

Feasibility of Structured Assignment Sheet in Sub Material Factors Affecting Reaction Rate Based on Three Scientific Question (Ontology, Epistemology, and Axiology)

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Abstract- The research objectives was to produce a *Structured Assignment Sheet based on Three Scientific Questions (SAS-3SQ)* in sub material factors affecting reaction rate, which was feasible to use. The feasibility were validity, practicality, effectiveness. The method used in this research was *R&D*. To determine whether SAS-3SQ was feasible to use on validity, practicality, and effectiveness criteria, a limited trial was conducted. SAS-3SQ tested in 15 students of 11th grade respondents at SMAN 2 Lamongan. The validation data obtained from 3 validators were analyzed by using *expert judgment*. SAS-3SQ filled the construct validity (consistency) and content validity (relevance). The result of content validity and construct validity valued with the frequently occurring score was $M_o \geq 4$ in every component, and the percentage of agreement among the validators in range 86%–100% which means reliable with $R \geq 75\%$. The practicality of SAS-3SQ was obtained from student questionnaire responses. The result obtained from students' questionnaire response is 100% with very practical category. The effectiveness of SAS-3SQ data obtained from student assessment in *pretest-posttest*. The result obtained from the *pretest-posttest* was analyzed using *normal gain* score. The result obtained *normal gain* score is 0,8 which was in the high category. According to the validity, practicality, and effectiveness SAS-3SQ is feasible to use. The feasibility means that SAS-3SQ can be used as learning media in chemistry learning factors affecting.

Index Terms- structured assignment sheet, scientific question, factors affecting reaction rate

I. INTRODUCTION

Chemistry learning is now a demand along with the times. At present, the focus of chemistry education is not only to increase students' competence in the cognitive aspects of chemistry knowledge. However, it also prepares students who can become agents of change, have character, and be cultured, especially in facing the challenges of the XXI century [16]. In dealing with these demands, innovation is needed to build students' understanding independently so that they can have a scientific attitude as an initial provision for students to face the demands of the XXI century.

Chemistry is a science that includes ways of thinking, reasoning, formulating problems, conducting experiments, observations, analyzing data, and concluding scientific products [9]. Ontology chemistry is a branch of natural science that studies the substance, composition, structure, properties, changes in matter, and the energy that accompanies it [10]. Epistemologically and axiologically, chemistry is a branch of natural science that is developed empirically, rationally, and pragmatically with the aim of benefiting creatures on earth [19]. One of the concepts in chemistry learning that requires thinking to understand the application of the concept in everyday life is the material for reaction rates.

Scientific questions (ontology, epistemology, and axiology) question knowledge comprehensively that seeks to examine problems that arise in all events and experiences. This can be interpreted that scientific questions are needed in answering questions that arise in various life situations, including problems in the field of education [3]. Basically, chemistry is very closely related to ontology, epistemology, axiology questions, mainly on the material of reaction rates.

The material for reaction rates discusses the factors affecting reaction rate, which requires principles and concepts. Factors affecting reaction rate consists of concentration, temperature, surface area, and catalyst [6]. In order to learn about speed up a chemical

reaction or slow down a chemical reaction. Factors affecting reaction rate is a material that has characteristics which often found in the form of phenomena in everyday life [1].

It can be conducted as factors affecting reaction rate learn about the principle the rate of reaction which filled with what question (ontology), how question (epistemology), and the question of it essential (axiology) in comprehensive way. The material for reaction rates requires thinking to understand the application of these concepts and principles in everyday life. This makes three scientific questions (ontology, epistemology, and axiology) used as guidelines in comprehensively studying the factors affecting reaction rate.

Ontology questions are questions that ask the nature of the existence of everything that exists [22]. Ontology is defined as a study of the nature of reality from the object studied in producing knowledge [21]. Chemistry is the result of scientific products, consisting of facts, concepts, principles, laws, theories [19]. When asking the concept there are elements of the concept, namely; names, definitions, characteristics, examples, and non examples [2]. In practice, when asking the principle of factors that affect the rate of a reaction, able to adopt opinion about concept elements [2]. Ontology explains and answers questions based on what questions [7].

Epistemology deals with how knowledge is acquired. Explaining that thinking is a mental activity that can produce knowledge [23]. The scientific method is needed in the form of disclosing the workings of the mind so that it makes it easier for the mind to move the thinking activity.

Axiology discusses questions related to the meaning and benefits of knowledge [23]. The benefits of chemistry are obtained when the knowledge is studied and applied to solve a problem. The purpose of the existence of chemistry subjects is so that students realize the greatness of God Almighty, cultivate a scientific attitude, gain experience related to the scientific method, and know the application of chemistry to solve problems in life [12].

Each type of science certainly has specific characteristics to answer what (ontology), how (epistemology), and for what (axiology) a science is structured. The three aspects of philosophical thinking among ontology, epistemology, and axiology are interconnected each other. If talking about the epistemology of science, it must be related to the ontology and axiology of science as well. That's the ontology of science is related to the epistemology of science, and the epistemology of science is related to the axiology of science and so on. This is because in discussing the scientific dimension, it is based on a systematic thinking model so it must always be linked. Therefore, it is impossible for the three of them to be separated from ontology, epistemology, and axiology [18].

Currently, three scientific questions are considered neglected in implementing learning in schools. This case is strengthened by the interview result with chemistry teachers, they never make or use structured assignment sheet based on scientific question. Scientific questions (ontology, epistemology, axiology) play an important role in studying a science, especially chemistry, to be implemented in solving a problem and realizing the greatness of God. Currently, structured assignments are a very important part of the learning process to improve students' abilities independently. Based on the Regulation of the Minister of Education and Culture (Permendikbud) of the Republic of Indonesia Number 36 year 2018 states that the learning load for structured assignments and independent activities is a maximum of 60% of the face-to-face activities of the subject in question. Optimization of structured assignments can be developed with the existence of structured assignment sheets. Structured assignment sheets can be interpreted as a collection of worksheets that are arranged to guide students to achieve a goal with a little help from the teacher so that the initial goal can be achieved [11].

Based on the overview, the researcher developed a structured assignment sheet in sub-material factors affecting reaction rate based on three scientific questions (ontology, epistemology, and axiology), acronymized by the name SAS-3SQ. The SAS-3SQ developed is expected to be able to train chemistry learning comprehensively, apply the knowledge that has been obtained by students to answer problems around them, make students independent in exploring knowledge. In addition, SAS-3SQ can also be a reference in developing chemistry learning tools to optimize time allocation for independent activities and structured assignments for students.

II. METHODS

The type of research carried out is development in the education major. The method that was used was *Research and Development (R&D)*. In education major R&D is used for developing, validating, and testing the effectiveness of a product [21]. This research is conducted at SMAN 2 Lamongan. The object that is used in limited testing are 15 students of grade 11th.

The procedure of this research is guided by the steps conducted in R&D but only be confined in seven steps as: (1) analysis problems and potential; (2) collecting the data; (3) designing the product; (4) design validation; (5) design revision; (6) product trial; (7) product. The SAS-3SQ has been designed and reviewed, then tested for validity by the *expert judgment* in the chemistry education major. SAS-3SQ which has been declared valid by the expert, tested to the students to evaluate the effectiveness and the practical.

Validity consists of construct validity (consistency) and content validity (relevance). The validity is taken from filling out the validation sheet by 3 lecturers of chemistry. The practical data is taken from the questionnaire student response as the research object. The effectiveness data is taken from test sheet that consists of pretest-posttest containing three scientific questions. Data of validation result analysis by using a descriptive quantitative method by using Likert scale in Table 1 [17].

Table 1 Likert Scale

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

The validity of SAS-3SQ that consists of construct validity (consistency) and content validity (relevance) were analyzed descriptive quantitative using the frequently occurring score (Mo) obtained from expert judgment. Validation scores are obtained from three validators, so it is necessary to calculate the agreement of the three scores obtained. This agreement can be obtained with the percentage of agreement (R) as follows:

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

A is the score from validator A, B is the score from validator B. A is the bigger score than B, so B score is the lowest. Validation score was got from three validators, so each R is being calculated the percentage of agreement. The percentage agreement consist of (R)_{1,2}; (R)_{1,3}; (R)_{2,3}. Both validity of construct (consistency) and validity of content (relevance) determined as reliable if R ≥ 75% [4]. SAS-3SQ is determined as qualified in construct validity and content validity if has minimal Mo equal to 4 and not found the disagreement among the validators.

The practicality of SAS-3SQ is obtained from the response questionnaire that the students filled. The percentage of response questionnaire data is analyzed by using the Guttman scale. The calculation by using the Guttman scale was conducted to get the answer with 2 statements "yes" or "no" in the students response questionnaire. The highest score is valued as one, and the lowest score is valued as zero [21]. The calculation in Guttman scale can be conducted in Table 2 [17].

Table 2 Guttman Scale

Score	Answer Criteria
1	Yes
0	No

The practicality data analyzed as descriptive quantitative with the percentage from Guttman scale that obtained by using the formula as follows:

$$\text{Percentage (\%)} = \frac{\sum \text{total score}}{\sum \text{criteria score}} \times 100\%$$

The percentage that obtained, interpretation in five response criteria as shown in Table 3 [17].

Table 3 Interpretation Response Score Criteria

Percentage (%)	Criteria
0-20	Not practical
21-40	Less practical
41-60	Quite practical
61-80	Practical
81-100	Very practical

According to the criteria in Table 3, SAS-3SQ is easy and practical to use in chemistry learning if get percentage result ≥ 81% with criteria very practical.

The effectiveness of SAS-3SQ is obtained from assessment sheet based on three scientific questions (ontology, epistemology, and axiology). The data got from the *pretest* and *posttest*. *Pretest* is given to determine the initial ability of students, while *posttest* is

given to determine the ability of the students after using SAS-3SQ. Data that has already been obtained is analyzed using an *N-gain score* formulated as follows:

$$\text{Normal Gain (g)} = \frac{\text{Posttest score} - \text{Pretest score}}{\text{Maximum Score} - \text{Posttest Score}}$$

According to the results of the calculation of the normal gain (g) the results are interpreted according to Table 4 [8].

Table 4 Interpretation of Normal Gain Category

Normal Gain (g)	Category
$(g) \geq 0,7$	High
$0,7 > (g) \geq 0,3$	Medium
$(g) < 0,3$	Low

If refers to Table 4, it can be declared that SAS-3SQ is effective if the N-gain score is 0,7 means obtained in the high category.

III. ANALYSIS AND DISCUSSION

Structured assignment sheets are worksheets designed to direct students with the teacher's help achieve learning targets [11]. Structured Assignment Sheet as a tool which it contains stages to achieve certain goals. The Structured Assignment Sheet in this research is a structured assignment sheet in sub material reaction rate based on three scientific questions (ontology, epistemology, and axiology) that are acronymized as SAS-3SQ. Scientific question (ontology, epistemology, and axiology) are important questions in every science material. Within scientific question able to know the science comprehensively to explore and understand as well.

SAS-3SQ needs to be tested for feasibility so that it can be used in chemistry learning. The feasibility of SAS-3SQ is assessed according to three criteria which includes validity (content and construct), practicality, and effectiveness [13]. The SAS-3SQ developed is reviewed first by a lecturer in the chemistry department, FMIPA, Unesa. The results of the review are in the form of suggestions and input for improving the SAS-3SQ before the feasibility test is carried out.

SAS-3SQ provides content scientific question to make the deep understandings within the student. The ontology question in SAS-3SQ was conducted the understanding of students in key word "what" question. In order asking about the of what is the object is studied about, in this case is the principle of the factors affecting reaction rate. The epistemology question in SAS-3SQ was conducted in key word "how" question. In order asking about the things, ways, and mechanisms of a science, in this case is the principle offactors affecting reaction rate. The axiology question is based on the essence and benefits of a science, in this case the principle of the factors that affect the rate of a reaction.

Validity of SAS-3SQ

One of the feasibility criteria is validity (construct and content) [14]. Validity must consist of content validity and construct validity [21], another recommendation that indicators of validity include consistency (construct validity) and relevance (content validity) [13]. The validity test was carried out through expert judgment involving three experts in the field of chemistry education (validators). Validation data was obtained by filling out the validation sheet by three validators. The score is given by the validator on the aspect of suitability between the substance of the question and the scientific question. The data collected in construct validity (consistency) result conducted in Table 5.

Table 5 Construct Validity Result from Validators

No	Score			Mo	Category
	V1	V2	V3		
1	5	4	5	5	Very valid
2	5	4	5	5	Very valid
3	5	4	5	5	Very valid
4	4	4	4	4	Valid
5	3	4	4	4	Valid
6	4	4	4	4	Valid
7	4	4	4	4	Valid
8	4	4	4	4	Valid
9	4	4	4	4	Valid

According to Table 5 the frequently occurring score (Mo) the question numbers 1, 2, 3 are 5, categorized as very valid. Another question is the frequently occurring score (Mo) the question numbers 4, 5, 6, 7, 8, 9 are 4, which are valid. In all aspects, the frequently occurring score (Mo) is 4 with a valid category. SAS-3SQ can be declared as required in consistency or construct validity to provide scientific question (ontology, epistemology, and axiology). Validation scores were obtained from three validators so that the *percentage of agreement* in construct validity each R was calculated, such as (R)_{1,2}; (R)_{1,3}; and (R)_{2,3}. The results of the calculation of the *percentage of agreement* (R) occur in Table 6.

Table 6 Percentage of Agreement in Construct Validity Recapitulation

No	Score			Percentage of Agreement (%)		
	V ₁	V ₂	V ₃	R _{1,2}	R _{1,3}	R _{2,3}
1	5	4	5	89	100	89
2	5	4	5	89	100	89
3	5	4	5	89	100	89
4	4	4	4	100	100	100
5	3	4	4	86	86	100
6	4	4	4	100	100	100
7	4	4	4	100	100	100
8	4	4	4	100	100	100
9	4	4	4	100	100	100

According to Table 6, the percentage of agreement among the validators on a scale of 86%-100% can be seen. There are no significant differences, and in range $\geq 75\%$, which means reliable [4]. SAS-3SQ can be declared as required in consistency or construct validity to provide scientific question (ontology, epistemology, and axiology).

The validity of content (relevance) was also analyzed using *expert judgment*. The score of content validity from three validators can be shown in Table 7.

Table 7 Content Validity Result from Validators

No	Score			Mo
	V ₁	V ₂	V ₃	
1	5	4	5	5
2	4	3	4	4
3	5	4	5	5
4	5	4	5	5
5	5	4	5	5
6	5	4	5	5

According to Table 7 the frequently occurring score (Mo) the question numbers 1, 3, 4, 5, 6 are 5 which is categorized as very valid. Another question is the frequently occurring score (Mo) question number 2 is 4 which is valid. In all aspects, the frequently occurring score (Mo) is 5 with very valid category. So, it can be declared that SAS-3SQ has required in terms of content validity (relevance) to provide scientific question (ontology, epistemology, and axiology). Validation scores were obtained from three validators so that the *percentage of agreement* in content validity each R was calculated, such as (R)_{1,2}; (R)_{1,3}; and (R)_{2,3}. The results of the calculation of the *percentage of agreement* (R) occur in Table 8.

Table 8 Percentage of Agreement in Content Validity Recapitulation

No	Score			Percentage Of Agreement (%)		
	V ₁	V ₂	V ₃	R _{1,2}	R _{1,3}	R _{2,3}
1	5	4	5	89	100	89
2	4	3	4	86	100	86
3	5	4	5	89	100	89

4	5	4	5	89	100	89
5	5	4	5	89	100	89
6	5	4	5	89	100	89

According to Table 8, the percentage of agreement among the validators on a scale of 86%-100% can occur there are no significant differences, and in range $\geq 75\%$, which means reliable [4]. So, it can be declared that SAS-3SQ has required in terms of content validity (relevance) to provide scientific question (ontology, epistemology, and axiology).

Practicality of SAS-3SQ

One of the feasibility criteria is practicality [12]. Practicality data of SAS-3SQ was obtained based on the results of filling out questionnaire sheets by students. SAS-3SQ has been validated and revised, then tested on 15 students of class XI. SAS-3SQ is declared to be practical if it is easy to use. The questionnaire asks for the component of a scientific question. The recapitulation of the results of the student's response questionnaire is available in Table 9.

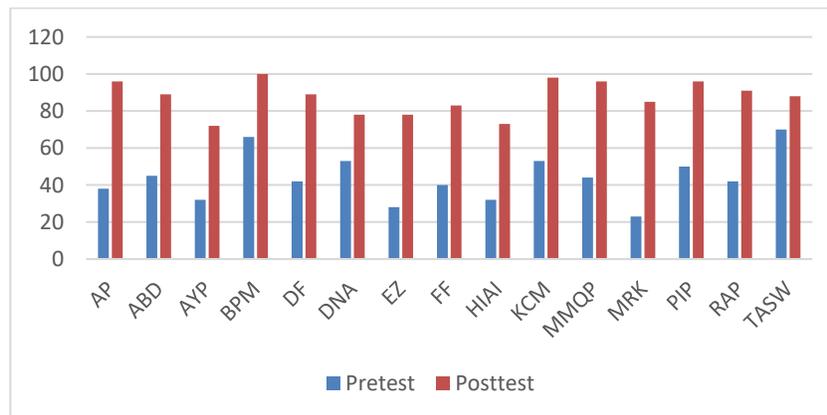
Table 9 Recapitulation of Students Response Questionnaire

Scientific Question Component	Percentage	Category
Ontology	100%	Very Practical
Epistemology	100%	Very Practical
Axiology	100%	Very Practical

SAS-3SQ has developed, giving the students an overview of the ontology, epistemology, and axiology in factors affecting reaction rate. Using SAS-3SQ, students declared that knowing the usage of each factor in affecting reaction rate facilitates thinking of all aspects comprehensively based on a scientific question. In addition by SAS-3SQ the students declared that understanding the factors affecting reaction rate in all aspect comprehensively and independently. They also declared that after using SAS-3SQ they become know that factors affecting reaction rate is near with daily life activities. According to Table 9, from practicality aspect SAS-3SQ has percentage 100% in practicality which means very practical and easy to use in self study out of the face to face schedule in class.

Effectiveness Of SAS-3SQ

One of the feasibility criteria according to [14] is effectiveness. Effectiveness data were obtained from assessment based on three scientific question. The research instrument used is *pretest and posttest* that occur to know the effectiveness of SAS-3SQ. *Pretest* is used to know the initial ability of the students about scientific question (ontology, epistemology, and axiology). While *posttest* is used to know the ability of the students based on three scientific questions. The data of the *pretest-posttest* shown in Picture 2.



Picture 2 Pretest-Posttest Result

Data that got, shown in Picture 2 processed by using the *normal gain* and interpreted in its scale. The result is shown in Table 10 about the recapitulation of *pretest-posttest* result.

Table 10 Recapitulation of Pretest-Posttest Result

No	Name	Pretest	Posttest	N-Gain	Category
1	AP	38	96	0,9	High
2	ABD	45	89	0,8	High
3	AYP	32	72	0,6	Medium
4	BPM	66	100	1,0	High
5	DF	42	89	0,8	High

No	Name	Pretest	Posttest	N-Gain	Category
6	DNA	53	78	0,5	Medium
7	EZ	28	78	0,7	High
8	FF	40	83	0,7	High
9	HIAI	32	73	0,6	Medium
10	KCM	53	98	1,0	High
11	MMQP	44	96	0,9	High
12	MRK	23	85	0,8	High
13	PIP	50	96	0,9	High
14	RAP	42	91	0,8	High
15	TASW	70	88	0,6	Medium
Average		44	87	0,8	High

SAS-3SQ provides the scientific question as the learning media to make the comprehensive understanding. Learning chemistry cannot be separated from scientific question. Learning chemistry means learning the science product such as facts, concept, principle, laws, and theory. SAS-3SQ provides an ontology question that asks the question within the keyword "what" question word. SAS-3SQ also provides epistemology that asks the question within the keyword "how" question word. The last, SAS-3SQ provide the axiology question as the essential question. When students do not understand themselves to the axiological aspect, they will not get the meaning of learning. The main product of science in chemistry must be studied to the aspect of axiology. Learning chemistry should connected with the existance of chemistry in daily life [20]. A comprehensive understanding of a scientific product is an indicator of intellectual ability and is one of the important goals in studying chemistry [5]. It can be concluded that the comprehensiveness of the understanding can have implications for the quality of thinking SAS-3SQ provides the deep understanding to gain comprehensive thinking as the implication of good quality of thinking in nowadays.

According to Table 10 can be shown that the average score in the *pretest* is 44. The average score in the *posttest* is 87 it means that after using SAS-3SQ, there is increasing in the score. *Normal gain* score that occur is 0,8 which it's in high category. So, that SAS-3SQ can be declared as effective to use in learning chemistry rate reaction material.

IV. CONCLUSION

The conclusion obtained from this research are: (1) SAS-3SQ that developed has feasibility based on the requirements, in terms of validity criteria such as construct validity (consistency) and content validity (relevance). (2) SAS-3SQ developed has feasibility based on the requirements in terms of practicality. (3) SAS-3SQ developed has feasibility based on the requirement in terms of effectiveness within the high category of *normal gain* score. So, SAS-3SQ is proper to use as the learning media in chemistry learning factors that affect reaction rate.

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