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Feasibility of Structured Assignment Sheet to Train the Ability to Draft a Frame of Mind in Solving Chemical Problems in Reaction Rate Material

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Structured assignment sheet, The ability to draft a frame of mind, Reaction rate material

Abstract

The study aimed to produce a feasible structured assignment sheet as a learning device. The structured assignment sheet was feasible to be used to train the ability to draft a frame of mind in solving chemical problems in reaction rate material. This developed learning device is named SAS-ADFM. The feasibility of SAS-ADFM included criteria of validity, practicality, and effectiveness. SAS-ADFM was developed using the Research and Development (R&D) method. SAS-ADFM was tested on 15 students of class XI who had obtained reaction rate material at SMAN 3 Surabaya. The instruments were the sheets of validation, student response questionnaire, and frame of mind drafting ability test. The validity of SAS-ADFM based on the assessment of three validators met the criteria of validity with a value of Mo $\geq$ 4 and R $\geq$ 75%. Meanwhile, the practicality of SAS-ADFM based on the analysis of the assessment of the student response questionnaire produced a very practical category with a percentage of 99%. Finally, the effectiveness of SAS-ADFM based on the analysis of the assessment of the ability to draft a frame of mind produced an N-gain score of 0.5 with a medium category. Hence, the developed SAS-ADFM was feasible to be used as a learning device.

INTRODUCTION

Education determines the progress of a nation. The quality of education contributes to improving the quality of human resources (Helena, 2017). Schools as educational institutions must have 21st-century skills to face the challenges of the technological and information advancement. 21st-century skills are known as 4C competencies, namely critical thinking skills and problem-solving, creative thinking, communicating, and collaborating (Septikasari & Frasandy, 2018). Thus, education is important in the 21st century to produce human resources who have strong communication and collaboration skills, the ability to solve problems, creative and innovative thinking skills, and experts in using technology (Andrian & Rusman, 2019).

Students are driven by 21st-century education to have broad knowledge and understanding to become life-long learners (Afandi *et al.*, 2016). Knowledge is obtained through scientific approaches (Ary *et al*., 2018). According to Setiawan (2017), scientific approach is an approach designed in the learning process so that students can develop a concept, observe a scientific concept, ask, reason, try, and create a network of subjects.

Chemistry is a branch of natural science that studies matter and its changes (Chang, 2003). Based on the 2013 Revised Curriculum, chemistry is included in the interest lessons of Mathematics and Natural Sciences. Chemistry has many learning materials, such as reaction rate. The basic competence in the reaction rate material of class XI in SMA is found in the topics of 3.6, 4.6, 3.7, and 4.7 regarding factors that affect reaction rate, reaction order, and rate constant (Permendikbud, 2018).

Chemistry is developed by scientists using the scientific method. Ideally, the learning of chemistry should be studied as chemistry was developed. The learning of chemistry must be conducted using the scientific method. The learning of chemistry should make students to act as "little scientists". According to Permendikbud (2016), students are expected to be able to carry out the process of scientific discovery as a scientific approach after the chemistry learning. The scientific approach is carried out in the learning process using the scientific method.

Drafting a frame of mind is one of the essential stages in the scientific method. The stages of the scientific method are presented in a flowchart in Figure 1 (Suriasumantri, 2009).

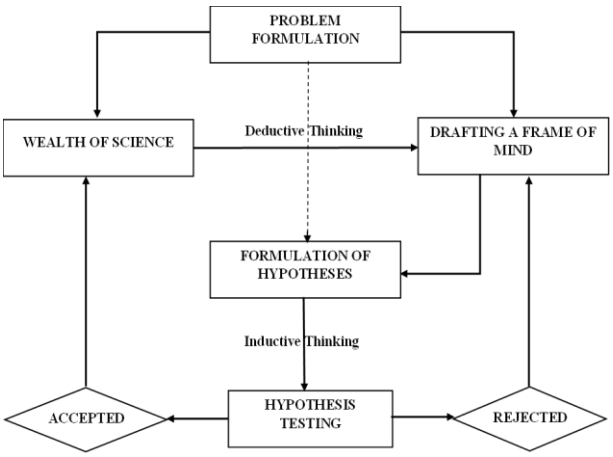

Figure 1. Flowchart of Scientific Method

Drafting a frame of mind becomes the basis reason in proposing hypotheses. Drafting an essential frame of mind is done in learning, especially in solving a problem. So, students do not determine hypotheses directly after formulating the problem. Hypotheses can be determined after drafting a frame of mind. The frame of mind is developed from deductive thinking. The frame of mind is logical with consistent argumentation of previously arranged knowledge (Rinaldi & Mujianto, 2017).

The frame of mind is drafted to provide a foundation for problem solving and hypotheses formulation. In the practices of chemical learning with the scientific method, students must be trained to draft a frame of mind if they are going to solve problems. The practice of drafting this frame of mind is often forgotten. The researcher has analyzed the learning process plan and the student worksheet. The result of the analysis shows that only 10% of the learning process plan and the student worksheet ask students to draft a frame of mind after formulating the problem. On average, after the student formulates the problem in the student worksheet, the student is asked to draft the hypothesis directly without drafting a frame of mind. According to Suriasumantri (2009), the hypothesis should not be directly drafted after formulating the problem, but first, draft a frame of mind. One of the processes of drafting a frame of mind is through literature reading. If students draft hypotheses directly without the activity of literature reading, then this can lead to assumptions that do not follow the characteristics of science. Therefore, there needs to be quality learning tools to train the ability to draft a frame of mind that can affect learning outcomes and guide students to learn independently.

Based on the Regulation of the Ministry of Education and Culture (Permendikbud) of the Republic of Indonesia Number 36 of 2018 on Changes to the Regulation of the Ministry of Education and Culture Number 59 of 2014 on 2013 Curriculum of SMA/MA, the load of learning structured assignments and independent activities has a maximum of 60% of the time of face-to-face activities of the subjects concerned. The learning load of chemistry subjects in grade XI of SMA/MA is four hours per week, with 45 minutes for one hour of lessons.

Interviews with teachers of chemistry subject show that teachers have given structured tasks to students. However, they do not develop a structured assignment sheets. Thus, a learning device needs to be developed in the form a structured assignment sheet.

An advantage of a structured assignment sheet is that it can improve the understanding of concepts in a structured manner and learning outcome process of students. Based on Kundi (2013), the learning outcomes of students of Science class XI at Senior High School 1 Polombangkeng Utara on school year 2013/2014 were higher using structured student activity sheets than without using structured student activity sheets. Otania *et al.* (2019) show that the use of structured question exercises has an effect on improving the understanding of students' concepts.

Based on the above problems, we have developed a structured assignment sheet to train the ability to draft a frame of mind in solving chemistry problems in reaction rate material, which is called SAS-ADFM. The study aims to produce a feasible structured assignment sheet as a learning device. The structured assignment sheet can be used to train the ability to draft a frame of mind for solving chemistry problems in reaction rate material. The SAS-ADFM feasibility criteria assessed include validity, effectiveness, and practicality (Nieveen, 2010). SAS-ADFM is expected to be an assignment sheet reference as one of the student's obligations to train the ability to draft a frame of mind. In addition, SAS-ADFM is expected to facilitate students in understanding the concept of reaction rate.

RESEARCH METHOD

The study was conducted in February 2022 at SMAN 3 Surabaya. The subjects in the study were 15 students of class XI who had obtained reaction rate material.

The type of research was development research in the field of education by applying Research and Development (R&D) method. Developmental research in the field of education was used to develop and validate educational

products (Borg & Gall, 1989). According to Sugiyono (2016), R&D method is used to produce and test the effectiveness of a product.

The research procedure was based on the R&D stage. This research was carried out until the seventh stage, i.e.: product revision after the product trial because it was adapted to the development needs until the final product of the SAS-ADFM. This research procedure scheme was presented in Figure 2.

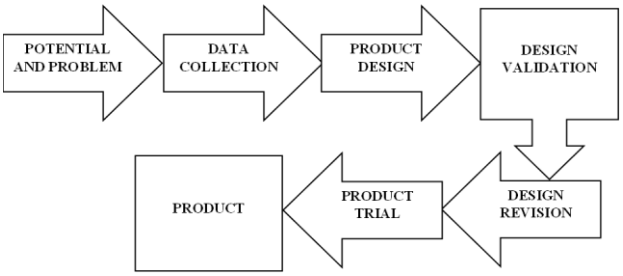

Figure 2. Research Procedure

The type of the research data was quantitative data. The research data were obtained from the validation, practicality, and effectiveness instruments. The instruments consisted of validation sheets, student response questionnaire, and frame of mind drafting ability test.

The SAS-ADFM validation was carried out by three lecturers of the Department of Chemistry, Faculty of Mathematics and Natural Sciences, UNESA. The effectiveness of the SAS-ADFM was obtained from the results of the ability test for the drafting of the frame of mind (pretest-posttest). The practicality of the SAS-ADFM was obtained through the student response questionnaire. The validity of the SAS-ADFM was based on the results of validation analysis using quantitative descriptive methods with the Likert scale given in Table 1.

Table 1. Likert Scale (Riduwan, 2016)

Category	N-gain Score
High	(g) ≥ 0.7
Medium	0.7 > (g) ≥ 0.3
Low	(g) < 0.3

Validity of the data was analyzed descriptive quantitatively using frequently appeared scores (Mo). The validation scores obtained through three validators need to be conducted through agreement calculations. The agreement score was obtained by the percentage of agreement (R) equation as follows:

$$\mathrm{R} = \left[1 - \frac{A - B}{A + B}\right] \times 100\%,$$

where A is the highest validator score and B is the lowest validator score. Each R was calculated in the percentage, i.e.: $(R)_{1,2}$; $(R)_{1,3}$; and $(R)_{2,3}$. Reliable decision was declared if R ≥ 75% (Borich, 1994). If each question had a minimum Mo of 4 and disagreement was found between validators, then the SAS-ADFM was declared to meet the criteria for content feasibility, construct feasibility, presentation component, and language component.

The effectiveness of the SAS-ADFM was tested using the one-group pretest-posttest design (see Table 2). Initially, students were given a pretest to find out their initial ability before the treatment using SAS-ADFM. After that, in order to observe the influence of SAS-ADFM students were given a posttest. In the one group pretest-posttest design (Table 2), O_1 is the value before being treated with SAS-ADFM. X is the treatment to students through the use of SAS-ADFM. O_2 is the value after the treatment.

Table 2. One Group Pretest-Posttest Design

Pretest	Treatment	Posttest
O_1	X	O_2

The effectiveness of SAS-ADFM was determined from the results of the analysis of student tests. The data from the tests were analyzed using quantitative descriptive methods with N-gain scores, calculated through the following formula:

$$(g) = \frac{[\%(\mathrm{Sf}) - \%(\mathrm{Si})]}{[100\% - \%(\mathrm{Si})]},$$

where (g) is an increase in the learning outcomes, (Sf) is the posttest average, and (Si) is the pretest average. The calculated value of (g) was interpreted using the criteria in Table 3. Based on Table 3, if the increase in N-gain scores ≥ 0.7 with a high category, then the SAS-ADFM was declared effective.

Table 3. Interpretation of N-Gain Score (Hake, 1998)

Rating Category	Scale
Very valid	5
Valid	4
Quite valid	3
Less valid	2
Invalid	1

The practicality of SAS-ADFM was determined from the results of the analysis of students' responses. Data from the student

response questionnaires were analyzed using quantitative descriptive methods with the Guttman scale given in Table 4.

Table 4. Guttman Scale

Answer Criteria	Scale
Yes	1
No	0

The Guttman scale aimed to get the answer to the statement of "yes" or "no" expressly and clearly, with the highest score of 1 and the lowest score of 0 (Riduwan, 2016). Next, calculations were performed to get the percentage of each criterion by using the following formula:

$$\text{Percentage (\%)} = \frac{\sum \text{score obtained}}{\sum \text{criteria score}} \times 100\%. \quad (3)$$

Then, the percentages were interpreted using the criteria presented in Table 5. Based on Table 5, if the percentage of research results was ≥ 81% with a very practical category, then the SAS-ADFM was declared easy to use in chemical learning.

Table 5. Interpretation of Response Score (Riduwan, 2016)

Category	Percentage (%)
Very impractical	0-20
Impractical	21-40
Quite practical	41-60
Practical	61-80
Very Practical	81-100

RESULTS AND DISCUSSION

A structured assignment sheet is a learning device to guide students' learning activities outside face-to-face meeting hours to achieve certain learning goals. The purpose of using this device is to support the implementation of intra-curricular programs and to practice the ability to draft a frame of mind in problem solving. Students are trained to draft a frame of mind through the use of logical arguments based on common facts in the learning process of the reaction rate material, especially in the sub-material of collision theory.

The indicators of drafting a frame of mind proposed by Pebriana *et al*. (2019) and Rinaldi & Mujianto (2017) were synthesized and adjusted to draft a frame of mind trained for students, i.e.: 1) determine research variables, 2) read books and research results, 3) theoretical descriptions and research results, 4) critical analysis of the theory and research results, 5) synthesis of conclusions, and 6) frame of mind.

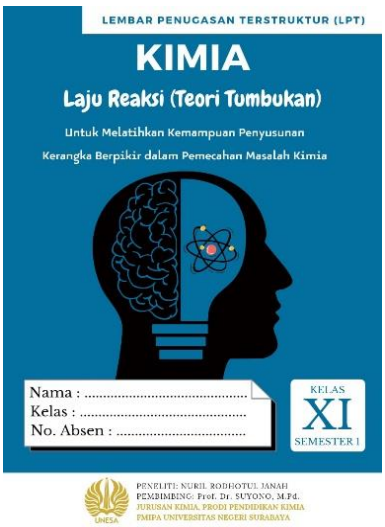

Figure 3. SAS-ADFM Cover

The SAS-ADFM needs to be tested for feasibility to be used in the learning process. The feasibility of SAS-ADFM assessed on three criteria, namely validity, effectiveness, and practicality (Nieveen, 2010). Before the feasibility test, the SAS-ADFM was reviewed by lecturers, majoring in chemistry FMIPA UNESA. The review results were in the form of suggestions or responses for the improvement of SAS-ADFM. The cover of SAS-ADFM was designed following the purpose of developing SAS-ADFM, namely to train the ability to draft a frame of mind in solving problems in reaction rate material that is presented in Figure 3.

The validity component items on the validation sheet include the feasibility of content, construct, presentation, and language adapted to the BSNP assessment instrument. The SAS-ADFM validity test is conducted by three validators, namely lecturers of the Department of Chemistry FMIPA UNESA. The scores that the validators assign to the content component are indicated in Table 6. Based on Table 6, all numbers in the content component obtain a mode of 5 with a very valid category. Thus, the SAS-ADFM has met the content component's validity criteria, which means that the content of the SAS-ADFM is feasible, including the accuracy of the reaction rate material, the update, and the dimensions of the ability to draft a frame of mind.

The validity score of the content component obtained from the three validators is based on R. The result of calculating $(R)_{1,2}$; $(R)_{1,3}$; and $(R)_{2,3}$ is presented in Table 7. Based on Table 7, the R of all validators is in the range of 89% - 100% and the scores between validators do not have a significant difference. Thus, the SAS-ADFM is

declared to have met the content component's validity criteria.

Table 6. Validation Result of Content Component

Number	Aspect	Score			Mo	Category
		V_1	V_2	V_3		
1	Accuracy of the Material a. Phenomena presented according to concepts and facts in practicing the ability to draft a frame of mind	4	5	5	5	Very valid
	b. Concepts/laws/theories about matter do not give rise to much interpretation	4	5	5	5	Very valid
	c. The truth of facts, concepts, and images	4	5	5	5	Very valid
2	Update Examples and questions of exercises are up-to-date	4	5	5	5	Very valid
3	Skill Dimensions The activities presented can train the ability to draft a frame of mind	4	5	5	5	Very valid
4	Coherence and Regularity of the Thought Flow a. Material explanations are regular and have relationships	4	5	5	5	Very valid
	b. Presentation of material in theme unity	4	5	5	5	Very valid

Table 7. Result of R of Content Component Validity Score

Aspect Number	Score			Percentage of Agreement (R) (%)		
	V_1	V_2	V_3	$R_{1,2}$	$R_{1,3}$	$R_{2,3}$
1a	4	5	5	89	89	100
1b	4	5	5	89	89	100
1c	4	5	5	89	89	100
2	4	5	5	89	89	100
3	4	5	5	89	89	100
4a	4	5	5	89	89	100
4b	4	5	5	89	89	100

Table 8. Validation Result of Construct Component

Number	Aspect	Score			Mo	Category
		V_1	V_2	V_3		
1	Construct Criteria a. There are phenomena according to the concept	5	5	5	5	Very valid
	b. There are directions accompanied by a brief explanation of skill indicators	4	5	5	5	Very valid
	c. Have good consistency as a learning device	4	5	5	5	Very valid
2	Conformity with Skill Indicators in Each Chapter a. Directing students to determine variables	3	5	5	5	Very valid
	b. Directing students to read books and research results	5	5	5	5	Very valid
	c. Directing students to describe the theory and results of the research	3	5	5	5	Very valid
	d. Directing students to analyze theories and research results	4	5	5	5	Very valid
	e. Directing students to synthesize conclusions	3	5	5	5	Very valid
	f. Directing students to draft a frame of mind	4	5	5	5	Very valid

The validity score of the entire validators reviewed from the construct component is given in Table 8. Based on Table 8, all numbers in the construct component obtain a mode of 5 with a very

valid category. Thus, the SAS-ADFM has met the construct component's validity criteria. This means that the substance in the SAS-ADFM satisfies the indicators of the ability to draft a frame of mind so that it has good consistency as a learning device.

The validity score of the construct component obtained from the three validators is calculated using R. The result of R is presented in Table 9. Based on Table 9, R of all validators is in the range of 75% - 100% indicating that the scores between validators do not have a significant difference. Thus, the SAS-ADFM can be declared to have met the construct component's validity criteria.

Table 9. Result of R of Construct Component Validity Score

Aspect Number	Score			Percentage of Agreement (R) (%)		
	V_1	V_2	V_3	$R_{1,2}$	$R_{1,3}$	$R_{2,3}$
1a	5	5	5	100	100	100
1b	4	5	5	89	89	100
1c	4	5	5	89	89	100
2a	3	5	5	75	75	100
2b	5	5	5	100	100	100
2c	3	5	5	75	75	100
2d	4	5	5	89	89	100
2e	3	5	5	75	75	100
2f	4	5	5	89	89	100

Table 10. Validation Result of Presentation Component

Number	Aspect	Score			Mo	Category
		V_1	V_2	V_3		
1	Supporting Material Presentation a. Illustrations in accordance with the material to be understood by students	5	5	5	5	Very valid
	b. Giving examples of questions to make it easier for students	5	5	5	5	Very valid
	c. Tables and figures according to the captions	4	5	5	5	Very valid
2	Completeness of Presentation a. Introduction presented simply and straightforwardly	4	5	5	5	Very valid
	b. There is a table of contents (chapter titles, sub-chapters, table lists, and picture lists)	5	5	5	5	Very valid
	c. There is a bibliography used as a reference	4	5	5	5	Very valid

Table 11. Result of R Presentation Component Validity Score

Aspect Number	Score			Percentage of Agreement (R) (%)		
	V_1	V_2	V_3	$R_{1,2}$	$R_{1,3}$	$R_{2,3}$
1a	5	5	5	100	100	100
1b	5	5	5	100	100	100
1c	4	5	5	89	89	100
2a	4	5	5	89	89	100
2b	5	5	5	100	100	100
2c	4	5	5	89	89	100

The validity score of all validators reviewed from the presentation component is indicated in Table 10. Based on Table 10, all numbers in the presentation component obtained a mode of 5 with a very valid category. Thus, the SAS-ADFM has met the presentation component's validity criteria that the presentation of the SAS-ADFM has been presented systematically and has been supplemented with an introduction, table of contents, and bibliography.

The validity score of the presentation component obtained from three validators is calculated using R. The result of R calculation is presented in Table 11. Based on Table 11, the percentage of agreement of all validators is in the range of 89% - 100% and that the scores between

validators do not have a significant difference. Thus, the SAS-ADFM can be declared to have met the presentation component's validity criteria.

The validity score of all validators reviewed from the language component is presented in Table 12. Based on Table 12, the number 1 problem obtained a mode of 4 with a valid category, while the number 2 problem obtained a mode of 5 with a very valid category. Thus, the SAS-ADFM has met the language component validity criteria that the use of language in the SAS-ADFM has satisfies the development of students and motivates students to always think logically in drafting a frame of mind of the reaction rate material.

Table 12. Validation Result of Language Component

Number	Aspect	Score			Mo	Category
		V_1	V_2	V_3		
1	The use of language is in accordance with the development of students.	4	4	4	4	Valid
2	The presentation of materials motivates students to think logically in drafting a frame of mind.	4	5	5	5	Very valid

Table 13. Result of R of Language Component Validity Score

Aspect Number	Score			Percentage of Agreement (R) (%)		
	V_1	V_2	V_3	$R_{1,2}$	$R_{1,3}$	$R_{2,3}$
1	4	4	4	100	100	100
2	4	5	5	89	89	100

The validity score of the language component obtained from the three validators is calculated using R. The result of calculating each R is presented in Table 13. Based on Table 13, R of all validators is in the range of 89% - 100% and the scores between validators do not have a significant difference. Thus, the SAS-ADFM can be declared to have met the language component validity criteria.

Table 14. Result of Student Response Questionnaire

Question Number	Percentage (%)	Category
1	100	Very practical
2	93	
3	100	
4	100	
5	100	
6	100	
7	100	
8	100	
9	100	
10	100	
11	93	

The practicality of the SAS-ADFM is obtained from the student response questionnaire sheet. The response questionnaire sheet was given to students after the implementation of SAS-ADFM. The data of student response questionnaires are presented in Table 14. Table 14 shows that questions 2 and 11 obtain a percentage of 93%, while questions 1, 3, 4, 5, 6, 7, 8, 9, and 10 obtain a percentage of 100%. The percentages of 93% and 100% were in the very practical categories. This means that there is no significant difference. Furthermore, the average data of student response questionnaire is calculated and produces a value of 99% with a very practical category. Thus, the SAS-ADFM is declared easy to be used to train students the ability to draft a frame of mind on reaction rate material.

The effectiveness of the SAS-ADFM is determined from the analysis results of the students' tests. The data of students' test results are analyzed using quantitative descriptive method calculated using N-gain scores. The goal is to determine the ability to draft a frame of mind and students' understanding of concepts before and

after the implementation of the SAS-ADFM. The test results of students are presented in Table 15.

Table 15. Test Result of the Ability to Draft the Frame of Mind

Student	Pretest	Posttest	N-Gain	Category
1	61,0	94,0	0,8	High
2	49,0	75,0	0,5	Medium
3	59,0	83,0	0,6	Medium
4	67,0	98,0	0,9	High
5	54,0	76,0	0,5	Medium
6	33,0	93,0	0,9	High
7	68,0	96,0	0,9	High
8	36,0	70,0	0,5	Medium
9	49,0	67,0	0,4	Medium
10	46,0	63,0	0,3	Medium
11	46,0	61,0	0,3	Medium
12	21,0	47,0	0,3	Medium
13	57,0	65,0	0,2	Low
14	34,0	46,0	0,2	Low
15	62,0	65,0	0,1	Low

Based on Table 15, four students obtain N-gain scores with high categories. Eight students obtain N-gain scores with medium categories. Moreover, three students obtain N-gain scores with low categories. The percentage of N-gain score categories of 15 students is presented in Figure 4. The average data of students' test result that has been analyzed using N-gain scores is presented in Table 16.

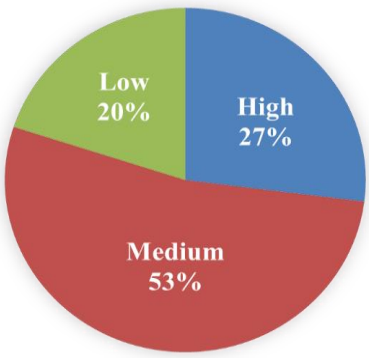

Figure 4. The Percentage of N-gain Score Categories

Table 16 Average Test Result of the Ability to Draft the Frame of Mind

$\bar{x}$ *Pretest*	$\bar{x}$ *Posttest*	N-Gain	Category
49.5	73.3	0,5	Medium

The ability to draft a frame of mind is trained based on six indicators. The first indicator is determining research variables. All students can determine variables correctly based on the given phenomenon. The phenomena are related to factors that affect the reaction rate, such as concentration, temperature, surface area, and catalysts.

The second indicator is reading books and research results. Students read relevant books and research results and write down the reading source. Two students do not list relevant reading sources at this stage, while information from relevant reading sources is essential for producing a frame of mind.

The third indicator is describing the theory and research results. Students are asked to define each variable, describe in detail the scope of each variable, and the relationship between one variable and another. Eight students answered incorrectly. Most students simply state the position of one variable with another without describing each variable.

The fourth indicator is a critical analysis of the theory and research results. Most students are incorrect in analyzing the theory and research results, especially in the activation energy and catalyst section. Students directly assume that the reaction rate of a substance can be faster due to its activation energy being lowered. Students should analyze the initial understanding that - sooner or later - a reaction is due to factors affecting it. This is related to the presence or absence of catalysts. Then, students can continue with analyzing the energy aspect of its activation.

The fifth indicator is the synthesis of the conclusion. Students conclude by connecting the

variables studied based on the information. Three students are incorrect in concluding. Students tend to conclude the collision theory by the reaction rate factor without being associated with the reaction rate itself.

The sixth indicator is the frame of mind. Most students can create the right frame of mind. Only two students are incorrect for making a frame of mind.

Based on the test result in Table 16, the N-gain score is 0.5 with medium criteria. The reason is because students are not optimal at using the SAS-ADFM. Most students do not understand the stage of the description of the theory and research results and the analysis stage of theories and research results. This is seen through students' incorrect answers to the questions. In short, there is an increase in the ability to draft a frame of mind on the reaction rate material. Thus, the SAS-ADFM is quite effective or feasible to be used to train students' ability to draft a frame of mind on reaction rate material.

CONCLUSION

Based on the above data and discussion, it can be concluded that the SAS-ADFM is feasible to be used as a learning instrument. The validity of the SAS-ADFM meets the criteria of validity based on the assessment analysis of three validators. The practicality of the SAS-ADFM meets the very practical category obtained based on the analysis of the assessment of students responses. The effectiveness of the SAS-ADFM meets the medium category based on the analysis of the assessment of the ability to draft a frame of mind.

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