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Student Worksheets Based on Science Literacy to Practice Students' Argumentation Skills on Electrolyte and Non-Electrolyte Solution Materials

Sisilia Fil Jannati[1], Rusmini[2]

[1,2]Department of Chemistry, Faculty of Mathematics and Natural Sciences, State University of Surabaya
Jl. Lidah Wetan, Lidah Wetan, Kec. Lakarsantri, Kota SBY, Jawa Timur 60213
*Correspondinge-mail: rusmini@unesa.ac.id

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Abstract: Student Worksheets Based on Science Literacy to Practice Students' Argumentation Skills on Electrolyte and Non-Electrolyte Solution Subjects. The purpose of this research is to produce student worksheets in training students' argumentation skills that are feasible. This research uses the 4D development method but is limited to the Develop stage. The validity of the student worksheets in terms of content, presentation, language, and graphic aspects obtained very valid criteria with an average percentage of 87.50%: 89.50%; 88.00%; 85.50%. The practicality of the student worksheets is assessed from the student activity observation and student res ponse and obtained very practical. The effectiveness of student worksheets is very effective. It seen from the increase in learning outcomes on cognitive tests and students' argumentation skills tests with n-gain values of 0.79 and 0.85, which have high interpretations. This result is supported by the Paired Sample T-Test and obtained a Sig valueof 0.000. It means there is an influence in the use of student worksheets developed on the results of students' argumentation skills. Student worksheets based on scientific literacy are very important to train students' argumentation skills.

Keywords: student worksheet, science literacy, argumentation skills, electrolyte and non-electrolyte solutions

Abstrak: Lembar Kerja Peserta Didik (LKPD) Berbasis Literasi Sains untuk Melatihkan Keterampilan Berargumentasi Peserta Didik pada Materi Larutan Elektrolit dan Non-Elektrolit. Tujuan penelitian untuk menciptakan LKPD yang layak dalam melatihkan keterampilan argumentasi peserta didik. Penelitian ini menggunakan metode penelitian 4D namun sampai tahap Develop. Kevalidan LKPD ditinjau dari aspek isi, penyajian, kebahasaan, dan kegrafikan memperoleh kriteria sangat valid dengan persentase sebesar 87,50%: 89,50%; 88,00%; 85,50%. Kepraktisan LKPD dinilai dari lembar observasi aktivitas dan angket respon yang memperoleh kriteria sangat praktis. Keefektifan LKPD memperoleh hasil sangat efektif dengan nilai n-gain sebesar 0,79 dan 0,85 yang berinterpretasi tinggi. Hasil ini didukung oleh hasil uji Paired Sample T-Test dan memperoleh nilai Sig. (2-Tailed) sebesar 0,000. Hal ini berarti adanya pengaruh dalam penggunaan LKPD terhadap keterampilan argumentasi peserta didik.

Kata kunci: lembar kerja peserta didik, literasi sains, keterampilan berargumentasi, larutan elektrolit dan non elektrolit

- **INTRODUCTION**

Education plays an important role in elevating human dignity, intelligence, and morals to form quality human resources. Advances in science and technology affect the progress of the educational system in Indonesia (Ariningtyas, 2017: Dewi, 2018). Therefore, the government implements the 2013 curriculum, which can enhance the grade of human resources. Chemistry is a subject in high school listed in the curriculum.

Chemistry is a component of science that studies matters' content, structure, and properties and its changes closely connected to its application in daily life (Chang, 2010: Irwansyah et al., 2017). However, often in the chemistry learning process, it is not associated with daily life, which causes students to have difficulty understanding and interpreting chemical material (Aisyah, 2017). This is in accordance with the results of a pre-research conducted in class X SMAN 1 Puri Mojokerto. Respondents stated that learning chemistry is often not associated with daily life, so they have difficulty understanding chemistry. One of the chemistry materials whose learning is emphasized on the phenomena of everyday life is an electrolyte and non-electrolyte solutions. Students are expected to create and conduct experiments to discover the concept of materials are the characteristics of this materials (Aisyah, 2017).

Student-centered learning with a scientific approach is applied in the 2013 curriculum. A scientific approach is an approach that requires students to find facts, evidence, reasons and think critically. This learning refers to 21st-century skills requiring students to have 4C skills, namely critical thinking, collaboration, creativity, and communication. Critical thinking skills are basic skills in solving a problem, while communication skills are the capability of individuals to communicate their thoughts. Critical thinking skills and effective communication, both orally and in writing, are skills needed by students as a provision to face 21st-century life and are packaged into an interconnected unit in argumentation skills (Devi et al., 2018: Wagner, 2010).

Argumentation is a scientific skill that aims to convince someone of an opinion or statement accompanied by factual data (Afandi, 2021). Arguments have levels described in the Toulmin diagram, namely claim, data, warrant, backing, rebuttal, and qualifier (Toulmin, 2003). The claim is a statement of a phenomenon from scientific observations that have been made. Data is evidence used to support claims. The warrant is an explanation of the relationship between data and claims. The backing is the reason that forms the basis of justification. The rebuttal is an obstacle that arises when there is no proof of the information or statement submitted. The qualifier is a final statement on claims made in general terms (Afandi, 2021: Ginanjar & Utari, 2015: Muna, 2021).

Argumentation skill is important to developing students in critical thinking, facilitating understanding of ideas, increasing problem-solving abilities, increasing confidence in conveying their ideas because supported by evidence and explanations, and clarifying scientific theories about the universe (Deane & Song, 2014: Osborne *et al.*, 2004: Rahayu, 2018). Argumentation skills need to be applied in learning chemistry which is a branch of science by involving three levels, namely claims (macroscopic), showing data or evidence (microscopic), and explaining the relationship between claims and scientific evidence (symbolic) (Erduran, 2008: Hong & Talib, 2018). The outcomes of interviews with chemistry teachers and pre-research questionnaires in class X of SMAN 1 Puri Mojokerto discovered that they never taught argumentation skills in chemistry learning.

Argumentation skills are still not applied because there are no student worksheets that practice argumentation skills (Saputri, 2018). Student worksheets consists of tasks

that students must complete. Student worksheets is important for supporting the learning process and helping students understand the material, especially material that requires experimentation as a guide in practical activities (Muna, 2021). This worksheet contains stages of scientific literacy and argumentation.

Scientific literacy is the ability in science learning and processes to investigate questions, describe phenomena, and construct conclusions based on scientific data and truths related to scientific issues (Ulandari, 2021). PISA defines four dimensions in scientific literacy: knowledge, context, competence, and attitude. Scientific competence is used to see the ability of students to analyze scientific phenomena, prepare an investigation, and analyze scientific data (OECD, 2016). Scientific literacy can include in the learning process, such as developing Student Worksheets. It can enhance students' scientific literacy skills so that students' argumentation skills also increase (Maknun, 2014: Zahroh, 2021). Scientific literacy directs students to describe, examine natural phenomena, identify scientific issues based on situations and conditions, collect data, and solve problems that occur so that they can use to improve students' skills in argumentation (Putriana, 2021).

Based on these descriptions and facts, it is necessary to develop student worksheets that support scientific literacy activities and argumentation. This research produces a Science Literacy-based student worksheet to Practice Students' Argumentation skills on Electrolyte and Non-Electrolyte Solution Subject that are feasible.

• METHOD

This research using a 4D development model by Thiagarajan, Semmel, and Semmel, which consists of Define, Design, Develop, and Disseminate, but only to the Develop stage. The define stage aims to select and describe the needs in the learning process. Design stage is the stage of designing learning devices. Develop stage is the step that produces a development product that includes two sets, namely expert assessment followed by revision and limited trials (Ibrahim, 2001: Sinaga, 2019).

The data obtained from the student worksheets are based on enhancing learning outcomes, validation, and test results. The research instruments in this study were validation sheets, observation sheets, student response, pretest and posttest sheets of cognitive and argumentation skills tests. The feasibility of student worksheets is assessed in three parts: validity, practicality, and effectiveness.

The validity is assessed from the data of validation result from three experts based on the Likert scale in Table 1 below :

Table 1. Likert scale

Score	Criteria
1	Very bad
2	Bad
3	Normal
4	Good
5	Very good

(Riduwan, 2016)

The data obtained from the validator then calculated the percentage using this formula:

$$(\%)\text{validity} = \frac{\text{Total score}}{\text{Criteria score}} \times 100\%$$

The results of the validation analysis in percentages are interpreted into the criteria in Table 2 below:

Table 2. Interpretation of Validity Scores

Percentage (%)	Category
0 - 20	Very Invalid
21 - 40	Invalid
41 - 60	Quite Valid
61 - 80	Valid
81 - 100	Very Valid

(Riduwan, 2016)

The student worksheets are valid and can be used for trials in learning if the percentage of achievement is ≥ 61%.

The activity observation sheets from three observers and student response questionnaires define the practicality aspect. The student activity observation sheet is processed into percentages using the following calculation formula:

$$\text{Percentage}(\%) = \frac{\Sigma\text{student activity}}{\Sigma\text{overall activity}} \times 100\%$$

Student response questionnaires were used to determine student responses using the Guttman scale in Table 3 below:

Table 3. Guttman Scale

Question	Answer	Score
Positive Statements	Yes	1
	No	0
Negative Statments	Yes	1
	No	0

(Riduwan, 2016)

The student response questionnaire data is then converted into percentages. The results of the analysis of activity observation sheets and student responses in percentages are interpreted into categories in table below:

Table 4. Interpretation of Practical Criteria

Percentage (%)	Category
81 - 100	Very Practical
61 - 80	Practical
41 - 60	Practical enough
21 - 40	Less Practical
0 - 20	Not Practical

(Riduwan, 2016)

Scientific literacy-based student worksheets based are practical for practicing argumentation skills if the activity observation sheets and student response get ≥ 61%.

The effectiveness is assessed based on improving student learning outcomes in cognitive aspects and argumentation skills. Cognitive test pretest and posttest sheets consist of 10 multiple-choice questions. The pretest and posttest sheets of the argumentation skill aspect consist of 5 essay questions containing the stages of Toulmin's

argumentation. Three validators have validated the test sheets. The data were analyzed using n-gain scores, prerequisite tests, and hypothesis testing using the SPSS 23 program. Student learning outcomes in cognitive aspects and argumentation skills were calculated using this formula:

$$\text{Learning outcames} = \frac{\text{obtained score}}{\text{maximal score}} \times 100$$

Student learning outcomes on cognitive tests and argumentation skills are complete if they get a score more than 75. Data on student learning outcomes on cognitive tests and argumentation skills were analyzed using n-gain score according to this formula:

$$(\text{g}) = \frac{\text{post score} - \text{pre score}}{\text{max score} - \text{pre score}}$$

(Prastowo, 2015)

The n-gain scores are then interpreted according to the criteria in Table 5 below:

Table 5. Interpretation of N-Gain Criteria

Value (g)	Criteria
(g) > 0,7	High
0.7 ≥ (g) ≥ 0,3	Currently
(g) < 0,3	Low

(Hake, 1998)

The developed student worksheets are effective if the *n-gain score* on students' cognitive aspects and argumentation skills are more than 0,7.

The pretest and posttest data were also analyzed using SPSS 23 to strengthen the n-gain results. Using the Kolmogorov-Smirnov test, data from the examination of cognitive and argumentation skills were tested for normality as a prerequisite test and then analyzed using the Paired Sample T-Test for hypothesist test (Rahmawati, 2021).

• RESULTS AND DISCUSSION

The results of this study are study sheets, validation sheets, activity observation sheets, student response questionnaires, and pretest-posttest tests of cognitive aspects and argumentation skills. The stages of developing this student worksheet use a 4D model with the following steps:

Define stage

The define stage determines the needs in the learning process and collects information related to the product. There are five activities in the define stage to analyze the requirements in chemistry learning. The first stage is an initial analysis to collect information in the field, such as problems in the learning activities. The first stage result shows that students' learning resources only use textbooks and no other learning resources. The second stage is the analysis of students to determine the characteristics of students who become a reference to the development of appropriate media. The result of the second stage is that students have difficulty understanding the chemistry material because the learning activity is still teacher-centered and is not linked to everyday life. The third stage is task analysis to determine the content of the material and competencies to be achieved in the learning process by paying attention to the suitability between the student worksheets and core competencies, primary competencies, and competency

indicators in the revised 2013 curriculum. The third stage of the analysis revealed that had not applied students' argumentation skills and scientific literacy in learning activities. The fourth stage is concept analysis to identify important concepts that students in the chemistry learning process must master. The chemical ideas analyzed are electrolyte and non-electrolyte solutions. The fifth stage is to formulate learning objectives based on competency standards and basic competencies, then apply them in student worksheets.

Design Stage

Design stages carried out include four steps: prepare the instruments, select the media, select the format, and initial design. The instrument's preparation aims to determine students' cognitive abilities and argumentation skills.

Media selection aims to identify learning media relevant to the formulated learning materials and objectives. The choice of format seeks to develop student worksheets following the criteria for good student worksheets. This student worksheet contains the domain of scientific literacy, which consists of 4 domains, namely the context domain, the competence domain, the knowledge domain, and the attitude domain. The scientific literacy domain aims to assist students in collecting information that strength their arguments. This student worksheet also contains stages of argumentation to train students in arguing, namely claim, data, warrant and backing, and qualifier. The initial design at this stage is called Draft I. An initial draft of the developed student worksheets is produced at this stage. This study created two student worksheets. The first student worksheet contains the distribution of solutions based on their electrical conductivity. The second student worksheet contains reasons why a solution can cause electricity and cannot cause electricity.

Development Stage

The development stage aims to create a student worksheet based on science literacy that has been revised and deserves to be developed. The first stage is a review of Draft I from experts to get suggestions and improvements are made so that Draft II is obtained. Draft II was submitted for validation to assess the feasibility and input from three validators in chemistry and chemical education. After the revision, Draft III was followed by a limited trial of 25 students. The test results were analyzed, and student worksheet products were feasible, practical, and effective.

The Validity

The validity of student worksheets is set from content and construct validity (Anisa, 2020: Plomp, 2010). Construct validity consists of language, presentation, and graphics. The validity is analyzed, and get average percentage in Table 6 below:

Table 6. Validation Results

Aspect	Average Percentage	Category
Contents	87,50%	Very Valid
Language	89,50%	Very Valid
Presentation	88,00%	Very Valid
Graphics	85,50%	Very Valid

Based on Table 6, it can see that the validity aspects, including content, language, presentation, and graphics of the developed student worksheets, are very valid. It shows that the scientific literacy-based student worksheets to train students' argumentation skills can use in the learning process and try on students.

Content validity is very valid, with an average percentage of 87,50%. It shows that the student worksheets developed are follow the core competencies and basic competencies listed in the 2013 curriculum (BSNP, 2012). Student worksheets have contained clear learning objectives, contain accurate facts, present correct concepts, include theories and procedures for presenting accurate material, present elements that provide value, contain the domain of scientific literacy and stages of argumentation. According to the National Education Standards Agency, this student worksheet has fulfilled the content eligibility indicators (BSNP, 2012).

Construct validity in the language aspect is very valid, with an average of 89,50%. It shows that the language used is under the Indonesian language rules and uses communicative language and the right sentence structure. According to Enhanced Spelling, good student worksheets must use writing to avoid misconceptions (Widjajanti, 2008). The presentation aspect is very valid, with an average of 88,00%. It shows that the technique of presenting material is under the syntax of the learning model, meets the coherence of the concept, there are references or sources of authority in the presentation, the completeness of the identity of tables and figures, and the accuracy of the numbering of tables, figures, and attachments. The graphic aspect is very valid, with an average of 85,50%. It shows that the student worksheets developed by the typography make it easier to understand, read, and are interesting. The appearance design, color, point of view, composition, and size of the layout elements in the student worksheets are harmonious and clarify the function. Illustrations in student worksheets can clarify and facilitate understanding. The construction requirements of student worksheets are to use appropriate language, simple and clear sentence structures, use figure to help students understand the concept, have clear learning objectives and benefits, and have an identity to facilitate administration (Darmodjo & Kaligis, 1993).

The Practicality

Student response questionnaires consist of questions about student worksheets with yes and no choice methods. The data from the student response questionnaires that have been processed into percentages in Table 7 below:

Table 7. Results of Student Response Questionnaires

Aspect	Percentage	Category
Contents	97,33%	Very Practical
Presentation	96,80%	Very Practical
Language	93,33%	Very Practical
Graphics	95,83%	Very Practical

Based on Table 7, aspects of content, presentation, language, and graphics are very practical. It means the student worksheets can use in the learning activity.

The content aspect gets the highest percentage among other elements, with a value of 97.33%. This shows that students understand the material and objectives presented in student worksheets and apply material concepts in everyday life. Students also understand the domain of scientific literacy presented in student worksheets and the stages in arguing. Presentation and graphic aspects also get a high percentage. It shows that the student worksheet has an attractive design that motivates students to learn activities. Visuals that are attractive and have striking colors will build and encourage students in learning activities (Schunk, 2012). The linguistic aspect gets the lowest percentage among other

elements. It causes several terms in writing student worksheets that students still do not understand.

The practicality of LKS is also seen in the activity observation sheet. Student activity sheets contain questions about relevant activities during learning with yes and no choice methods. The results of student activity at the first meeting were 92.86%, and the percentage was 90.48% at the second meeting. It shows that the developed worksheets are practically used in the learning process because they get more than 61% (Riduwan, 2016). Student activities include listening to the teacher's explanation, observing the application of material concepts in everyday life, reading literature, answering the teachers' questions, discussing worksheets, identifying questions in worksheets related to the phenomena presented, formulating alleged answers, conducting experiments in earnest. , analyze data from observations, develop conclusions, and write claims, data, warrants/backings, and qualifications.

The Effectiveness

The effectiveness is assessed from the increase in students' test results in the cognitive and argumentation skills test. Three chemists have validated cognitive test questions and argumentation skills. Students are declared complete if the results are obtained to reach thcompleteness criteria. The results of the cognitive and argumentation skills test were analyzed and obtained n-gain scores in Table 8 below:

Table 8. N-Gain Score

Test Type	N-Gain Score	Interpretation
Cognitive Test	0,79	High
Argumentation Skills Test	0,85	High

Based on the Table 8, the cognitive aspect test obtained an n-gain value of 0,79 with a high interpretation. The argument skill test also got a high interpretation with an n-gain value of 0,85. So that the student worksheet is effective because both the cognitive test and the argumentation skill test have an n-gain value of more than 0.7 (Hake, 1998). This student worksheet is effective because it increases student test results on cognitive and argumentation skills tests. This student worksheet can train students' argumentation skills according to a statement by Toulmin that practicing argumentation stages consisting of claims, data, warrants, backing, and qualifiers can help improve students' ability to argue (Toulmin, 2003). The argumentation stage can train students in discussing and use to analyze students' argumentation skills (Lazarou, 2009).

The effectiveness is strengthened by performing statistical analysis tests using the SPSS 23 application. The statistical analysis test begins with the normality test as a prerequisite test. The data is normally distributed if the Sig value is > 0.05 (Ghozali, 2016: Sugiyono, 2017). This study used the Kolmogorov Smirnov Test as a normality test. The results of the normality test show in Table 9 and Table 10 below:

Table 9. Normality Test Results of Cognitive Test

Unstandardized Residual	
N	25
Normal Parameters [a,b]	Mean 0.0000000
	Std. Deviation 5,43522462
Most Extreme Differences	Absolute ,156
	Positive ,138

		Negative -,156
asymp. Sig. (2-tailed) ,120 [c]		

Table 10. Normality Test Results of Argumentation Skills Test

Unstandardized Residual		
	N	25
Normal Parameters [a,b]	Mean	0.0000000
	Std. Deviation	2.54168484
Most Extreme Differences	Absolute	,125
	Positive	,125
	Negative	-,125
asymp. Sig. (2-tailed)		,200 [c]

Based on Table 9 and Table 10, the Sig. value on the cognitive test data is 0,120, and the Sig. value on the argumentation skill test data is 0,200. The sig value obtained on the cognitive and argumentation skill tests was > 0,05. It means that the data on cognitive tests and argumentation skills tests are normally distributed so using the paired sample t-test as the hypothesis test (Ghozali, 2016).

Hypothesis testing was used to see the effect of using student worksheets on the results of cognitive tests and tests of argumentation skills. The formulation of the hypothesis used is:

H_0 : there is no effect between the results of the test after learning by using student worksheets that have been developed.

H_a : there is an effect between the results of the test after learning by using student worksheets that have been developed.

If the value of Sig. (2-tailed) < 0.05, H_a is accepted. If the value of Sig. (2-tailed) > 0.05, H_a is rejected (Santoso, 2014). The results of the paired sample t-test of cognitive test data and students' argumentation skills test show in Table 11 and Table 12 below:

Table 11. Hypothesis Test Results of Cognitive Test

		Paired Differences					t	df	Sig. (2-tailed)
		mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Cognitive Pretest - Cognitive Posttest	-45,60000	7.11805	1.42361	-48,53819	-42.66181	-32,031	24	,000

Table 12. Hypothesis Test Results of Argumentation Skills Test

		Paired Differences					t	df	Sig. (2-tailed)
		mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Pretest Argumentation - Posttest Argumentation	-62.48000	7,21757	1.44351	-65,45927	-59,50073	-43.283	24	,000

Based on Table 11 and Table 12, the cognitive test got a Sig (2-tailed) score of 0,000, and the argumentation skill test got a Sig (2-tailed) score of 0,000. Value of Sig. (2-tailed) obtained <0.05, so H_a is accepted. It means that there is an influence between the pretest and posttest results after learning by using student worksheets developed both at cognitive tests and argumentation skills tests (Ghozali, 2016). Based on these results, the developed student worksheets can be declared effective in learning activities to train students in arguing in chemistry learning.

Other studies support this study with the results that student worksheets containing the stages of argumentation can train students' argumentation skills got a high category with n-gain value of 0,84 (Muna, 2021). Similar research also obtained results that student worksheets containing the stages of argumentation can improve argumentation skills with an n-gain value of 0.84 and supported by the Wilcoxon test with an Asymp Sig value. (2-Tailed) of 0.000 (Afandi, 2021). Other research also states that scientific literacy improves argumentation skills (Putriana, 2021). This scientific literacy-based student worksheet is very important in learning activities to strengthen the argumentation skills needed in 21st-century skills. It is hoped that improving students' argumentation skills will increase their communication and critical thinking skills.

• CONCLUSION

Based on the data result, it can conclude that the developed student worksheets are declared very feasible to train students' argumentation skills seen from three aspects of feasibility, namely validity, practicality, and effectiveness. This developed student worksheet can practice argumentation skills on electrolyte and non-electrolyte solution material. Further research is expected of the efficacy of using scientific literacy-based worksheets to practice argumentation skills in class, school, and other student conditions.

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