



The Effectiveness of Student Worksheet Based on Scientific Literacy to Train Argumentation Skills on Factors that Affecting Reaction Rate

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Abstract

This study purposes to determine the effectiveness of scientific literacy-based worksheets to practice students' argumentation skills on the factors that affect the rate of reaction. The variables of this study were argumentation skill and science literacy. Subject and population of this study were 35 student of class XI IPA at SMAN 12 Surabaya. The analysis of this study used the N-gain and statistical tests including the Wilcoxon test and the Spearman test. The effectiveness of Student Worksheet was stated to be very effective in terms of the scientific literacy test with N-Gain score of 0.7 in the high category and an argumentation test with N-Gain score of 0.8 in the high category. Supported by the Wilcoxon test with acceptance of H1 which showed an average difference in scientific literacy and argumentation before and after treatment, and the Spearman correlation test gets an rho of 0.873 which indicates a strong relationship between literacy and argumentation.

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INTRODUCTION

The subject are contained in the 2013 high school curriculum is chemistry. Chemistry is a science that focuses on the discussion of matter, material changes, and energy (Brady, dkk., 2012). Good chemistry learning when students can relate learning material to their lives so that it can provide meaning to students (Izzatunnisa, dkk., 2019). This meaningfulness can be achieved if learners are good at science literacy (Khair, dkk., 2021).

Programme for International Student Assessment (PISA) (2018) describes science literacy as the ability to use scientific knowledge, identify questions, and make conclusions based on existing reality so that it can be applied in everyday life. Four domains of science literacy are context, knowledge, competence, and science attitude (OECD, 2018). Science literacy skills are essential for students because they need to make decisions and actions based on their knowledge (Cigdemoglu, dkk., 2017).

However, in reality, in recent years Indonesia's science literacy skills have dropped from an average score of 403 in 2015 to an average score of 396 in 2018. The lack of practice and development of scientific understanding by educators causes students to have difficulty in applying chemical concepts in everyday life (Izzatunnisa, dkk., 2019). This results in students experiencing low science literacy skills, so that learning chemistry becomes less meaningful or does not have significant meaning (Izzatunnisa, dkk., 2019).

The average science literacy skills in chemistry learning in the aspects of content, context, and competence are in the poor category, and the attitude aspect is in the very good category (Imansari, dkk., 2018). Science literacy skills are linked to argumentation skills (Kulisah, dkk., 2023). The relationship between science literacy and argumentation skills is strongly correlated (Kulisah, dkk., 2023). If the students' science literacy skills are higher, the students' argumentation skills will also increase (Fadlika, dkk., 2022). Correlation of argumentation skills with students' literacy gets a medium category (Fadlika, dkk., 2022).

Argumentation is a type of statement that tries to influence others along with logical and scientific evidence to support the arguments expressed (Belland & Kim, 2021). Toulmin's stages of argumentation are claim, data, warrant, backing, and rebuttal (Toulmin, 2003). However, in reality, students are still lacking in terms of argumentation.

Students' ability in terms of argumentation is low, students when submitting a statement are not accompanied by scientific evidence and do not have basic reasons for choosing the statement (Saputri, dkk., 2018). Students lack understanding of the material so that when giving examples and answers, they are not accompanied by scientific data (Rahayu, dkk., 2020). Teachers only use student textbooks in conducting learning (Azmarita, dkk., 2019). Student textbooks in circulation pay little attention to science literacy (Azmarita, dkk., 2019). Good learning media can support the achievement of learning objectives better. Student worksheet is one of the appropriate learning media or suitable for use. Student worksheet is effective in improving students' argumentation skills. (Mellenia & Admoko, 2022).

Student worksheet is one of the materials for teaching which contains worksheets for students based on the basic competencies achieved. The flexible of student worksheet allows teachers to choose, adapt, or create their own student worksheet according to the learning objectives (Kusdiningsih, dkk., 2019). Student worksheet must pay attention to several aspects, including the design aspects and development steps. (Khair, dkk., 2021). One of the criteria for product feasibility is effectiveness (Plomp & Nieveen, 2007).

The criteria for the effectiveness of a product is based on those who use the product can produce the desired goals (Plomp & Nieveen, 2007). Student worksheet based on scientific literacy are effective to train student's argumentation skills (Jannati & Rusmini, 2022). According to Jannati (2022), science literacy's student worksheet effective to train argumentation of student based on high interpretation of N-gain score, supported by the results of the Paired Sample T-Test and obtained a Sig value. (2-Tailed) of 0.000 on cognitive tests and tests of argumentation skills. It means there is an influence in the use of student worksheets developed on the results of cognitive tests and students' argumentation skills. Science worksheet was effective in developing argumentative skills of student with medium criteria (Lismawati et al., 2021).

METHOD

Subject and Population

This research was conducted in June 2023 at SMA Negeri 12 Surabaya involved 35 students of class XI IPA who had received material on factors affecting the reaction rate as research subjects.

Research

This study applied a one group pretest-posttest design. Data collection using the test method includes pretest and posttest of science literacy and argumentation skills (Sugiyono, 2007).

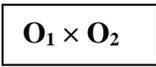


Figure 1. One group Pretest-Posttest

O1 : Cognitive pretest scores, science literacy, and argumentation skills carried out before being given science literacy-based LKPDs using a test.

X : The treatment of students is the use of science literacy-based LKPD.

O2 : Cognitive posttest scores, science literacy, and argumentation skills carried out after being given a science literacy-based LKPD using a test.

Analyze

Data analysis used N-Gain and statistical analysis including Wilcoxon test and Spearman test.

Analysis of pretest and posttest results of science literacy and argumentation each using N-Gain score with the following formula:

$$g = \frac{\text{posttest score} - \text{pretest score}}{\text{maximum score} - \text{pretest score}}$$

The N-Gain score results were interpreted into the criteria in Table 1.

Table 1. Interpretation of N-Gain Score (Hake, 2002)

N-Gain Score	Category
$g \geq 0,7$	High
$0,7 > g \geq 0,3$	Medium
$g < 0,3$	Less

The Wilcoxon test is a non-parametric test, it means of two variables in one group are compared (Sugiyono, 2007). The hypothesis formulas are follows:

H0 : There is no difference in students' science literacy/argumentation skills before and after treatment.

H1 : There are differences in students' science literacy/argumentation skills before and after treatment.

The Spearman test was used to test the correlation between science literacy and argumentation. Correlation test to determine whether there is a relationship between two variables (Sugiyono, 2007). The hypotheses are follows:

H0 : Science literacy does not have a significant positive relationship with argumentation skills.

H1 : Science literacy has a positive significant relationship with argumentation skills.

Guidelines for the Spearman correlation strength criteria in Table 2.

Rho	Category
$0,9 \leq \rho < 1$	Very strength
$0,7 \leq \rho < 0,9$	Strength
$0,5 \leq \rho < 0,7$	Modetate
$0,3 \leq \rho < 0,5$	Weak
$0,0 \leq \rho < 0,3$	Very Weak

RESULTS AND DISCUSSION

The criteria for the effectiveness of a product is based on those who use the product can produce the desired goals (Plomp & Nieveen, 2007). Effectiveness is evaluated through pretest and posttest results. The pretest was conducted before students received treatment in the form of

learning using science literacy LKPD, while the posttest was conducted after students received the treatment.

Analysis using N-Gain is used to measure the improvement before and after treatment (Nismalasari, dkk., 2016). Before treatment in this study was the pretest result and after treatment in this study was the posttest result.

Table 3. The Result of N-Gain of Science Literacy

Category	Number of Students
Low	0
Medium	16
High	19

The overall average score was 0.7 in the high category. Of the 35 samples tested, there were 16 students in the medium category and 19 students in the high category. This can occur due to significant differences between the pretest and posttest of science literacy. The results of the science literacy pretest, it was found that there were 32 learners who got a low score category, 3 learners who were in the medium category, and no learners were in the high category. While the results of the science literacy posttest, there are no students who get a low score category, 13 students in the medium score category, and 22 students in the high category. The N-Gain score of science literacy obtained ≥ 0.3 . Therefore, the LKPD that has been developed is proven effective in improving students' science literacy skills. The science literacy's difference between pretest and posttest shows on figure 2.

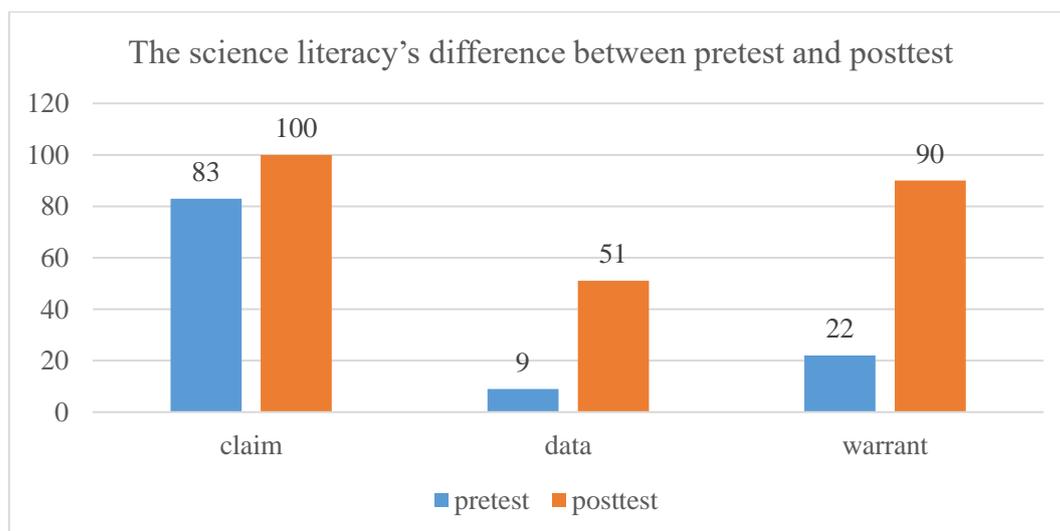


Figure 2. The Science literacy's Differences between Pretest and Posttest

LKPD contains a summary of the material contained in the content knowledge domain. The material summary contains the concept of the material being studied. The material summary is contained in the content knowledge domain. The scientific knowledge domain refers to the concepts, facts and explanations of theories from science that are needed to understand natural phenomena as a basic form of scientific knowledge (OECD, 2015). The concepts that had been obtained were used by students in answering questions on the science literacy posttest.

Table 4. the Result of N-Gain of Argumentation Skill

Category	Number of Students
Low	0
Medium	10
High	25

The results of N-Gain argumentation in the table. It is obtained an overall average of 0.8 in the high category. Out of 35 learners, 10 learners are in the medium category and 25 learners are in the high category. The significant and positive difference between the argumentation pretest and posttest causes this to happen. The results of the argumentation pretest, it was found that learners who got a low score category were 29 learners, 6 learners in the medium category, and none were in the high category. while the results of the argumentation posttest, there were no learners who got a low score category, 11 learners in the medium score category, and 24 learners in the high category. The N-Gain score obtained ≥ 0.3 . Therefore, the LKPD that has been developed is proven effective in improving students' argumentation skills. The argumentation skill's differences between pretest and posttest shows on figure 3.

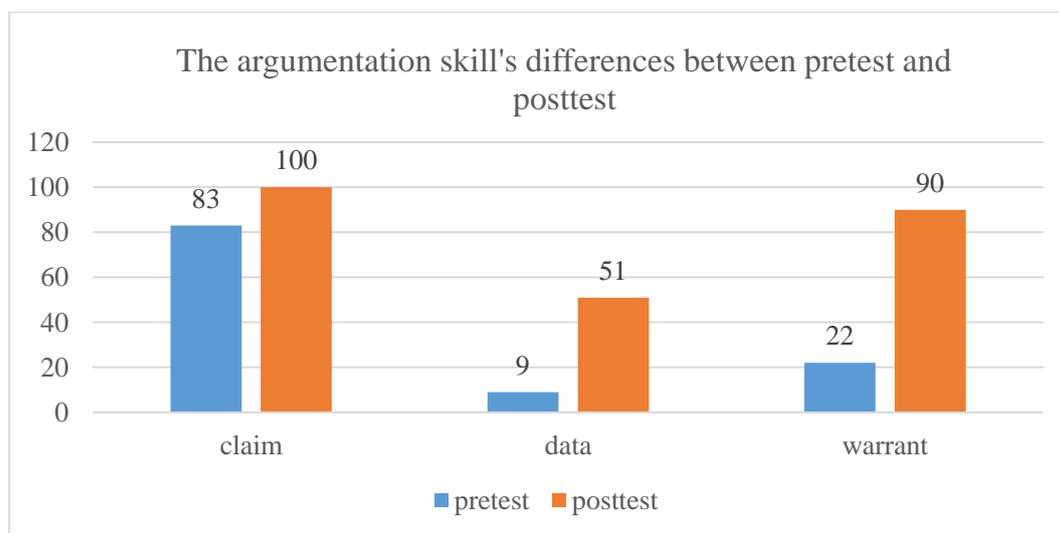


Figure 3. The Argumentation Skill's Differences between Pretest and Posttest

Table 5 shows the percentage of differences in students' argumentation skills before and after treatment and figure 4 shows the graphic.

Table 5. Percentage of Students' Argumentation Skills

Component of Argumentation	Percentage	
	Pretest	Posttest
Claim	83%	100%
Data	9%	51%
Warrant	22%	90%
Backing	71%	82%
Qualifier	0%	95%
Rebuttal	41%	81%

The argumentation component of the claim increased by 17%. The increase to 100% indicates that students understand the concept of the material. Argumentation skills trained to learners in the claim aspect must have support or assistance so that students really understand the concept of science. (Yudistira & Fauziah, 2023). Claim is a statement to be proven (Toulmin, 2003).

The data argumentation component increased by 42%. The posttest data score of only 51% is due to students' lack of reading the data in the problem. In the student worksheet, students write variables and data in the table. When learning is not emphasized that variables are part of the research. Data is defined as facts, evidence, or observations that support the claim. (Toulmin, 2003).

The warrant argumentation component increased by 68%. This increase was caused by students constructing concepts and theories about collision theory and factors that affect the reaction rate derived from LKPD features in the form of material summaries and LKPD activities, namely practicum activities. Some constructivist learning activities include observing events that take place, gathering information, formulating and testing hypotheses, and collaborating with other colleagues (Dale, 2012). The theory that learners gain comes from literacy activities and the results of inquiry activities (Yudistira & Fauziah, 2023). Warrant is in the form of an explanatory such as a principle that as a warrant shows the relationship between data and claims (Erduran & Jimenez-Aleixandre, 2007).

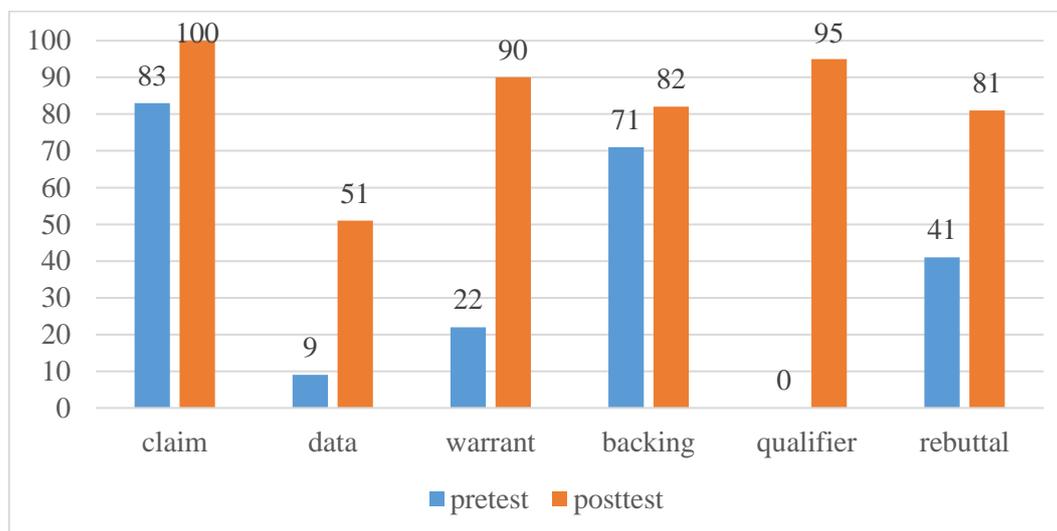


Figure 4. The Componen of Argumentation between Pretest and Posttest

The backing argumentation component increased by 11%. Learners understand the meaning of backing so that they are able to identify backing data from the problem. Backing is support identified as supporting the warrant (Erduran & Jimenez-Aleixandre, 2007).

The qualifier argumentation component increased by 95%. This increase was caused by learners knowing the definition of the qualifier itself. This can be seen from the learner response questionnaire which states that 92% of learners are helped in making qualifications. Qualifiers are qualifications, limits, or explicit conditions that are part of the claim that show the strength of the data to warrant and can be the limit of the claim (Erduran & Jimenez-Aleixandre, 2007).

The rebuttal argumentation component increased by 40%. This increase was caused by 100% of learners knowing the correct claim so that they know the wrong claim along with the reasons why the claim is wrong. This increase is caused by learners constructing concepts and theories about collision theory and factors that affect the reaction rate derived from LKPD features in the form of material summaries and LKPD activities, namely practicum activities. When learners already know that the concept is correct, then they can give reasons for the wrong claim. Some constructivist learning activities include observing events that take place, gathering information, formulating and testing hypotheses, and collaborating with other colleagues (Dale, 2012). Rebuttal is a refutation of a claim (Erduran & Jimenez-Aleixandre, 2007).

The test of differences in science literacy conducted using pretest data (results from before treatment) and posttest (results from after treatment) science literacy. The results of the test of differences in students' science literacy using the Wilcoxon test are in Table 6. Science literacy obtained a sig. (2-tailed) of 0.00. then H_0 is rejected. So there is a difference in science literacy skills between before and after being treated in the form of learning using LKPD. This is in line with the N-Gain value of science literacy obtained stating that there is an increase before

and after treatment with a high category. The difference is also seen from the negative ranks which is 0, meaning there is no decrease in value from pretest to posttest. Positive Ranks showed that there were 35 samples (N = 35) that experienced an increase of 18% (mean rank) with a total positive rank or Sum of Rank of 630 points.

Table 6. Wilcoxon Test of Science Literacy Used SPSS 23

Test Statistics^a

	PostLS - PreLS
Z	-5.166 ^b
Asymp. Sig. (2-tailed)	.000

a. Wilcoxon Signed Ranks Test
b. Based on negative ranks.

Ranks

		N	Mean Rank	Sum of Ranks
PostLS - PreLS	Negative Ranks	0 ^a	.00	.00
	Positive Ranks	35 ^b	18.00	630.00
	Ties	0 ^c		
	Total	35		

a. PostLS < PreLS
b. PostLS > PreLS
c. PostLS = PreLS

The test of differences in argumentation conducted using pretest data (results from before treatment) and posttest (results from after treatment) of science literacy. The results of the test of differences in students' argumentation using the Wilcoxon test are in Table 7.

Table 7. Wilcoxon Test of Argumentation Skill Used SPSS 23

Test Statistics^a

	PostArg - PreArg
Z	-5.168 ^b
Asymp. Sig. (2-tailed)	.000

a. Wilcoxon Signed Ranks Test
b. Based on negative ranks.

Ranks

		N	Mean Rank	Sum of Ranks
PostArg - PreArg	Negative Ranks	0 ^a	.00	.00
	Positive Ranks	35 ^b	18.00	630.00
	Ties	0 ^c		
	Total	35		

a. PostArg < PreArg
b. PostArg > PreArg
c. PostArg = PreArg

Based on the wilcoxon argumentation test table, the sig value is obtained. (2-tailed) of 0.00. then H0 is rejected. So that there is a difference in argumentation skills between before and after being given treatment in the form of learning using LKPD. This is in line with the N-Gain value of argumentation obtained stating that there is an increase before and after treatment with a high category. The difference is also seen from the negative ranks which is 0, meaning that

there is no decrease in value from pretest to posttest. Positive Ranks show that there are 35 samples ($N = 35$) that have increased by 18% (mean rank) with a total positive rank or Sum of Rank of 630 points.

The next test is the correlation test to determine whether there is a relationship between two variables (Sugiyono, 2007). The variables here are science literacy and argumentation. The Spearman correlation test is carried out after the normality prerequisite test is met, if the normality test is not met, then the alternative is to use a non-parametric statistical test, namely using the Spearman correlation test (Sugiyono, 2007). The results of the correlation test using Spearman are in Table 8.

Table 8. Corellation Spearman Test Science Literacy and Argumentation Skill Used SPSS 23

Correlations			PostLS	PostArg
Spearman's rho	PostLS	Correlation Coefficient	1.000	.843**
		Sig. (2-tailed)	.	.000
		N	35	35
	PostArg	Correlation Coefficient	.843**	1.000
		Sig. (2-tailed)	.000	.
		N	35	35

** . Correlation is significant at the 0.01 level (2-tailed).

From the data in the table, it is found that the sig. (2-tailed) of 0.000 which means <0.05 so that H_0 is rejected. This means that there is a correlation between science literacy and argumentation. The strength of the correlation in the table is seen from Spearman's rho which produces a value of 0.843. This value is included in the strong category. This is because the posttest scores of science literacy and argumentation of each learner are almost the same. There are no students who get the low category between the two, 13 students on the science literacy posttest and 11 students on the argumentation posttest in the medium category, and 22 students on the science literacy posttest and 24 students on the argumentation posttest in the high category. So that the average score of students between literacy tests and argumentation is the same. This is comparable to the research of Kulisah, et al. (2023) revealed that there is a strong correlation between science literacy and argumentation skills. There is a significant and positive relationship between argumentation skills and science literacy skills (Delfita, dkk., 2021). Argumentation skills and science literacy are closely related (Delfita, dkk., 2021).

CONCLUSION

The effectiveness of the science literacy-based LKPD was assessed from N-gain, difference test, and correlation test. N-Gain of science literacy and N-gain of argumentation got an average score of 0.7 and 0.8 in the high category. The Wilcoxon test results in the acceptance of H_1 which shows that there is an average difference in science literacy and argumentation before and after treatment, and the Spearman correlation test gets an rho of 0.873 which indicates a strong relationship between literacy and argumentation.

RECOMMENDATIONS

It is expected that science literacy-based learner worksheets to train argumentation skills. And it is hoped that this research can be used as a reference for other researchers to develop science literacy-based learners in other materials.

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