Science literacy-based sound wave e-worksheet: Validity aspects

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Abstract. This study aims to describe the validity of e-worksheets based on science literacy in sound-bearing materials. This research is research and development with the ADDIE model. This science literacy-based e-worksheet validator numbers three people, consisting of two academics and one practitioner. The validation results using an e-worksheet validation sheet based on science literacy show that the validity of e-worksheets in sound wave material has good criteria. Therefore, e-worksheets based on science literacy can be used to learn physics in sound wave material.

1. Introduction
Science literacy is a crucial ability to be mastered by every individual. Science literacy is closely related to understanding the environment and the problems facing modern society with the ongoing development of knowledge and technology [1]. These problems include the environment, such as energy sources, pollution, and climate change [2]. Awareness of the importance of science literacy will also accelerate scientific and technological knowledge [3,4]. Science literacy skills can be trained in learners through learning in school as a means of formal education [5–8]. One of the subjects in the school related to the rapid development of the world of technology lately is physics. In training science, literacy skills in school learners, teachers, learning environments, and teaching materials that support science literacy are needed [9–11].

However, the current pandemic conditions require schools to conduct distance learning with learners through online learning. This situation encourages teachers to innovate in using teaching materials, one of which is the student worksheet. The student worksheet was chosen because it is a teaching material that can encourage learners to be actively involved in learning [12,13]. The student worksheet is an activity sheet containing instructions and information about the tasks that learners must do to achieve learning goals [14]. Tasks in the student worksheet can be practicums or problems that learners must solve. Current technological advances allow the use of worksheets presented in electronic form (e-worksheets). So that its use remains efficient because it can be used anytime and anywhere as long as the internet network is available [15,16]. In this case, e-worksheet as a tool used in learning plays an essential role in the success of the learning process [14,17]. The application used in this development research is Flip PDF Professional. This application converts the shape of a PDF into a flipbook. Flipbook is a learning medium with voice and page transition effects such as turning the pages of a book,[18]. In addition, there are also various features such as images and videos from Youtube with pop-ups,
hyperlinks, quizzes, and more [19]. Products produced from this application can be used on various devices without installing because it is website-based.

Based on previous research, the use of the student worksheet that applies discovery learning is considered to improve learners' science literacy skills. [20]. In addition, the student worksheet, which contains a link between science and everyday life problems, can increase learners' literacy [21]. Learning that uses the student worksheet based on science literacy is considered to improve critical thinking skills, obtained if you have good science literacy skills [22]. Other research that develops e-worksheets based on science literacy using interactive media gets a positive response from teachers and learners. It is classified as very feasible to be used in learning [23]. The study draws on three cognitive domains of science literacy. It can be concluded that overall the use of e-worksheets has a positive effect and can improve the science literacy of learners. However, no research has developed e-worksheets by concocting on aspects of science literacy, namely the role of science, scientific thinking and doing, science and society, and mathematics and science [24]. These aspects are then used as the basis in the preparation of activities and components in this e-worksheet. Sound waves were chosen because they have many applications in everyday life, making it easy to connect concepts with appropriate problems. Based on the description above, developing an e-worksheet based on sound wave science literacy is feasible to be used in physics learning during pandemics.

2. Method
This research is research and development with the ADDIE model (Analyze, Design, Development, Implementation, and Evaluation). The stage of e-worksheet development is shown in Figure 1.

| Analyze |
|------------------|
| • Analyzed the competency by determining the indicators and learning objectives related to the aspects of scientific literacy used |
| • Analyzed the characteristics of students in class XI MIPA 1 who need guidance in building knowledge independently |
| • Analyzed the characteristics of sound wave material, by dividing the material sub-chapters in each meeting and determining the topic of scientific literacy in this material |

| Design |
|------------------|
| • Designed the structure and framework of the e-worksheet, including the cover, layout, font, color composition, and the arrangement of activities referring to the predetermined scientific literacy indicators |

| Development |
|------------------|
| • Choose an electronic media development application |
| • Gather various relevant reference sources to enrich the material, images, charts, typing, and editing of e-worksheets |
| • The scientific literacy-based e-worksheet that has been developed was then validated by two academic validators, and one practitioner |

**Figure 1. ADDIE model development stage**

This science literacy-based e-worksheet validator numbers three people, consisting of two academics and one practitioner. The research instrument used is an e-worksheet validation sheet based on science literacy. The data analysis technique used is a validity test with assessment criteria in Table 1 below [25].

| Interval | Criteria |
|----------|----------|
| X > 3.4  | Excellent|
| 2.8 < X ≤ 3.4 | Good |
| 2.2 < X ≤ 2.8 | Pretty good |
| 1.6 < X ≤ 2.2 | Less good |
| X ≤ 1.6  | Bad     |
The results of the assessment of the three validators are then carried out a reliability test, which is calculated using the Formula Alfa Cronbach. The reliability coefficient obtained is categorized based on the criteria Widoyoko [26].

3. Result and Discussion

This research produces a product in the form of an e-worksheet based on science literacy on sound wave material as a guide for learners in conducting science literacy activities. The components contained in this science literacy-based e-worksheet are the front cover, instructions for use, experimental tools and materials, and bibliography. In addition, the element of science literacy that is loaded on aspects of the role of science is the text of scientific phenomena and the formulation of problems. Aspects of thinking and working scientifically contain components in hypothesis formulation, variable identification, experimental procedures, experimental results data, data analysis, predictions, test predictions, and conclusions. Finally, the details of questions and stabilization are contained in aspects of science and society and mathematics in science. Each element of this science literacy is written as a subheading in the e-worksheet.

E-worksheets based on science literacy are divided into two parts. The first part contains the characteristic subject matter of sound waves and the degree &intensity of sound waves. The second part of the e-worksheet contains a sub-material rapid propagation of sound waves, Doppler effects, as well as sound sources. Each section consists of literacy activities, namely reading, practicum, and working on problems to solidify the concept obtained through previous activities. An example of a developed e-worksheet display is shown in Figure 2.

![Figure 2. Scientific literacy-based e-worksheet display](image)

Reading activities are complemented by a discourse on scientific phenomena presented in the form of pop up pictures. Practicum activities use the lab's virtual simulation service, PhET Colorado so that learners get a meaningful learning experience and can still be done in groups even remotely. Virtual lab simulations are selected to get the same results even though each learner does them in a different place. This becomes one of the alternatives to overcome distance learning obstacles during pandemics [27]. Virtual lab simulations can also improve science literacy skills, which require applying knowledge and scientific performance skills [8]. Then, learners can work on and discuss with group colleagues through Whatsapp groups and send the answers through Google Form, which is connected to an e-worksheet using a hyperlink and barcode features. The advice given by validators in improving the quality of e-worksheets is presented in Table 2.
Table 2. Validator Suggestion

| Suggestion | Revision |
|-------------|----------|
| 1. The cover image must match the material studied, and the identity on the cover must contain complete information (e.g., class, semester, etc.). | 1. The image on the cover is changed, and the cover's identity is equipped according to the validator's advice. |
| 2. Improve language usage in the e-worksheet instructions to make it more effective. | 2. Improve sentence arrangement and word usage in e-worksheet instructions so that they are clearer and easier to understand. |
| 3. Allow learners to identify some research questions of the phenomena presented and then choose one of them to investigate. | 3. They were switching questions about problem formulation to a form that allows learners to identify scientific questions independently. |
| 4. Complete the identity of the e-worksheet. | 4. Add a day and date column to an e-worksheet identity. |
| 5. Provide a bibliography in each section of the e-worksheet. | 5. Add the bibliography to each section of an e-worksheet. |

These suggestions are then used as a reference to improve the e-worksheet based on science literacy developed. The difference between the e-worksheet before it is fixed and after it is fixed is shown in Table 3.

Table 3. The Difference Between The E-Worksheet Before and After is Fixed

| | Before | After |
|---|---|---|
| Front Cover | ![](front_cover_before.png) | ![](front_cover_after.png) |
| E-worksheet Identity and Instructions | ![](worksheet_before.png) | ![](worksheet_after.png) |
The results of the e-worksheet validation assessment by the validator are presented in Figure 3.

![Figure 3. E-worksheet Validity Results](image)

Based on Figure 3 above shows that the average results of the validation aspect of the e-worksheet developed include valid with very high reliability.
E-worksheet can be good if it meets the active, construction, and technical aspects [28]. These aspects are detailed into several assessment criteria, namely can be used by learners as a whole, emphasis on the process of concept discovery, variety of stimulus through various activities, practicing skills, providing a learning experience based on goals, appropriate language, clarity of sentences, simple construction towards complex, simplicity of crawl formulation, conformity of material, there is sufficient space, effective illustration, the existence of clear goals and identity, suitability of capital letters, size, distance, the separator between clues and answers, effective images, interesting colors [28–31]. The color used in this e-worksheet design is white as a primary color with black, red, orange, and yellow elements. This selection is because white is a color with a bright and clean impression so that the writing and image are visible. At the same time, the color red, orange and yellow is a unique, warm, active, cheerful, spirited color that tends to bring closer to the user and suitable combined with the white background color [32].

E-worksheets based on science literacy also meet aspects of science literacy, detailed into several criteria [22]. The criteria are the conformity of science literacy materials and indicators, the existence of science literacy stages, information/images/science literacy activities, and available descriptions/texts that can train learners to identify scientific questions, identify experimental variables, analyze information, solve mathematical problems, make conclusions based on evidence and use of application problems in everyday life. This criterion follows the indicators of science literacy set in learning. This aspect of science literacy is also the basis for preparing components in the e-worksheet [33]. The text of discourse and the problems contained in the e-worksheet apply material learned in everyday life. The everyday phenomena presented concerning the material in this e-worksheet increase the learning motivation of learners [34].

In addition, as an electronic medium, e-worksheet must meet the aspects of software engineering and visual communication. [35]. Details of these aspects are, the media used is effective and efficient, reliable, easy to manage, simple in operation, the accuracy of application selection of media development, communicative, attractive and straightforward display, and navigation icons function correctly. This interactive electronic media used makes e-worksheet an exciting and effective learning medium and is considered to influence the interest and motivation of learners towards the learning presented [15], [13]. E-worksheet can also be used as an alternative learning medium to support students' digital literacy skills [34]. Thus, e-worksheets as teaching materials can help learners learn at home during pandemic times and conduct experimental activities to improve their science literacy [13,36,37]. Therefore, e-worksheets can be developed on different physical materials or other branches of science for further research.

4. Conclusion

Based on the study results, it can be concluded that e-worksheet sound waves based on science literacy are considered valid with very high reliability. Thus, this e-worksheet can be used in learning the physics of sound wave material during the period, especially to improve the science literacy skills of learners.

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