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IDENTIFICATION OF SCIENTIFIC ATTITUDE ON SENIOR HIGH SCHOOL STUDENTS IN SOLUBILITY AND SOLUBILITY PRODUCT CONCEPT

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Abstract

The main objectives of this study is to describe students' scientific attitudes on the solubility and solubility product concept before and after guided inquiry-based learning. The scientific attitude in this study includes four indicators, that is student attitudes towards science, the importance of science in life, student responses to science as a career, and student responses to learning science in school. Scientific attitudes play an important role in student decision making to develop scientific knowledge further, pursue careers in science, and use scientific concepts and methods in their lives. This study used a survey method for 40 students enrolled in the 2017/2018 academic year. Data obtained through questionnaires and observations of scientific attitudes during learning activities. The questionnaire technique consisted of a self-assessment sheet and an assessment sheet between friends, each containing 30 statements (positive and negative). This sheet was given before and after learning activities. Data were analyzed quantitatively and qualitatively according to the description. The results of scientific attitudes obtained from the self-assessment sheet and among friends are presented in Table 1. From the results of the study, it was shown that student attitudes towards science were the highest scores for the scientific aspects and there were differences in students' scientific attitudes before and after guided inquiry-based learning on the solubility and solubility product concept.

Keywords: Scientific attitude, guided inquiry, solubility and solubility product concept

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INTRODUCTION

The 21st century is marked by the development of three skills namely learning and innovating skills, skills in using information, media and technology, as well as skills in life and career (Trilling and Fadel, 2009). Authentic learning can be used in the 21st century to direct and guide student learning. Besides the skills needed in the 21st century can also be trained through the application of the 2013 curriculum designed to realize educational goals with the characteristics of developing a balance between spiritual and social attitudes, curiosity, creativity, cooperation, using intellectual and psychomotor abilities in the hope of increasing and a balance between the ability to be a good human being, to have the skills and knowledge to live properly (Kemendikbud, 2013). Therefore, the scientific approach is very suitable to be implemented in the learning process that will touch three domains, namely attitude (affective), knowledge (cognitive), and skills (psychomotor) in obtaining a concept.

Meaningful chemistry learning is chemistry learning that provides clarity of relationships between concepts for students. This meaningfulness can occur if students are able to connect new knowledge with the knowledge they already have (Dahar, 2011). An optimal level of meaningfulness in learning chemistry for students can be obtained if students have good scientific literacy skills. Science literacy is the ability to engage with science-related issues, scientific ideas, and become someone who thinks reflectively (OECD, 2016). The 2015 Program for International Student Assessment (PISA) report revealed that someone who is a literate of science must have the competence to explain phenomena, evaluate and design investigations, and interpret scientific data and evidence. The scientific literacy assessment framework according to PISA 2015 covers aspects of context, knowledge, competencies, and attitudes.

Based on the results of the PISA assessment, the ability of Indonesian students 'scientific literacy from 2000 to 2012 has decreased from year to year, whereas between 2012 and 2015 students' scientific literacy skills have increased by 21 points (OECD, 2016). The low scientific literacy of students in Indonesia is also supported by the results of TIMSS (Trends in International Mathematics and Science Study). TIMSS assessment results in the field of science from 2007 to 2015 also showed a decrease from year to year. Based on the results of assessments on an international scale (PISA and TIMSS) it can be concluded that the scientific literacy skills of Indonesian students are below the average value. The contributing factor is partly because Indonesian students are less trained in solving PISA and TIMSS problems which have the characteristics of testing students' understanding, especially high-level thinking skills. The questions tested not only require students' knowledge, but also involve various levels of thinking, such as applying concepts in daily life, analyzing, hypothesizing, inferring and assessing conditions, and solving problems related to daily life.

One of the problems faced in education is the weak learning process (Sanjaya, 2013). Students are less encouraged to develop thinking skills, so they tend to be passive, less creative in solving problems, and low levels of participation. Based on the results of the questionnaire students showed as much as 80% agreed with the statement. Basically the essence of chemistry includes two inseparable things, namely chemistry as a product and process that can develop scientific attitudes (Aulia et al, 2018). Chemistry as a product includes a collection of knowledge consisting of facts, concepts, and chemical principles (Aulia, 2019). Chemistry as a process includes the skills and attitudes to acquire and develop chemical knowledge. The skills used are called process skills and attitudes possessed are called scientific attitudes (Susiwi, 2007). Thus, the learning and assessment of chemistry learning outcomes must pay attention to the characteristics of chemistry as processes and products. If viewed from the characteristics of chemistry lessons, especially the solubility and solubility product concept, a suitable method used to make learning meaningful and develop thinking skills is the guided inquiry model. The guided inquiry learning model is a learning activity that involves all students' abilities to search for and investigate a problem systematically, logically, and analytically with the guidance of the teacher, so students can formulate their own findings with confidence (Gulo, 2008)

Various studies have shown that the implementation of the guided inquiry model accompanied by guided inquiry-oriented learning tools on effective and efficient chemical materials to obtain the best quality learning outcomes. Students' learning activities and achievements on solubility and solubility product concept can be increased if a guided inquiry learning model is implemented that is equipped with student worksheet (Setiowati et al, 2015). Through the guided inquiry learning model, a significant increase occurred in all aspects of student attitudes and academic achievement, and there was a significant decrease in student anxiety in the chemistry laboratory (Ural, 2016). In inquiry-based laboratory activities, students have fewer

misconceptions, understand concepts more meaningfully, and the average value of student performance also experiences a significant increase (Sesen and Tarhan, 2013). Learning inquiry-based scientific literacy in laboratory activities proves that the ability of high school students' scientific literacy in the aspects of content, context, process, and attitude of students increases (Rakhmawan et al, 2015). The guided inquiry learning model can help students link knowledge systems consisting of theories, enhance conceptual understanding, and encourage students to be interactive in the learning process (Gültepe N and Kiliç, 2013). Students express a positive attitude towards the importance of science and believe that science (chemistry) is an important component (Salta and Tzougraki, 2004)(Menis, 1989).

The results of the field study show that students' interest in science is still lacking, when given a questionnaire that represents four aspects of student attitudes namely student attitudes toward science, the importance of science in life, student responses to science as a career, and student responses to science at school are still low. As many as 60% of students have a negative response to science, 75% of students consider science unimportant in life, 83% of students have a negative response to science as a career, and 75% of students choose a negative response to learning science in school. Therefore, this study aims to describe students' scientific attitudes on the solubility and solubility product concept before and after implementing guided inquiry-based chemistry learning..

METHOD

This study used quantitative and qualitative approaches to categorize scientific attitudes in every aspect. The subjects of this study were two classes, consists of 40 students in 11th grade Senior High School Surabaya in academic year 2017/2018. This study was conducted at the end of the even semester. The collection of data and information was carried out with several techniques, namely by distributing questionnaires and observing scientific attitudes directly.

Data collection techniques by giving a questionnaires that were developed using a Likert scale and observation in class during learning. Likert scale can be used to measure attitudes, opinions, and perceptions of a person or group about social phenomena. Dimensions and aspects of scientific attitudes measured include students' attitudes toward science, the importance of science in life, students' responses to science as a career, and students' responses to science at school.

The validity of the scientific attitude questionnaire instrument used was content validity, as well as language validity and statement writing. Validation is done by requesting the assessment of three experts, namely two chemistry education lecturers and one high school chemistry teacher. Each validator validates the instrument by putting a checklist (√) on the questionnaire in accordance with its assessment in the column provided. Assessment consists of 4 criteria, namely not good (value 1), not good (value 2), good (value 3), and very good (value 4). The assessment given by the validator determines the quality of the instrument being developed.

Validity analysis was performed on the instruments that developed. Each aspect is assessed by referring to the validity rating scale in Table 1 (Riduwan, 2012). Furthermore, the validity data is analyzed using quantitative descriptive analysis, which is done by calculating the average value provided by the validator.

Table 1. Validity Rating Scale

Assessment	Score
Very good	4
Well	3
Quite good	2
Not good	1

Data on the results of self-assessment of attitude and assessment between friends (final score) on the questionnaire instrument was calculated using the formula:

$$\frac{Score\ obtained}{Maximum\ Score}\ x\ 4 = final\ score$$

In accordance with Permendikbud, students get: Very Good score if they get a score of 3.51 ≤ score ≤ 4.00; Good if get a score of 2.51 ≤ score ≤ 3.50; Enough if get a score of 1.51 ≤ score ≤ 2.50; Less if get a score ≤ 1.50.

RESULTS AND DISCUSSION

1. Validation of Instrument Scientific Attitudes Questionnaire

The developed instrument consisted of 30 statements (positive and negative) representing four aspects of attitude, namely students' attitudes toward science, the importance of science in life, students' responses to science as a career, and students' responses to science in school. Assessments by validators include two categories, namely content validity, as well as language and statement writing. The validation results are presented in Table 2.

Table 2. Results of Questionnaire Validation

Statement	Content validity		Validity of Language and Writing Expressions	
	Average	Reliability (%)	Average	Reliability (%)
1	4	100	4	100
2	3.67	66.67	3.33	66.67
3	4	100	4	100
4	3.67	66.67	3.67	66.67
5	3.67	66.67	3.67	66.67
6	4	100	4	100
7	3.67	66.67	4	100
8	4	100	4	100
9	4	100	4	100
10	4	100	4	100
11	3.67	66.67	3.67	66.67
12	3.67	66.67	3.67	66.67
13	4	100	4	100
14	3.67	66.67	3.67	66.67
15	4	100	4	100
16	4	100	4	100
17	4	100	4	100
18	3.67	66.67	3.67	66.67
19	4	100	4	100
20	3.67	66.67	3.67	66.67
21	4	100	4	100
22	4	100	4	100
23	4	100	4	100
24	4	100	4	100
25	3.67	66.67	3.67	66.67
26	3.67	66.67	3.67	66.67
27	4	100	3.67	66.67
28	4	100	4	100
29	4	100	4	100
30	4	100	4	100

Data Table 2 showed that the results of validation on the aspects of content validity, language and statement writing obtained an average range of values of 3.33 - 4. These results indicate that overall each statement on the questionnaire developed is included in the valid category and is very valid because it reaches value ≥ 2.9. The results of the validation of the statement based on the content validity most obtained an average value of 4 with a very valid category, while based on language validity and writing the most statements also obtained an average value of 4 with a very valid category, except in statement number 2 obtained an average value 3.33 with a valid category.

Based on these data, the range of reliability percentages between assessors (validators) reaches 66.67% - 100% with a percentage of 100% more, this means that the ratings between the three validators are very good suitability.

2. Students' Scientific Attitudes

Scientific attitude was reflected through four attitude indicators, namely students' attitudes towards science, the importance of science in life, students' responses to science as a career, and students' responses to learning science in school. The results of the scientific attitude were obtained from the questionnaire through self-assessment and between friends which are presented in Table 3.

Table 3. The results of students' scientific attitudes

Student	Student attitudes toward science				The importance of science in life				Student responses to science as a career				Student responses to learning science in school			
	Pretest		*Posttest*		*Pretest*		*Posttest*		*Pretest*		*Posttest*		*Pretest*		*Posttest*	
	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value
1.	2.35	E	3.72	VG	2.00	E	3.55	VG	2.84	G	3.67	VG	1.98	E	3.19	G
2.	1.95	E	3.60	VG	2.25	E	3.35	G	2.00	E	4.00	VG	2.02	E	3.24	G
3.	2.23	E	3.60	VG	2.95	G	3.80	VG	2.00	E	3.67	VG	2.57	G	3.37	G
4.	3.03	G	3.72	VG	2.00	E	3.10	G	3.17	G	3.67	VG	2.20	E	3.60	VG
5.	2.34	E	3.71	VG	2.20	E	2.90	G	2.50	E	4.00	VG	2.20	E	3.41	G
6.	3.03	G	3.60	VG	2.90	G	3.80	VG	2.33	E	3.50	B	2.75	G	3.37	G
7.	2.34	E	3.31	G	2.00	E	3.10	G	1.67	E	2.83	G	1.98	E	3.01	G
8.	2.63	G	4.00	VG	1.80	E	3.15	G	2.50	E	3.67	VG	2.42	E	3.41	G
9.	1.94	E	3.03	G	2.95	G	3.60	VG	2.50	E	3.67	VG	2.83	G	3.33	G
10.	2.06	E	3.03	G	2.20	E	3.55	VG	1.83	E	3.50	G	2.24	E	3.01	G
11.	1.66	E	3.43	G	1.80	E	3.15	G	2.50	E	3.67	VG	2.16	E	3.60	VG
12.	2.34	E	4.00	VG	2.65	G	3.60	VG	2.33	E	3.50	G	2.65	G	3.82	VG
13.	2.74	G	3.60	VG	3.15	G	3.80	VG	1.67	E	3.17	G	2.61	G	3.60	VG
14.	2.63	G	3.60	VG	2.25	E	3.15	G	2.50	E	3.33	G	2.16	E	2.97	G
15.	2.74	G	3.71	VG	2.70	G	3.60	VG	2.83	G	3.67	VG	2.83	G	3.37	G
16.	2.06	E	3.71	VG	2.40	E	3.50	G	1.50	L	3.17	G	2.42	E	3.45	G
17.	3.03	G	3.60	VG	2.85	G	3.15	G	2.33	E	3.33	G	2.46	E	2.97	G
18.	2.91	G	4.00	VG	2.50	E	3.60	VG	2.83	G	4.00	VG	1.98	E	3.23	G
19.	2.51	G	4.00	VG	2.20	E	3.35	G	2.50	E	3.17	G	2.38	E	3.15	G
20.	2.34	E	3.43	G	2.45	E	3.35	G	2.00	E	4.00	VG	2.20	E	3.19	G
21.	2.35	E	3.72	VG	2.00	E	3.55	VG	2.84	G	4.00	VG	1.98	E	3.42	G
22.	2.63	G	4.00	VG	2.45	E	3.80	VG	2.00	E	3.17	G	2.38	E	3.41	G
23.	2.34	E	3.71	VG	2.60	G	3.50	G	3.17	G	4.00	VG	2.42	E	3.19	G
24.	2.23	E	3.60	VG	2.95	G	3.80	VG	2.00	E	3.67	VG	2.57	G	3.37	G
25.	3.03	G	3.71	VG	2.00	E	3.10	G	3.17	G	4.00	VG	2.20	E	3.60	VG
26.	2.34	E	3.43	G	2.65	G	3.75	VG	2.00	E	3.67	VG	2.42	E	3.64	VG
27.	3.03	G	4.00	VG	2.90	G	3.80	VG	2.33	E	3.50	G	2.75	G	3.37	G
28.	2.34	E	3.31	G	2.00	E	3.10	G	1.67	E	2.83	G	1.98	E	3.01	G
29.	3.03	G	3.31	G	3.10	G	4.00	VG	3.33	G	4.00	VG	2.38	E	3.37	G
30.	2.63	G	4.00	VG	1.80	E	3.15	G	2.50	E	3.67	VG	2.42	E	3.41	G
31.	1.94	E	3.03	G	2.95	G	3.60	VG	2.50	E	3.67	VG	2.83	G	4.00	VG
32.	3.03	G	4.00	VG	3.10	G	3.55	VG	2.00	E	2.83	G	2.79	G	3.60	VG
33.	2.46	E	3.31	G	2.20	E	3.10	G	2.50	E	3.67	VG	2.20	E	3.01	G
34.	2.34	E	4.00	VG	2.65	G	3.60	VG	2.33	E	3.50	G	2.65	G	3.82	VG
35.	2.74	G	4.00	VG	3.15	G	3.80	VG	1.67	E	3.17	G	2.61	G	3.60	VG
36.	2.63	G	3.60	VG	2.25	E	3.15	G	2.50	E	3.33	G	2.16	E	2.97	G
37.	2.74	G	3.71	VG	2.70	G	3.60	VG	2.83	G	3.67	VG	2.83	G	3.82	VG
38.	2.06	E	3.03	G	2.20	E	3.35	G	2.83	G	4.00	VG	2.61	G	3.37	G
39.	3.03	G	4.00	VG	2.85	G	3.55	VG	2.33	E	3.67	VG	2.46	E	3.41	G
40.	2.91	G	3.60	VG	2.50	E	3.40	G	2.83	G	4.00	VG	1.98	E	3.01	G

Note: L = Less, E = Enough, G = Good, VG = Very good

The data in Table 3 showed that students' attitudes towards science at the time of the pretest ranged from 1.66 to 3.03 with the category of sufficient to good, where as many as 20 students got grades with enough categories and 20 students got grades with good categories. After being given

guided inquiry-based learning and conducted a posttest, students' attitudes toward science range from 3.03 to 4.00 in the good to very good categories, where as many as 11 students get good categories and 29 students get very good categories.

Attitude is a tendency to act like or dislike towards objects. Attitudes include positive or negative feelings and affect various behaviors (Ratumanan and Laurens, 2011). Attitude aspect assessment is a series of activities designed to measure students' attitudes toward science as a result of a guided inquiry-oriented learning activity. Attitude assessment in this research is done through self-assessment and assessment between friends. Self-assessment is an assessment technique by asking students to express their strengths and weaknesses in the context of achieving competence. Peer-to-peer assessment is an assessment technique by asking students to assess each other related to achieving competence. The instrument used in this study was a checklist accompanied by an assessment rubric (Kemendikbud, 2013).

The range of reliability of the attitude assessment instruments between the validators reaches 66.67% - 100% with a percentage of 100% more, this means that the judgments between the three validators are very good suitability or the instrument is reliable (reliable) so that the possibility of errors in measuring aspects attitude is getting smaller. The results of the attitude show that the average value of self-assessment and assessment between friends for all attitude indicators at the time of the pretest reached the category of good enough to good, while at the time of the posttest experienced an increase in the category of good to very good. This is consistent with Ural's research which shows that there is a significant increase in all aspects of students' attitudes and academic achievements with the guided inquiry-based laboratory experiment method (Ural, 2016). Sesen & Tarhan (2013) also stated that inquiry-based laboratory activities can improve all dimensions of student attitudes and performance. Differences in the average value of student attitudes that are the focus of research according to the type of assessment are shown in Figure 1.

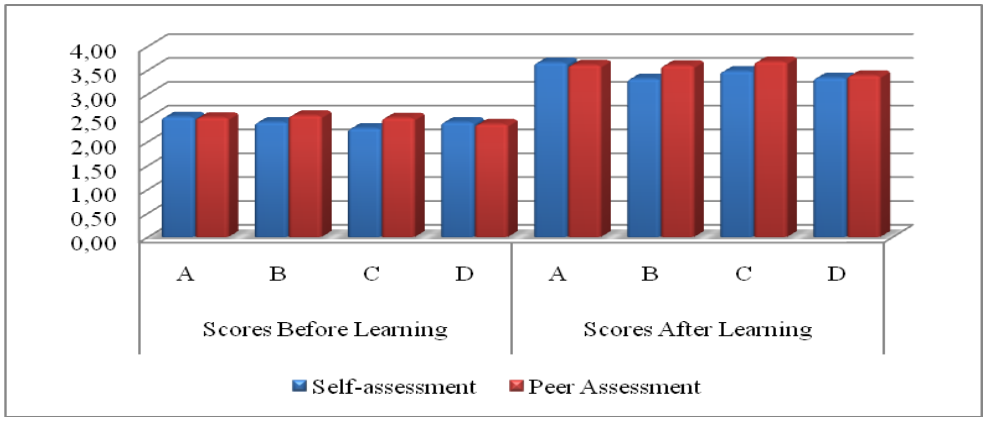

Figure 1. Differences in the Average of Students Attitudes Based on the Type of Assessment

Information:
A = Attitudes of students towards science
B = The importance of science in life
C = Student responses to science as a career
D = Student responses to learning science in school

Based on Figure 1, the average value of attitude based on self-assessment and peer-to-peer evaluation did not show a significant difference. This is because self-assessment and between friends are carried out in the same way which is to fill out an attitude assessment sheet in the form of a checklist, so that the scores obtained are not too much different. This shows that the self-attitude assessment sheet and the assessment sheet between friends are able to provide mutually supportive results, even though grades are given by different people. This result is supported by the results of validation which show that the three validators agreed to give a value with a category that is very valid in both types of assessment.

CONCLUSION AND SUGGESTION

Conclusion

Guided inquiry-based learning is effective to improving student scientific attitude in four indicators, namely students' attitudes towards science, the importance of science in life, students' responses to science as a career, and students' responses to learning science in school. Student attitudes towards science were the highest scores for the scientific aspects and there were differences in students' scientific attitudes before and after guided inquiry-based learning.

Suggestion

This research needs to be further developed for other subjects or materials in order to train students' scientific attitudes, skills in conducting experiments, knowing the usefulness of experiments in everyday life and being able to apply them. Teachers should prepare varied reading sources (literature), master the steps of learning, and be able to manage the class well so that guided inquiry-oriented learning is more effective in improving students' scientific attitudes.

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