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STUDENT WORKSHEETS WITH VIRTUAL LABORATORY TO TRAIN SCIENCE LITERACY IN ACID-BASE LEARNING

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Abstract: This study aimed to obtain Student Worksheets suitable for training students' scientific literacy. This research includes research and development. The research procedure carried out to develop this teaching material refers to the steps of the ADDIE model but is only carried out until the development stage and limited trials are carried out. The problem was carried out in one class that was randomly selected. Feasibility was tested based on validity, practicality, and effectiveness. An expert validator carries out the validity, and a score is determined using the mode. Validity results obtained a score of 4 with a very valid category on student worksheets 1 and 2. The results of the practicality analysis were viewed from the effects of student responses and observations of student activities. A practicality percentage of 90%-100% was obtained in the very practical category, then the results of observations of students' activities with relevant activities at meeting 1 amounted to 97.04%, and at meeting two amounted to 98.03%. From the two activity percentages, the relevant activity percentage obtained ≥ 61%, so it can be said that student worksheets are very practical. The results of the analysis of the effectiveness of student worksheets were measured based on the results of scientific literacy ability scores, which were analyzed using the t-test and obtained a significance value of 0.000 so that the developed student worksheets were said to be effective. Based on the results of the validation, practicality, and effectiveness analysis, it was found that the student worksheet with a virtual laboratory to train scientific literacy that was developed was feasible to use.

Keywords: *Student Worksheet, virtual laboratory, Science Literacy, Student Worksheets Feasibility*

INTRODUCTION

The 21st century is a century where science develops rapidly through the dissemination of information and technology. Various advances in knowledge, technology, and information are to improve the life of more modern society [1]. However, in addition to the advantages enjoyed by the community, there are drawbacks. Therefore, the public must know scientific truths and how science, technology, and society interact [2]. People are described as scientifically literate when they have information and can use it to solve problems related to everyday life [3]. Therefore, achieving a society that understands scientific literacy is urgently needed today. Among the 16 skills the World Economic Forum identified, scientific literacy is needed today [4].

Given the importance of scientific literacy, any reform in science education aims to increase scientific literacy in society [5]. The scientific literacy level of students in Indonesia based on PISA so far has shown quite apprehensive conditions. PISA shows that the Indonesian science curriculum needs to encourage scientific literacy. Therefore, it is vital to improve the learning process [6]

Factors that cause low scientific literacy are influenced by various factors, such as the education system/curriculum, learning methods, teacher competence, learning facilities and facilities, learning resources, and teaching materials [7]. The results of a field study at Al Islam Krian Sidoarjo High School by filling out lifts for students showed that Al Islam Krian Sidoarjo High School students did not know about scientific literacy and had not used Student Worksheets to practice scientific literacy.

The low average score of students' scientific literacy in Indonesia shows that learning chemistry in schools still ignores scientific literacy [8]. Learning methods and media such as Student Worksheets need to be developed in the chemistry learning process to improve the quality of learning. Developing worksheets as teaching materials for the learning process is vital [9]. Student worksheets can also increase student learning motivation by creating a pleasant learning atmosphere, arousing learning motivation, enthusiasm for learning, and improving student learning outcomes. [10]

This scientific literacy-oriented student worksheet is used to train students in solving problems and making decisions that can improve the quality of life based on students' scientific knowledge. The student worksheets, oriented towards scientific literacy, contain chemical material content combined with everyday life's context [11]. This student worksheet includes a practicum that students must do. Practicum activities in this laboratory cannot be separated from using hazardous chemicals, accidents during practicum implementation, and the formation of waste. Practicum activities can be carried out safely by using a virtual laboratory. One of the virtual laboratory platforms that can be used is Physics Education and Technology (PhET).

Chemistry subjects emphasize phenomena and concepts covering various aspects, including acids and bases. Acids and bases are chemicals that have many

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applications in everyday life, such as changing the color of flowers based on soil pH and using household products, fruits, and medicines. Chemistry learning on acid-base material can be done by connecting the concepts with the studied phenomena.

Based on these problems, it is necessary to develop worksheets that can be used to train students' scientific literacy skills. Therefore, the researcher aims to conduct a feasibility study on developing student worksheets with a virtual laboratory to teach scientific literacy skills on acid-base material.

RESEARCH METHODS

This study makes use of the research and development (R&D) method. The ADDIE model developed by Branch [12] consists of 5 stages: analysis, design, development, implementation, and evaluation.

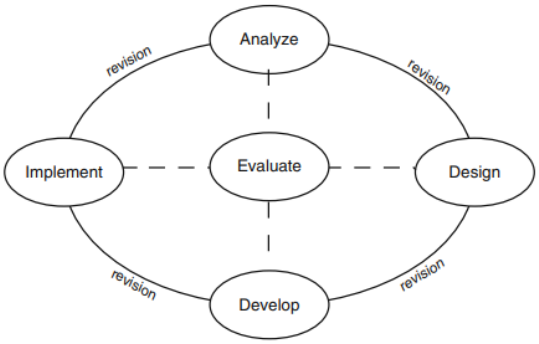

Figure 1. ADDIE Research Design.

The feasibility of student worksheets is obtained from the results of validation, effectiveness, and practicality. This research was only carried out until the development stage, but limited trials were carried out with all students randomly selected in one class. Validation sheets, student answer questionnaires, observation of learners' activity, and tests of scientific literacy abilities were employed.

Then a limited trial was conducted to determine if the developed student worksheets could be practical and effective. The instrument that will be used to assess practicality and effectiveness has previously been validated by an expert validator so that the tool to be used has been declared valid to be tested on students. Student response questionnaires and student activity observation sheets are used to determine the practicality of student worksheets. While the instruments used to assess the effectiveness of student worksheets are pretest and posttest sheets of scientific literacy ability.

Three expert validators tested the validity of learning tools by filling out validation sheets. The percentage of validation sheet results obtained is based on a Likert scale [13].

Data validity results that expert validators have carried out are then determined by the mode in each assessment which is validated with the condition that a decision is made if the method≥ 3, then the evaluation is declared valid, then if the mode < 3, then the assessment is declared invalid.

Table 1. Likert Scale Scores

Skor	Evaluation
4	Very Valid
3	Valid
2	Less Valid
1	Invalid

Practicality data is obtained from students' responses and observations of students' activities on the practicality of student worksheets. Percentage of learner responses obtained according to the Guttman scale [14].

Table 2. Guttman Scale Scores

Answer	Positive Answer Score	Negative Answer Score
Yes	1	0
No	0	1

Response questionnaire result data obtained were analyzed using the following practicality percentage formula.

$$\text{persentase jawaban positif (\%)} = \frac{\Sigma \text{jawaban YA}}{\Sigma \text{ responden}} \text{x100\%}$$

$$\text{persentase jawaban negatif (\%)} = \frac{\Sigma \text{ jawaban TIDAK}}{\Sigma \text{ responden}} \text{x100\%}$$

Student worksheets practicality data was also obtained from observing student activities with an interval of 3 minutes. Data from activity observations were analyzed using the following formula for the percentage of student activity.

$$\text{aktivitas} = \frac{\Sigma \text{frekuensi aktivitas yang relevan}}{\Sigma \text{frekuensi aktivitas keseluruhan}} \text{x100\%}$$

The percentage of response questionnaire results and observations of student activities was obtained based on the criteria in Table 3.

Table 3. Practicality Criteria

Percentage (%)	Practicality Criteria
81– 100	Very Practical
61-80	Practical
41-60	Quite Practical
21-40	Less Practical
0-20	Very Impractical

The developed student worksheets are said to be practical if the practicality percentage obtained is ≥ 61%.

The effectiveness of the student worksheets was analyzed based on the science literacy skills of students obtained based on the science literacy skills test from

the pretest and posttest scores. The effectiveness of the developed student worksheets was analyzed using the t-test to determine whether or not there was an increase and difference in the average value of the pretest and posttest results of science literacy skills. A normality test was conducted before analyzing using the t-test to determine whether the data obtained were normally distributed. The normality test used is the Shapiro-Wilk Test using SPSS. Data is declared normally distributed if the sig value is more significant than 0.05, and data is declared not normally distributed if the value is smaller than 0.05 [15]. Then if the data is normally distributed, the t-test is used to continue data analysis. Otherwise, the Wilcoxon test is used.

RESULTS AND DISCUSSION

Analysis Stage

The first stage is based on the ADDIE model, namely the analysis stage. An analysis was carried out to determine students' demands in learning chemistry. The research carried out was in the form of literature studies and field studies by distributing pre-research questionnaires to 32 students at Al Islam Krian Sidaorjo High School and conducting interviews with chemistry teachers at Al Islam Krian Sidoarjo High School.

Based on the results of preliminary research, it is known that 81.8% of students needed help understanding scientific literacy skills. Even though this scientific literacy will help students to form mindsets, behaviors and build the character of students to be more concerned and responsible for their environment that depends on technology [16]. Factors that are thought to cause low scientific literacy are influenced by several things, such as the education system/curriculum, learning methods, teacher competence, learning facilities and infrastructure, learning resources, and teaching materials. Teaching resources that can be used to train scientific literacy are student worksheets. Student worksheets aim to facilitate students in receiving lessons, where later, students are expected to understand the material [17] better. The interviews with Al Islam Krian Sidoarjo high school chemistry teachers showed that the students used student worksheets. Still, the student worksheets used had not supported scientific literacy training because the student worksheets used were general.

Student worksheets contain a practicum that students must carry out. This practicum is the best means for developing scientific literacy skills because it provides opportunities for students to conduct their own experiences from the activities in the student worksheets, which can later be processed according to their cognitive abilities [18]. However, in reality, not all schools can carry out practicums, and the high risks that come from implementing practicums. It is supported by the results of interviews conducted with Al Islam Krian Sidoarjo, a high school chemistry teacher, that the practicum implementation for this acid-base material could have gone better due to the lack of time that could have been used. One solution that can be taken from this problem is to use a virtual laboratory. Many virtual laboratory applications can be used, one of which is the virtual laboratory application which can help students to do practicum without using laboratory equipment.

Design Stage

The second stage is the design. This design stage is carried out by determining the product design, format selection, and application method. The contents of the student worksheets must be considered in the form of basic competencies, learning indicators, instructions, and activities that cover scientific literacy skills. At this design stage, also make a storyboard.

Figure 2. Design Student Worksheet

Development Stage

The third stage is development. At this development stage, the preparation of student worksheets, the manufacture of instruments, and the implementation of validation were carried out by expert validators. At this stage, student worksheets are prepared so that an initial student worksheets product will be produced (draft I). Furthermore, the chemistry lecturer will review the student worksheets to get criticism and suggestions, which the researcher will then revise so that a repaired product will be produced (draft II).

Figure 3. Student Worksheet Cover

The domain of scientific literacy, according to PISA, has four aspects, namely: 1) Context, in which literacy involves issues that are important in everyday life both personally, locally or nationally, and globally; 2) Competence in scientific literacy is divided into three aspects, specifically a) explaining phenomena scientifically; b) evaluation and designing investigations; c) interpreting scientific data and evidence; 3) Knowledge, in scientific literacy consists of content, procedural, and also epistemic; and 4) Attitude, in scientific literacy, namely interest in science, then concern, towards the environment and evaluating scientific approaches and also investigations. After the student worksheets were revised and draft II was obtained, the student worksheets were validated by three expert validators, namely two chemistry lecturers and one chemistry teacher, to provide assessments and suggestions, and comments. The results of the revised student worksheets, validated by the three expert validators, will produce feasible student worksheets for training students' scientific literacy abilities.

Media Validity

The first student worksheets feasibility test was carried out with validation carried out by three expert validators. The validated teaching materials are the student worksheets that will be developed. In compiling the student worksheets with this virtual laboratory, scores were obtained, and the validator gave suggestions for improvement. Three expert validators will analyze the content and construct validation of the student worksheets, which were made as an initial draft during the validation test procedure. The purpose of validating student worksheets is to produce student worksheets that are feasible and valid for students to try out. The validity test, apart from aiming to produce a feasible and valid product, is also used to determine the deficiencies or weaknesses of the product made using the validator's recommendations and criticism [19]. The validation results are presented in Table 4. The validation results for student worksheets at meeting 2 are in Table 5.

Table 4. Student Worksheet Validation Results 1.

Rated Aspect	Evaluation			Mode	Category
	V1	V2	V3		
Content	3	4	4	4	Very Valid
Construct	3	4	4	4	Very Valid
Validity Score Mode				4	Very Valid

Table 5. Student Worksheet Validation Results 2.

Rated Aspect	Evaluation			Mode	Category
	V1	V2	V3		
Content	3	4	4	4	Very Valid
Construct	3	4	4	4	Very Valid
Validity Score Mode				4	Very Valid

The scores of student worksheet one validation results were analyzed by determining the mode of the scores given by the three validators for each validated assessment. Based on Table 4 above on content validity, the method of the three validators is four, so the contents of the student worksheets are stated to be very valid. On construct validity, the process of the three validators is 4, so the construct validity of the student worksheets is very valid. The overall mode obtained is four so that student worksheet one is declared very valid and feasible to continue at the limited trial stage. Meanwhile, in Table 5, in terms of content validity, the mode of the three validators is 4, so the contents of the student worksheets are stated to be very valid. On construct validity, the method of the three validators is four, so the construct validity of the student worksheets is very valid. The overall mode obtained is four so that student worksheet two is declared very valid and feasible to continue at the limited trial stage.

It aligns with research who obtained a content eligibility percentage of 88% with very valid criteria [20]. Another study received a construct validity percentage of 86.67% in the very valid category [21].

Media Practicality

The following student worksheets feasibility test is to carry out the student worksheets practicality test. The instrument used to test the practicality of these student worksheets was a student response questionnaire which had previously been validated by an expert validator and had been declared feasible for

limited trials to students. The results of student responses are presented in Table 6.

Table 6. Recapitulation of student response questionnaire data.

Statement	Percentage %
This student worksheet made me interested in learning acid and base materials	100
This student worksheet made me understand acid-base material	96.8
PhET can make it easier for me to do the practicum	96.8
The domains in the student worksheet make it easier for me to practice scientific literacy skills	93.7
The works instructions on the student worksheet made it easier for me to carry out the activity	100
The phenomena contained in the student worksheet can help me find problems	90.6
The activities and questions in the student worksheet did not help me practice scientific literacy	93.7
PhET didn't allow me to understand/do the practicum	90.6

The percentage of student responses was 95.3%, so the student worksheets were categorized as very practical. It is in line, the practicality and effectiveness of problem-based learning worksheets for students to practice acid-base science literacy results in a response questionnaire with a percentage of 94.99% in the very good category [6].

The instrument used to test the practicality of the student worksheets is the observation sheet of student activities, which was previously validated by an expert validator and declared feasible for limited trials on students. The results of observing student activities are presented in Table 7.

The percentage of relevant student activity at meeting 1 was 97.04%, and at meeting 2 was 98.03%. From the two rates of these activities, the portion of total relevant activities obtained is ≥ 81%, so it is said that student worksheets are very practical.

Table 7. Recapitulation of the results of observing student activities

Student Activity	Activity Percentage	
	Meeting 1	Meeting 2
Relevant Activity	97.04 %	98.03 %
Irrelevant Activity	2.96 %	1.97 %
Total Percentage	100 %	100 %

Previous research conducted by Ni'mah on problem-based learning-based student worksheets to train science literacy skills on acid-base material obtained an average score of 94.99% with a very good category, so it can be said that student worksheets with virtual laboratories to train science literacy skills in practical to use.

Media Effectiveness

The next stage is to analyze the effectiveness of the student worksheets, which is obtained from the outcome of the preliminary test data (pretest) and the final test (posttest) on learner scientific literacy abilities. Previously, the effectiveness of these student worksheets was analyzed using the normality test first to determine whether the data obtained were normally distributed. Then if the data is normally distributed, the t-test is used to continue data analysis.

Table 8. Normality Test

Tests of Normality						
	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pretest	.128	32	.200*	.952	32	.167
Posttest	.147	32	.077	.935	32	.054

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Based on Table 8, the normality test results of students' science literacy skills obtained a significance value of 0.167 for the pretest score and 0.054 for the posttest score. Table 8 shows that students' science literacy skills are normally distributed because the significance value <0.05 so that testing can continue using the t-test.

Table 9. T-test

One-Sample Test						
	Test Value = 35					
					95% Confidence Interval of the Difference	
	t	df	Sig.	Mean Difference	Lower	Upper
Posttest	16.755	31	.000	40.93750	35.9544	45.9206

Based on Table 9 above, the significance value in the t-test obtained is 0.000, so it is said that if there is a difference in the average value of scientific literacy results for the pretest and posttest because the significance value obtained is <0.05, which means that the student worksheet is said to be effective.

The results of the scientific literacy test on salt hydrolysis material analyzed using N-gain experienced an increase in all students [22-23]. The N-gain score achieved was 0.83 in the high category, indicating that the student worksheets increased students' scientific literacy.

CONCLUSION

Student worksheets produced with the virtual laboratory are suitable as a learning tool to develop student's scientific literacy in acid-base materials. Feasibility is based on the results of validation, practicality, and effectiveness assessments. The validity was obtained by a score of 4 with a very valid category. The practicality of student worksheets based on students' responses received with a practicality strength of 90%-100% in the very practical category, and the results of observations of students' activities with relevant activities at meeting one amounted to 97.04% and at meeting two amounted to 98.03%. The effectiveness of student worksheets is based on the results of scientific literacy ability scores as measured using the t-test, and a significance value of 0.000 is obtained. This study was only limited to the development stage, so it is recommended that further researchers continue until the implementation and evaluation stage so that the developed student worksheets can be directly used for the learning process. For teachers, the developed student worksheets can be used as teaching material when learning acid-base materials to train scientific literacy.

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