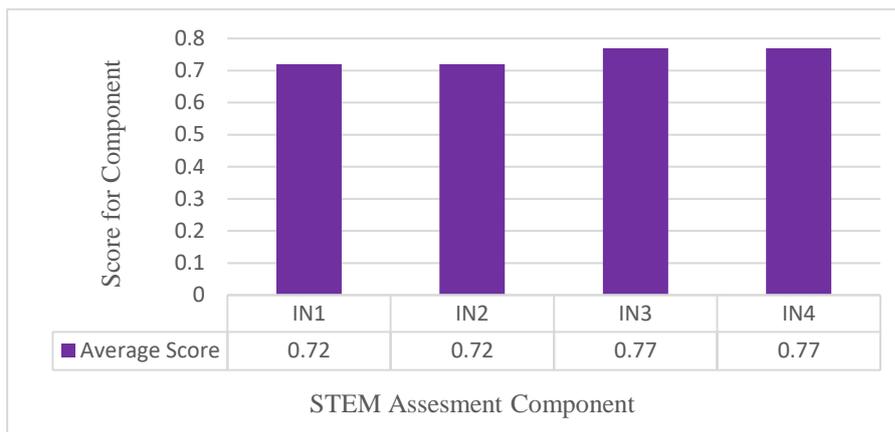


Fig.6. Validity Score of STEM Assessment Component

Based on the validity test results in in Figure 6, it is known that the results for all components of the STEM assessment are obtained with values greater than 0.6. The results of the assessment show that the highest validity value is obtained in indicator 3 and indicator 4 with a value of 0.77, while the lowest validity value is obtained in indicators 1 and 2 with a value of 0.72. This shows that ICT-based work and energy materials of teaching that integrate STEM education in improving data and technology literacy of high school students have been tested valid in the STEM assessment component.

Based on the validity test results assessment carried out on the components of the substance of the material, visual communication display, learning design, software usage, the results of the overall validity test assessment of materials of teaching are obtained. ICT-based work and energy integrate STEM education improve literacy data and technology for high school students can be seen in Figure 7.

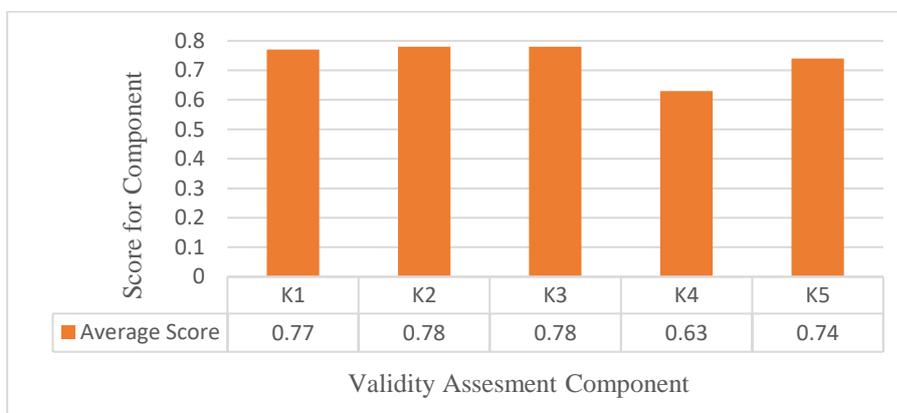


Fig.7. Validity Score of ICT materials of teaching work and Energy

Based on the validity test results obtained on the assessment of the validity of the material teach ICT-based work and energy integrate STEM education improve literacy data and technology for high school students are all valid components with a value greater than 0.6. The highest validity value was obtained in the display component of learning design and visual communication with a value of 0.78. The lowest validity assessment is the use of the software component with an average validity value of 0.63. With these weaknesses, it can be used as input for researchers and make improvements to the developed materials of teaching. Based on the overall assessment of ICT-based work and energy materials of teaching integrating STEM education improve literacy data and technology for high school students that have been developed are valid in terms of “material substance, visual communication display, learning design, software usage and STEM assessment” so that they can be used to be applied in schools in the context of utilizing ICT and improving the application of STEM and data and technology literacy for students in physics learning.

Discussion

Based on the research that has been done, it has been tested the validity of materials of teaching on ICT-based work and energy materials integrate STEM education improve literacy data and technology for high school students. The validity test was carried out on 5 components consisting of components of “material substance, visual communication display, learning design, software usage and STEM assessment”.

The first validity test was carried out on the components of the substance of the material. Based on the results of the assessment, it was obtained that the results of the validity test on the component substance of the material were obtained that the validity results ranged from 0.69 to 0.88. The average value obtained on the component substance of the material is 0.77. The highest value is obtained in the present sub-component and the lowest is in the truth sub-component. Of the four components of the substance of the material obtained in the valid category. These results indicate that ICT-based work and energy materials of teaching integrate STEM education to improve data literacy and technology for high school students developed to be valid in terms of the components of the substance of the material. This research is in line with research [17] entitled "Development of Science, Technology, Engineering, and Engineering-Based materials of teaching. and Mathematics (STEM) in Senior High School". The results showed that the materials of teaching developed were valid in terms of the suitability of the material and the presentation of the material. The study result show are also in line with research [18], regarding "the development of digital circular motion materials of teaching assisted by scratch based on science, technology, engineering, and mathematics". The results showed that the materials of teaching developed were valid from the substance components of the material. This study is also in accordance with the results of research [19], regarding "Development of STEAM-Based PJBL-Based materials of teaching to Facilitate Science Literacy Skills for Elementary School Students" in which the research results show that the materials of teaching developed are also valid from the component substance of the material.

The second validity test was carried out on the visual communication display. Based on the results of the assessment, it was obtained that the results of the validity test on the visual communication display component showed that the validity results ranged from 0.66 to 1.00. The average value obtained for the components of the material substance is 0.78. The highest value is obtained in the media sub-component and the lowest is in the layout sub-component. From the six components of the visual communication display, it is obtained in the valid category. These results indicate that ICT-based work and energy materials of teaching integrate STEM education to improve data literacy and technology for high school students developed to be valid in terms of components of visual communication display. This research is in line with research [21] entitled "Development of STEM-Based materials of teaching with Engineering Design Process Model on Global Warming: Validity Aspect". The results showed that the materials of teaching developed were valid in the presentation component. The results of this study are also in line with research [22], about "development of a STEM-based integrated science module on pressure materials". The results showed that the materials of teaching developed were very feasible from the readability component or visual communication display. This study is also in accordance with the results of research [23],

The third validity test was carried out on the learning design components. Based on the results of the assessment, it was found that the results of the validity test on the components of the learning design were obtained that the validity results ranged from 0.66 to 0.88. The average value obtained for the components of the material substance is 0.78. The highest score was obtained in the sub-component of title and compiler, then the lowest score was obtained in the sub-component of exercise. Of the nine components of the learning design, it was obtained in the valid category. These results indicate that ICT-based work and energy materials of teaching integrate STEM education to improve data literacy and technology for high school students developed to be valid in terms of learning design components. This research is in line with [21] entitled "Development of STEM-Based materials of teaching with Engineering Design Process Model on Global Warming: Validity Aspect". The results showed that the materials of teaching developed were valid in the instructional design component. The results of this study are also in line with research [22], on "Development of STEM Integrated Project-Based Science Modules on Pressure Materials". The results showed that the materials of teaching developed were very feasible from the learning design components. This study is also in accordance with the results of research [23],

The fourth validity test was carried out on the use of software components. Based on the results of the assessment, it was obtained that the results of the validity test on the software component used were obtained that the validity results ranged from 0.44 to 0.81. The average value obtained on the use of software components is 0.63. The highest value is obtained in the supporting software sub-component and the lowest is in the originality sub-component. From the three parts of the software component the use is obtained in the valid category. These results indicate that ICT-based work and energy materials of teaching integrate STEM education to improve data

literacy and technology for high school students developed to be valid in terms of the use of software components. This study is in line with research [23], about "The Validation Results of Integrated Science ICT materials of teaching Connected Model Integrating Character Values for Class VII Junior High School Student Learning" which research results show that the materials of teaching developed are in the very valid category for software users. The results of this study are also in line with research [24], regarding "Development of Integrated STEM (Science, Technology, Engineering and Mathematics) E-Modules with 3D Page flip Professional Software Assistance on Acid-Base Subjects". The results showed that the materials of teaching developed were valid from the components of software utilization. This study is also in accordance with the results of research [19],

The fifth validity test was carried out on the STEM assessment component. Based on the results of the assessment, it was obtained that the results of the validity test on the STEM assessment component were obtained that the validity results ranged from 0.72 to 0.77. The average value obtained on the STEM assessment component is 0.74. The highest score was obtained in the sub-component of engineering software and mathematics, then the lowest score was obtained in the sub-component of science and technology. From the four components of the STEM assessment, it was obtained in the valid category. These results indicate that ICT-based work and energy materials of teaching integrate STEM education to improve data literacy and technology for high school students developed to be valid in terms of STEM assessment components. This research is in line with research [25], entitled "Development of E-Book Based on Science, Technology, Engineering, And Mathematics (STEM) Materials for Plant Growth and Development to Practice Science Literacy Skills". The results showed that the materials of teaching developed were valid in STEM assessment. The results of this study are also in line with research [26], on "Development of STEM-Based Digital Modules to Develop Problem Solving Ability". The results showed that the materials of teaching developed were valid from the STEM characteristic components. This study is also in accordance with the results of research [27], regarding "Development of STEM Integrated Energy and Momentum Electronic materials of teaching to Improve High School Student Learning Outcomes" which research results show that the materials of teaching developed are also valid as STEM-based materials of teaching.

Based on the results of the assessment of the validity of materials of teaching ICT-based work and energy integrate STEM education improve literacy High school students' data and technology from all components can be declared valid and can be used as materials of teaching on ICT-based work and energy materials that integrate STEM Education to improve literacy data and technology for high school students in learning physics.

CONCLUSION

Based on the results of the research that has been carried out, it is obtained the results of research for the validity of materials of teaching ICT-based work and energy integrate STEM education improve literacy data and technology of high school students are valid. Materials of teaching were declared valid against the five components of the validity assessment consisting of material substance with a value of 0.77, visual communication display with a value of 0.78, learning design with a value of 0.78, software usage with a value of 0.63 and STEM assessment with a value of 0.74. Based on this validity assessment, it can be concluded that materials of teaching ICT-based work and energy integrate STEM education improve literacy data and technology for high school students are valid so that they can be used by students in learning physics, especially work and energy materials to improve STEM abilities in physics learning. This research has limitations in product development such as material on the product, the product only until validity, literacy skills, and software used. The researcher hopes the future research can be developed to the stage of effectiveness, other materials, measure other skills, and can use applications that are interactive for learning.

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