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Development of Science Technology Society (STS)-Based Physics Student Worksheet to Improve Students' Science Literacy

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ABSTRACT: The research on the development of Science Technology Society (STS)-based physics student worksheet has been conducted. This study aims to: (i) produce valid STS-based physics student worksheets, (ii) analyze the practicality of STS-based physics student worksheets, and (iii) analyze the effectiveness of STS-based physics student worksheets on students' science literacy at SMAN 4 Gowa. The research method is Research and Development (R&D) with 4D model. The subjects of this research trial were 35 students of class XI IPA 1 at SMAN 4 Gowa. The instruments used include validation sheets, practitioner assessment questionnaires, and science literacy test instruments. Validity criteria based on expert validation results analyzed with Aiken's Index. Practicality criteria based on practitioners' assessment result. Effectiveness criteria based on students' science literacy test result analyzed with N-gain equation. The results showed: (i) The validity of STS-based physics student worksheets meets the valid criteria with an expert agreement index (V) of 0.80, (ii) The practicality of STS-based physics student worksheets meets the practical criteria with a percentage of practitioner assessment of 91.88% in the very practical category, (iii) The effectiveness of STS-based physics student worksheets on science literacy of SMAN 4 Gowa students meets the effective criteria with an N-gain score of 0.42 in the medium category. Based on this research, it can be concluded that STS-based physics student worksheets are valid, practical, and effective in terms of improving students' science literacy.

KEYWORDS: physics student worksheet, Science Technology Society (STS), science literacy

INTRODUCTION

Science literacy is one of the important skills that students need to have in order to survive in the 21st century (World Economic Forum, 2015). Science literacy is the ability to use evidence and data to evaluate information or arguments in order to understand laws, theories, natural phenomena, etc (Dragoş & Mih, 2015). The competency or process aspect of science literacy prioritizes 3 indicators, namely explaining scientific phenomena, evaluating and designing scientific investigations, and interpreting data and evidence scientifically. The importance of science literacy skills makes Indonesia take part in the assessment conducted by the Program for International Student Assessment (PISA). Based on the results of the PISA study in 2022, the science literacy skills of students in Indonesia are still low. Indonesia occupies position 67 out of 81 countries with an average score of 383 which is lower than the score in 2018 (OECD, 2023). In line with that, the results of observations at SMAN 4 Gowa show that the science literacy skills of students, especially class XI IPA are still low. Science literacy skills can be trained and developed through learning at school. Physics which is one of the subjects at the high school level can be utilized as a vehicle in training students' scientific literacy. As part of the effort to improve students' science literacy, a teaching material that can be tailored to their needs is needed, one of which is the student worksheet. Student worksheets are student guides that are used to conduct investigation or problem-solving activities (Trianto, 2011). Student worksheets contain student activities as well as instructions and work steps to complete the tasks given by the teacher (Majid, 2012). Student worksheets are one of the means to convey concepts to students both individually and in groups (Ryandhosi, 2023). A quality student worksheet must meet valid, practical, and effective criteria. Before use, student worksheets need to pass validity, practicality, and effectiveness tests. Validity is a measure that shows the validity or feasibility of an instrument or teaching material (Widodo et al., 2023). Validity is also defined as the accuracy of the research instrument in measuring what you want to measure in research (Budiastuti & Bandur, 2018). The validity test includes 4 aspects, namely content feasibility, presentation feasibility, language feasibility, and graphic feasibility (Arsyad et al., 2020). Practicality is seen from the results of the teacher's assessment in considering the ease of material and ease of use of student worksheets by teachers and students (Rahayu et al., 2019). The practicality test can be carried out after the student worksheet is declared valid. Meanwhile, effectiveness shows that the product can achieve the goals that have been set (Afdalia et al., 2020). Student worksheets that have passed the effectiveness test and meet certain criteria can be declared effective. Student worksheet can be combined with certain learning

models or methods as needed. According to Hunaepi et al. (2014) Science Technology Society (STS) can be used in science learning as an effort to develop students' science literacy. Science Technology Society (STS) is an attempt to present science through the use of problems in everyday life (Husamah et al., 2018). STS consists of 4 learning stages, namely the invitation stage, the exploration stage, the stage of proposing explanations and solutions, and the stage of determining action (Kassiavera et al., 2019). The specificity of the STS learning model lies in the introduction section which raises issues or problems in society that can be explored from students (Rasto & Pradana, 2021). Research by Devi and Aznam (2019) showed that there is a positive and significant effect of STS model on science literacy of students of class XI IPA SMAN 4 Kota Ternate. Research by Zahara and Atun (2018) showed that there was a statistically significant effect of the STS approach on the science literacy of students of class XI IPA SMAN 2 Banguntapan. In line with that, research by Pratama, Abdurrahman, and Jalmo (2018) showed that student worksheet based on the STS approach can improve students' science literacy. Based on these studies, it is known that the Science Technology Society (STS) approach can improve students' science literacy. The worksheets that have been developed in this research are physics worksheets based on Science Technology Society (STS) to improve students' science literacy. STS-based physics student worksheet is a worksheet integrated with STS learning stages related to science literacy indicators. STS-based physics student worksheet consists of 3 main components, namely learning objectives, brief material integrated with Science-Technology-Society elements, and activities integrated with 4 stages of STS learning. The STS-based physics student worksheet that has been developed in this study is expected to be used as an alternative teaching material to train and develop students' science literacy skills in the physics learning process at school.

METHOD

This research was a Research and Development (R&D) by adapting the 4D development model which consists of 4 stages, namely Define, Design, Develop, and Disseminate. The research subjects in this study were 35 students of class XI IPA SMAN 4 Gowa. This research was held from February 2024 to June 2024. The product trial was carried out in the even semester of the 2023/2024 school year at SMAN 4 Gowa which is located in Tinggimoncong District, Gowa Regency, South Sulawesi Province. The instruments used in this study were validation sheets, practitioner assessment questionnaires, and science literacy test instruments, which had been validated. The data collection techniques used in this study were questionnaires and tests. The product trial design used One-Group Pretest-Posttest Design. The results of expert validation of research products and instruments were analyzed with the expert agreement index (Aiken's V) using the following formula.

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

If the analysis results show a value of V≥0.4, the expert agreement index can be said to be valid (Azwar, 2012). The results of the practitioner's assessment of the product were analyzed using the following formula.

$$PRS = \frac{\sum A}{\sum B} \times 100\% \quad (2)$$

The score interpretation criteria for describing the practicality of student worksheets based on the average percentage of practitioner assessments are shown in Table 1.

Table 1. Practitioner Assessment Criteria

Percentage of Practitioner's Assessment of the Product	Interpretation
PRS ≤ 20%	Not Practical
20% < PRS ≤ 40%	Less
40% < PRS ≤ 60%	Enough
60% < PRS ≤ 80%	Practical
80% < PRS ≤ 100%	Very Practical

Source: (Arikunto, 2010)

STS-based physics student worksheet can be declared practical if the percentage of PRS practitioner assessments >60% with practical and very practical categories (Finsi et al., 2021). The results of the students' science literacy test were analyzed by the Normalized Gain or N-gain test using the formula as follows.

$$g = \frac{S_{posttest} - S_{pre\,test}}{S_{max} - S_{pre\,test}} \quad (3)$$

A teaching material developed can be said to be effective if the purpose of making it can be achieved through its use (Akker et al., 1999). The N-gain score provides information about the extent to which students' science literacy improves after using STS-based

physics student worksheets, and the results are normalized against the maximum possible score. The interpretation criteria for the N-gain score are shown in Table 2.

Table 2. N-gain Score Interpretation

N-gain Score	Interpretation
$0,70 < g \leq 1,00$	High
$0,30 < g \leq 0,70$	Medium
$0,00 < g \leq 0,30$	Low
$g = 0,00$	No increase (stagnant)
$-1,00 \leq g < 0,00$	Decrease

Source: (Sundayana, 2014)

STS-based physics student worksheet can be declared effective if the N-gain score is g>0.3 with a medium category or high category (Hake, 1998).

RESULT AND DISCUSSION

The validity of the STS-based physics student worksheet was assessed by three experts based on aspects of content feasibility, presentation feasibility, language feasibility, and graphical feasibility. The results of expert validation were analyzed using Aiken's V index analysis and the results were obtained as in Table 3.

Table 3. Results of Expert Validation of STS-Based Physics Student Worksheets

Aspect	V	Category
Content Feasibility	0.84	Valid
Presentation Feasibility	0.80	Valid
Language Feasibility	0.78	Valid
Graphical Feasibility	0.79	Valid
Average	**0.80**	**Valid**

Based on Table 3, the four validation aspects obtained an expert agreement index (V) score of more than 0.4, thus meeting the valid criteria. The content feasibility aspect obtained the highest score, while the language feasibility aspect obtained the lowest score. On the content feasibility aspect, the validators agreed that the student worksheet material is accurate and in accordance with the learning outcomes and learning objectives, the information presented contains up-to-date references, the material contains contextual insights and can encourage students' curiosity. On the presentation feasibility aspect, the validators agreed that the material presentation technique is interesting and easy for students, as well as the material and activities presented are integrated with the elements and stages of STS learning. On the aspect of language feasibility, the validators agreed that the language used was in accordance with student development and the general guidelines for Indonesian spelling or PUEBI. On the aspect of graphic feasibility, the validators agreed that the aesthetics of the student worksheet display can provide reading comfort, the cover reflects the contents of the student worksheet, and the content display is simple and harmonious so that it is easy to read. Overall, the expert agreement index (V) score is 0.80 so that the STS-based physics student worksheet can be declared valid.

Table 4. Results of Practitioner Assessment of STS-Based Physics Student Worksheets

Aspect	PRS (%)	Category
Content Feasibility	91.17	Practical
Presentation	91.67	Practical
Language	93.33	Practical
Graphical	91.35	Practical
Average	**91,88**	**Practical**

The practicality of the STS-based physics student worksheet refers to the results of the practitioner's assessment of the aspects of content feasibility, presentation, language, and graphics. STS-based physics student worksheets were assessed by 15 practitioners consisting of high school physics teachers in Gowa Regency, postgraduate students of physics education study program, and physics tutors at a tutoring institution. In this study, the practitioners had never used STS-based physics student worksheets. However, these practitioners are experienced in preparing and presenting physics student worksheets, as well as having teaching experience and interacting with students in the learning process, so they are considered capable of assessing the practicality of the developed student worksheets. The results of practitioners' assessment are shown in Table 4. Based on Table 4, all aspects of the practitioner assessment

obtained a percentage assessment of more than 60%, thus meeting the practical criteria. Practitioners gave very practical ratings for all four aspects of the assessment. The language aspect obtained the highest percentage, while the content feasibility aspect obtained the lowest percentage. On the content feasibility aspect, practitioners assessed that the material in the student worksheet is in accordance with the learning outcomes or CP and learning objectives, related to the application of physics concepts in technology, can foster the ability to ask questions and curiosity, contains elements of Science Technology Society (STS) to train science literacy, and does not cause misconceptions. On the presentation aspect, practitioners assessed that the directions and instructions in the student worksheet were clear, the presentation of the material could stimulate students' activeness, and the presentation of the images did not cause double meanings. On the language aspect, practitioners assessed that the use of language was in accordance with the general guidelines for Indonesian spelling or PUEBI and according to the development of students, the material presented was communicative and did not cause misconceptions. On the graphical aspect, practitioners assessed that the STS-based physics student worksheet has an attractive appearance, simple typography of content, and provides reading comfort. Overall, the average percentage of practitioner assessment is 91.88% with a very practical category so that the STS-based physics student worksheet can be declared practical.

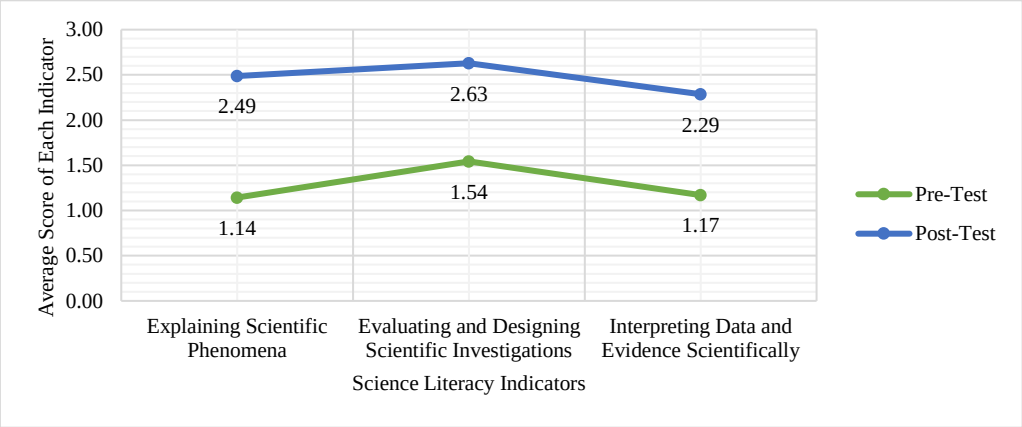

Figure 1. Graph of the Increase in Student Test Scores for Each Science Literacy Indicator

The effectiveness of STS-based student worksheets refers to the increase in students' science literacy scores. The test was given to the research subjects before (pre-test) and after (post-test) using the student worksheet. Students' science literacy test results were analyzed to determine the N-gain score. Based on the results of the analysis, the N-gain score was 0.42 with a medium improvement category and met the valid criteria. The N-gain score obtained indicates an increase in students' science literacy after the application of STS-based physics student worksheets in physics learning. Based on Figure 1, there was an increase in test scores on all three indicators of science literacy measured. The indicator of explaining scientific phenomena increased by 33.75% which is the first highest increase. Based on the test results, students have improved in explaining scientific phenomena, especially those related to daily life. Students show the ability to apply scientific knowledge, identify, represent a model, make predictions correctly, explain hypotheses clearly, and explain the implications of scientific knowledge for society. The indicator of interpreting data and evidence scientifically increased by 28% which is the second highest increase. Based on the test results, students have improved in interpreting several forms of scientific data presentation. Students can analyze and interpret scientific data, draw appropriate conclusions, and demonstrate the ability to convert data from one representation to another. Meanwhile, the indicator of evaluating and designing scientific investigations increased by 27.25% which is the lowest improvement when compared to the other two science literacy indicators. Based on the test results, students improved in explaining and assessing a scientific investigation. Students are able to propose ways to address scientific questions by showing the ability to identify questions explored in a scientific investigation, distinguish questions that require scientific investigation, and propose ways to explore the questions given.

CONCLUSIONS

Based on the results of the research and discussion, the following conclusions were obtained: 1) The validity of STS-based physics student worksheets meets the valid criteria with an expert agreement index (V) of 0.80. The profile of STS-based physics student worksheets that meet these criteria consists of: front cover, preface, table of contents, instructions for using the worksheet, worksheet description, learning outcomes, chapter cover, worksheet topic/title cover, objectives, brief material, activities (invitation stage, exploration stage, explanation and solution proposal stage, action determination stage), bibliography, and back cover. 2) The practicality of STS-based physics student worksheets meets the practical criteria with a percentage of practitioner assessment of 91.88% in the very practical category. 3) The effectiveness of STS-based physics student worksheets on science literacy of SMAN 4 Gowa students meets the effective criteria with an N-gain score of 0.42 in the medium category.

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