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THE DEVELOPMENT OF STUDENT WORKSHEET INQUIRY ORIENTED TO PRACTICE SCIENCTIFIC LITERACY ON FACTORS THAT AFFECTING REACTION RATES SUBMATTER

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Abstract

This study aims to develop student worksheets to practice scientific literacy based on feasibility in terms of content validity, construct validity, practicality, and effectiveness. The type of this reasearch refers to the method of Research and Development (R&D) adaptation of Sugiyono (2015) which was confined only to preliminary field testing stage. The instrument that is used were review sheets, content and construct validation sheets, learning outcomes test (pretest and posttest), student activities sheets and student responses sheets. This worksheets was tested on 12 students of 11th grade in SMAN 1 Krian. The result showed the worksheets that developed was valid viewed from content validity that obtained a percentage in range between 82.23%-89.99% with highly valid category, and viewed from construct validity 84.45%-93.33% with highly valid category. Practicality viewed from the result of student responses that obtained a percentage in range between 87.50%-94.45% with highly practical category which supported by observational student activities that obtained a percentage in range between 95.56%-99.51% with highly practical category. Effectiveness viewed from increasing student scientific literacy score through increasing n-gain that obtained scores in the range between 0.65-0.82 with range of categories between medium to high which is supported by the results of students completeness that obtained a percentage of 100% with complete category.

Keywords: Worksheets, Scientific Literacy, Inquiry, Factors that Affecting Reaction Rates

INTRODUCTION

The characteristics of life in 21st century are viewed from various issues of globalization, science, technology, and international education development [1]. Referring to the issues, Indonesia should be develop to follow the changes so it can produce a good quality of human resources. Education as one of aspect which play an important role to create or preparing quality human resources, so that Indonesian goverment take an action by revising the curriculum from KTSP 2006 become curriculum 2013 to follow the changes of international education development [2].

In curriculum 2013 for SMA/MA there are compulsory subjects and specialization subjects. One of the compulsory subjects is chemistry. A Good chemistry learning is able to give a meaning to students after learning chemistry matter. A meaningful learning can occur if students is able to connect between new knowledge and the knowledge which they have before [3], through make a meaningful relation between their experience with science learning in class.

The optimum level of meaningful learning in science can be obtained if students have a good scientific literacy skills [4]. This argue same as statement in A Guided to the Implementation of 21st Century Skills for Curriculum 2013 in SMA, learning in 21st century is a learning that integrates in literacy skills. Literacy as important part of educational process, students who held literacy activities in their life will get more learning experience than others [5].

A study based on PISA 2015 state that scientific literacy is the ability to engage with science related issues, and with the ideas of science, as a reflective citizen. A scientifically literate person is willing to engage in reasoned discourse about science and technology, which requires the competencies such as explain phenomena scientifically, evaluate and design scientific enquiry, and interpret data and evidence scientifically [6]. PISA measured student scientific literacy through problem that include analyzing socio-scientific context, understanding of science concept, and

evaluating scientific ideas using rigid scientific design [7].

The study of PISA 2015 which focuse on scientific literacy report that Indonesian was ranked 62 out of 69 participating countries [8]. This result shows that the literacy skills of Indonesian students is low. The reason of OECD evaluating education through PISA to improve the quality of education which focuse on scientific literacy, reading, and mathematics. Improving the quality of eduacation will affect the economic level of a country, which shows that countries with good achievements in PISA evaluation have advance in economic and technology [2]. The emphasis of scientific literacy is not only on knowledge, science concept, and science process but also directed student to make decision and participate in social life, culture, and economic growth [9].

Hendri explained that the most appropriate learning approach to practice scientific literacy skills of student is problem solving, inquiry. and discovery [10]. Holbrook's gave opinion that scientific literacy skills are closely related to meaningful learning. Learning will be meaningful if students are actively involve in their learning by applying types of following learning students centered, such as peer discussion, peer teaching, problem based learning, team based learning, and inquiry based learning [4]. Indonesian curriculum also concern in aplication of discovery / inquiry learning in their learning process [11].

Inquiry is a series of learning which puts the student as center of learning process, both the teacher and student are in equal position as discussion partners [12]. Inquiry as a process to obtain information by doing observations with or without experiments to find answers and solving problem [13]. The teacher's role as facilitator in learning, capable of educating, guiding, directing, training, and evaluating in learning process [14]. Inquiry learning provides a positive effects on science learning results, prosess skills, and attitudes toward science. So that students are expected to have inquiry skills to increase science learning process in class [15]. Inquiry model is closely related to content knowledge in learning process, inquiry provides an opportunity to understand scientific processes with the aim to develop students investigative abilities such as asking open-ended questions, gathering information, planning and conducting experiments, analyzing and presenting results. These things are done as well as to gain deeper and broader knowledge of science content [16].

The matter that is used in this research is factors that affecting reaction rates. This matter is considered suitable with the tree principles of PISA selecting content knowledge. Based on PISA 2015, content of knowledge that is suitable to be developed using scientific literacy skills are (1) has relevance to real life situations of students; (2) represents an important scientific concept or major explanatory theory that has enduring utility; (3) is appropriate to the 15 year olds which is the stages of students development [6]. So, factors that affecting reaction rates matter can be used to practice students literacy skills.

METHOD

The type of this reasearch refers to the method of Research and Development (R&D) adaptation of Sugiyono [17], which was confined only to preliminary field testing stage. This research was tested on 12 students of 11th grade in SMA Negeri 1 Krian which has a variety of academic ability and has been received reaction rates matter.

The stages which taken in this study includes potential and problem, collecting information, design of product, review of draft I, revision of draft I, validation of draft II, and preliminary field testing of product.

First stage to identify potential and problem with aims to know the demands of future learning as background for product development. Second stage to collect data as material to develop design product. Design product of student worksheets that has been completed as draft I, further will be review by chemistry lecturer and chemistry teacher who has given suggestion and comments to improved the worksheets that developed. Then made a revision accordance to the suggestions and comments from reviewers to obtained draft II.

Draft II, then validated by two chemistry lecturers and one chemistry teacher. Then, the data that obtaind were analyzed for each component. Analysis that is used in this research are :

1. Analysis of Review

Review data from chemistry lecturer and chemistry teacher were analyzed descriptively accordance to the suggestions and comments

from reviewers to improved the worksheets that developed.

2. Analysis of Validation

Data of validation was obtained from validators based on content and construct validation sheets. The data that obtained were analyzed descriptive quantitatively. Validation result assessed based on Likert scale as in Table 1.

Table 1. Likert Scale

Value Scale	Category
5	Very Good
4	Good
3	Enough
2	Less
1	Very Less

[18]

The data that obtained then calculated by using this formula :

$$\text{Percentage (\%)} = \frac{\text{Total score}}{\text{Criterion score}} \times 100\%$$

Information:
Criterion score : maximum score x total of aspect x total of respondent

The score that was in percentage, then interpreted as in Table 2.

Table 2. Interpreting Score Criteria of Validation

Percentage (%)	Category
0 – 20	Invalid
21 – 40	Less Valid
41 – 60	Valid Enough
61 – 80	Valid
81 – 100	Highly Valid

[18]

Student worksheets that developed was valid if the percentage result is ≥61% [18].

3. Analysis of Practicality

Analysis of practicality viewed from the result of student responses which supported by observational student activities. The data that obtained were analyzed descriptive quantitatively.

a. Student Responses

Data of student response was obtained from student response questionnaire after using the worksheets that developed. In this research, student response data consist of two statement were positive and negative statement. Student responses assessed based on Guttman scale as in Table 3.

Table 3. Guttman Scale

Statement	Score	
	Positive Statement	Negative Statement
Yes	1	0
No	0	1

[18]

The data that obtained then calculated by using this formula :

$$\text{Percentage (\%)} = \frac{\text{Total score}}{\text{Maximum score}} \times 100\%$$

The score that was in percentage, then interpreted as in Table 4.

Table 4. Interpreting Score Criteria of Practicality

Percentage (%)	Category
0 – 20	Inpractical
21 – 40	Less Practical
41 – 60	Practical Enough
61 – 80	Practical
81 – 100	Highly Practical

[18]

Student worksheets that developed was practical if the percentage result is ≥61% [18].

b. Observational Student Activities

Data of student activities was obtained from observers based on observational student activities sheets. Student activities assess based on Guttman scale as in Table 5.

Table 5. Guttman Scale

Criteria	Score
Yes	1
No	0

[18]

The data that obtained then calculated by using this formula :

$$\text{Percentage (\%)} = \frac{\text{Total of answer "yes"}}{\text{Total respondent}} \times 100\%$$

The score that was in percentage, then interpreted as in Table 4. Student worksheets

that developed was practical if the percentage result is ≥61% [18].

4. Analysis of Effectiveness

Analysis of effectiveness viewed from increasing student science literacy which supported by the results of students completeness. The data that obtained were analyzed descriptive quantitatively.

a. Results of Students Completeness

Data of student completeness was obtained from cognitive test based on pretest and posttest. Individual completeness can be calculated by using this formula :

$$\text{completeness} = \frac{\text{Total score}}{\text{maximum score}} \times 100\%$$

Student was completed individually if they reach minimum score of KKM ≥75.

From individual completeness can be calculated classical completeness by using this formula :

$$\text{Percentage} = \frac{\text{Total of completed student}}{\text{total student}} \times 100\%$$

Student was completed classically if they reach minimum score 85% [19].

b. Increasing Scientific Literacy Score

Data of increasing scientific literacy score was obtained from literacy test based on pretest and posttest. Science literacy score can be calculated by using this formula:

$$\text{Literacy score} = \frac{\text{Total score}}{\text{maximum score}} \times 100\%$$

Score that obtainded, then calculated the increasing by n-gain score :

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

The score that obtained, then interpreted as in Table 6.

Table 6. N-gain Score Criteria

Score	Criteria
G > 0.7	High
0.7 > G ≥ 0.3	Medium
G < 0.3	Low

[20]

Student was increased their scientific literacy score if the n-gain score ≥ 0.3.

RESULT AND DISCUSSION

This study aims to develop student worksheets to practice scientific literacy based on feasibility in terms of validity, practicality, and effectiveness which can describe as follows :

Validity

Validity result is obtained through content validity and construct validity sheets which examined by two chemistry lecturers and one chemistry teacher. validation aims to assess the feasibility of student worksheets that developed is valid or not. Component of validity in this study refers to Plom & Nieven, stated that the validity of a product is viewed through content validity and construct validity [21]. Student worksheets that developed was valid if each aspect has percentage ≥ 61% [18].

Aspects of content validity on worksheets that developed such as: (a) compability of material with curriculum; (b) compability of learning material substantion; (c) compability of worksheets with inquiry model; and (d) compability of worksheets with scientific literacy. Result of content validity can be shown on Table 7.

Table 7. Content Validity Result

Aspect	Percentage (%)	Category
compability of material with curriculum	86.67	Highly Valid
compability of learning material substantion	82.23	Highly Valid
compability of worksheets with inquiry model	89.99	Highly Valid
compability of worksheets with scientific literacy	84.45	Highly Valid

Based on table above is known that each aspect of content validity has percentage ≥ 61%, this result is appropriate with Riduwan

which stated that the worksheets that developed was valid if each aspect has percentage ≥ 61% [18]. Result of content validity that obtained is in range between 82.23%-89.99% with highly valid category. This result shows that this student worksheet is appropriate in feasibility of construct validity [21].

Aspect of construct validity on worksheets that developed such as : (a) language; (b) presentation; and (c) graphics. Result of construct validity can be shown on Table 8.

Table 8. Construct Validity Result

Aspect	Percentage (%)	Criteria
Language	84.45	Highly Valid
Presentation	93.33	Highly Valid
Graphics	86.67	Highly Valid

Based on table above is known that each aspect of construct validity has percentage ≥ 61%, this result is appropriate with Riduwan which stated that the worksheets that developed was valid if each aspect has percentage ≥ 61% [18]. Result of construct validity that obtained is in range between 84.45%-93.33% with highly valid category. This result shows that this student worksheet is appropriate in feasibility of construct validity [21].

Practicality

Practicality result is obtained from student responses questionnaires which supported by observational student activities sheet. Student worksheets that developed was practical if each aspect has percentage ≥ 61% [18].

Student activitivities result is obtained from observational student activities sheet which examined by 4 observer and conducted by 12 students as research subjects. Observational student activities aims to assess the actual activities which conducted by student during preliminary field testing using student worksheets that developed. Result of observational student activities can be shown on Table 9.

Result of observational student activities that obtained is in range between 95.56%-99.51% with highly practical category. This result is appropriate with Riduwan which stated that the worksheets that developed was practical if each aspect has percentage ≥ 61% [18]. This result shows that this student worksheet is appropriate in practicality criteria of product [21].

Table 9. Observational Student Activities Result

Meeting	Percentage (%)	Criteria
1(concentration)	95.56	Highly Practical
2 (catalyst and temperature)	97.05	Highly Practical
3 (surface area)	99.51	Highly Practical

Student responses result is obtained from student response sheet which conducted by 12 students as research subjects. Student response aims to assess the practicality of student woksheets based on student reaction after using student worksheets that developed. Result of student responses can be shown on Table 10.

Table 10. Student Responses Result

Aspect	Percentage (%)	Criteria
Worksheets presentation	91.67	Highly Practical
Worksheets language	91.67	Highly Practical
Worksheets material	87.50	Highly Practical
Scientific literacy in worksheets	94.45	Highly Practical
Inquiry in worksheets	92.86	Highly Practical

Result of student responses that obtained is in range between 87.50%-94.45% with highly practical category. This result is appropriate with Riduwan which stated that the worksheets that developed was practical if each aspect has percentage ≥ 61% [18]. This result shows that this student worksheet is appropriate in practicality criteria of product [21].

Effectiveness

Effectiveness result is obtained from student test through pretest and posttest to assess increasing of student scientific literacy score which supported by the result of student completeness. Pretest is given before student using worksheets that developed while posttest

is given after student using student worksheets that developed.

Student completeness result is obtained from pretest and posttest which conducted by 12 students as research subjects. Student completeness aims to assess students cognitive knowledge based on student learning outcomes on factors that affecting reaction rates matter in student worksheets that developed. Result of student completeness can be shown on Table 11.

Table 11. Student Completeness Result

Name of Student	Pretest Score	Category	Posttest Score	Category
AAB	30	Not complete	80	Complete
ACS	60	Not complete	90	Complete
BK	30	Not complete	80	Complete
CRL	40	Not complete	80	Complete
KAP	30	Not complete	80	Complete
MCP	60	Not complete	100	Complete
MNA	40	Not complete	90	Complete
NK	40	Not complete	90	Complete
RK	70	Not complete	90	Complete
RV	50	Not complete	80	Complete
SR	40	Not complete	80	Complete
WII	40	Not complete	90	Complete

Student was completed individually if they reach minimum score of KKM ≥75. Based on posttest result is obtained that student learning outcomes completeness with percentage 100%, it indicates that student was complete in cognitive knowledge based on student learning outcomes on factors that affecting reaction rates matter.

From individual completeness can be calculated classical completeness, which known that overall student was complete clasically with percentage 100%. This result is appropriate with Trianto, stated that student was completed classically if they reach minimum score 85% [19].

Student scientific literacy score is obtained from pretest and posttest which conducted by 12 students as research subjects. This test aims to assess the effectiveness of student worksheets that developed based on increasing of student scientific literacy score through increasing n-gain score. Result of increasing student scientific literacy score can be shown on Table 12.

Table 12. Increasing Student Scientific Literacy Score

Name of Student	Pretest Score	Posttest Score	n-gain score	Criteria
AAB	34,48	82,76	0,74	High
ACS	62,07	93,10	0,82	High
BK	27,59	79,31	0,71	High
CRL	58,62	89,66	0,75	High
KAP	31,03	75,86	0,65	Medium
MCP	51,72	86,21	0,71	High
MNA	48,28	89,66	0,80	High
NK	37,93	79,31	0,67	Medium
RK	41,38	86,21	0,76	High
RV	51,72	89,66	0,79	High
SR	31,03	86,21	0,80	High
WII	44,83	86,21	0,75	High

Based on table above is known that result of increasing student scientific literacy, there are 10 students obtained increasing n-gain score in high category and there are 2 students obtained increasing n-gain score in medium category.

Increasing n-gain score is obatained medium category is caused by the range of pretest and posttest result that student obtained was not in high increase. This is can caused by the posttest answer that student given in each number of question did not reach maximum point, especially in applicative questions that related to phenomenon of factors that affecting reaction rates. According to cognitive knowledge that has been tested before students were able to know the knowledge about factors that affecting reaction rates, but when a question or problem is included in aplicative problem, students have not able answer optimally. The lack of deep understanding of student about application of material in daily life cause students not able to provide critical assessment of phenomenon that given can be the one of the reason students have not able answer optimally in each question.

The importance of students understanding in phenomenon reading has big

influence ability to connect phenomenon with material that has been learned in class so that the knowledge that obtained becomes meaningful. This is appropriate with Korpan, et-al stated that the concept of scientific literacy included an understanding of how students ability to read science phenomenon so that students were able to find out and assess the information critically [9].

Result of increasing student scientific literacy score through increasing n-gain that obtained scores in the range between 0.65-0.82 with range of categories between medium to high. This result shows that this student worksheet is appropriate in effectivenes criteria of product [21].

CLOSURE

Conclusion

Based on correspondence between formulating problem and the result of research, it can be conclude that the development of student worksheets inquiry oriented to practice science literacy on factors that affecting reaction rates submatter is feasible to be used with the following details:

1. Based on content validity is valid with the percentage that obtained is in range between 82.23%-89.99% with highly valid category.
2. Based on construct validity is valid with the percentage that obtained is in range between 84.45%-93.33% with highly valid category.
3. Based on practicality is practical which viewed from the result of student responses with the percentage that obtained is in range between 87.50%-94.45% with highly practical category that supported by observational students activities with the percentage that obtained is in range between 95.56%-99.51% with highly practical category.
4. Based on effectiveness is effective which viewed from increasing of student scientific literacy through increasing n-gain that obtained scores is in range between 0.65-0.82 with range of categories between medium to high which is supported by the results of students completeness that with percentage that obtained is 100% with complete category.

Suggestion

Based on result and discussion of the research, the suggestion is given for further research are :

1. In a similar study, the next research should be given a feature that contains introduction information and an example in part of formulating problem, making a hypothesis, and determining variables on worksheets that developed.
2. The next research should be given more phenomenon or science reading material in context domain on worksheets that developed.
3. In similar study, the next research should be used the assessment of sciene literacy based on equalization scores in PISA, so that the scores that obtained by the student is based on PISA equalization scores of science literacy.

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