PROFILE OF XI GRADE STUDENTS' SCIENTIFIC THINKING ABILITIES ON SCIENTIFIC APPROACH IMPLEMENTATION

by Suciati Suciati Et Al.

Submission date: 26-Aug-2018 09:50AM (UTC+0700)
Submission ID: 993188644
File name: REVISED_JPII_ARTICLE_SUCIATI_ET_AL..docx (743.85K)
Word count: 2375
Character count: 13967

PROFILE OF XI GRADE STUDENTS' SCIENTIFIC THINKING ABILITIES ON SCIENTIFIC APPROACH IMPLEMENTATION

Abstract

This study aims to analyze XI grade students' scientific thinking abilities on the implementation of scientific approach. 82 students of XI grade science class at three state senior high schools in Surakarta were involved in this study. Students' scientific thinking abilities illustrated as students' competence in seven aspects: purpose of science; science question, science information, science interpretation, science concept, science assumption, science implication (Paul & Elder, 2003). Data on students' scientific thinking abilities were collected using essay test on worksheet and interview methods. Instrument had been validated by expert judgement and students as user. The scores were used to represent students' scientific thinking abilities in three categories (low, middle,high). The result of the study showed that students' competence in seven aspects of scientific thinking abilities: purpose of science (62,00%); science question (36,6%), science information (39,66%), science interpretation (41,00%), science concept (43,33), science assumption (38,33%), science implication (21,33%). Based on the result of the study can be concluded that XI grade students' scientific thinking abilities on the implementation of scientific approach was at low category. It's suggested that learning model based scientific approach be conducted for students' scientific thinking abilities improvement.

Keywords: scientific thinking abilities; scientific approach

INTRODUCTION

There are 4 skills demanded for 21st century generation that is 4C (creativity and innovation, critical thinking and problem solving, communication, and collaboration) (Osman et al., 2013). For that 21st century education is required to empower the students' scientific abilities (Osborne, 2013). Scientific thinking is a form of knowledge seeking that involves the process of thinking to increase knowledge or intellectual, thereby scientific thinking ability is not what already in a person's mind but the process of thinking that must be habituated to encourage the increase of knowledge (Kuhn, 2010; Paul and Elder, 2003). Scientific thinking ability is the result of the application of scientific discovery methods used in problems solving through proving a theory (Morris et al., 2007). Scientific thinking is obtained through inductive and deductive reasoning to find answers through explorations of factual scientific investigation, problem formulation, hypothesis, design, evaluation of evidence, hypothesis testing with

experiment, and conclusions (Dunbar, 1999; Gamlunglert, et al., 2012). Scientific thinking ability can be considered as part of critical thinking through claims and arguments about persons' behavior from a scientific view. Thus scientific thinking is a form of logical reasoning in a scientific paradigm (Kagee et al., 2010; Stevens & Witkow, 2014).

According to Paul and Elder (2003) there are 8 characteristics of scientific thinking: 1) the purpose of scientific thinking. Scientific reasons always have a purpose, therefore the delivery of scientific objectives to be achieved must be realistic and clear; 2) scientific question at issue that is the emergence of scientific questions related to the issues discussed. Usually questions are sub-questions to clarify the purpose and scope of the problem; 3) scientific assumptions. Assumptions are obtained by clearly identifying the problem situation by considering how the assumption is built on a particular point of view; 4) scientific point of view. Assumptions are built on views, therefore they need to be identified first to ensure the scientifically view. Once found the scientific points further identified the strengths and weaknesses; 5) thescientificinformation. Scientific thinking is always based on data, information, and scientific evidence. Not all claims are used, but are limited only those supported by data that are clear, accurate and relevant to the question of the problem; 6) the scientific concepts. Scientific thinking is built on scientific concepts and theories. The concepts or theories used must be accurately and carefully identified, since only scientific and clear concepts and theories are used; 7) scientific interpretations and inferences. Scientific thinking will lead to scientific conclusions that refer to inference or interpretation that gives meaning to scientific data. Conclusions are drawn only on the basis of the data obtained, so conclusions need to be checked for consistency with existing data and identify which assumptions underlying the conclusions; 8) scientific implications and consequences. Scientific thinking always has both negative and positive implications and consequences, both of which can be found by tracing them through data and thought. Referring to the characteristics of scientific thinking, then scientific thinking can be trained. This is relevant to Kuhn (2004) that trained scientific thinking can be done through 4 phases of activities which include: 1) investigation; 2) analysis; 3) inference; and 4) the argument. While Koerber, et al. (2015) argues that scientific thinking can be developed through activities such as: hypothesis testing, systematic experiments, data interpretations related to hypotheses, and a more general understanding of the nature of science. In nurturing scientific thinking ability, it is necessary to change the paradigm of learning from the teacher center to the

student center, from learning that emphasizes the content to the process, the textual approach to the contextual and the scientific approach, the transfer of knowledge toward problem solving. Efforts to optimize the implementation curriculum of 2013 in stages, it's showing that the Indonesia Government commit to respond the challenge of globalization era in order to meet the demands of 21st century skills of human resources. One of the important changes as contained in the science curriculum (Indonesia Minister of Culture and Education Regulation No.103 of 2014) is a shift from a textual approach to a scientific approach.

The scientific approach is an approach of learning that adopts from scientist steps in building knowledge through the scientific method by using inductive reasoning rather than deductive reasoning. Inductive reasoning starts from looking at a specific phenomenon or situation to then draw the overall conclusion. Inductive reasoning puts specific evidence into a wider relationship. Scientific methods generally originate from a unique phenomenon with specific and detailed studies to then be drawn conclusions in general through investigative activities. To be scientific, the method of inquiry should be based on the evidence, observable, empirical, and measurable objects with specific principles of reasoning. The scientific approach is the organizing of learning experiences in a logical sequence that includes: observing, questioning, gathering information, reasoning, and communicating. Learning with a scientific approach is a learning process designed in such a way that learners actively construct concepts, laws or principles through a series of data collection activities through observation, identifying problems, formulating hypotheses, testing hypotheses through investigation (experimenting), processing data or information, gathering and analyzing and by various techniques, drawing conclusions and communicating concepts, laws or principles found (Kemendikbud, 2014; Hosnan, 2014; Daryanto, 2014).

The characteristics of a scientific approach are: 1) The substance or subject matter is based on facts or phenomena which can be explained by certain logic or reasoning, not just imagination, story, reading, alone; 2) Teacher explanation, student response, and interaction between teacher and student are free from subjective thinking or reasoning that deviates from the logical thinking flow; 3) Encourage and inspire students to think critically, analytically and appropriately in identifying, understanding, solving problems and applying substance or subject matter; 4) Encourage and inspire learners to be able to think hypothetically in view of differences, similarities and links to one another from the substance or learning material; 5) Encourage and

inspire learners to be able to understand, apply and develop rational and objective thinking patterns in response to substance or learning materials; 6) Based on empirical concepts, theories and empirical facts that can be accounted for; 7) Learning objectives are formulated in a simple, clear, and interesting presentation system (Kemendikbud, 2013). Referring to the characteristics of the scientific approach, it can be argued that the scientific approach not only views learning outcomes as the final estuary, but the learning process is considered very important. Since the scientific approach emphasizes on the process skills, so it is believed to be a golden bridge for the development of attitudes, skills, and knowledge, especially in the empowerment of students' scientific thinking. Departing from the description above, this research is conducted to analyze XI grade students' scientific thinking abilities with regard to the implementation of scientific approach.

METHODOLOGY

The study involved 82 students of XI grade science class at three state senior high schools in Surakarta. Students' scientific thinking abilities illustrated as students' competence in seven aspects: purpose of science; science question, science information, science interpretation, science concept, science assumption, science implication (Paul & Elder, 2003). Data on students' scientific thinking abilities were collected using essay test on worksheet by formulating hypothesis, determining variables and analyzing the results of the investigation (Ghojazadeh et al., (2014) and interview methods. Interviews of students focused on students 'difficulties in filling out worksheets related to students' scientific thinking skills. Instrument had been validated by expert judgment and students as user. The scores were used to represent students' scientific thinking abilities in two categories (low and high category). If the score is $\leq 50\%$ in low category and $> 50\%$ in high category.

RESULTS AND DISCUSSION

The students' competence in seven aspects of scientific thinking abilities: purpose of science (62,00%); science question (36,66%), science information (39,66%), science interpretation

(41,00%), science concept (43,33%), science assumption (38,33%), science implication (21,33%) is shown in Figure 1. The percentage of each aspect is obtained from the results for the scores obtained by students divided by the maximum score that students can get from certain aspects and then multiplied by 100%. Among those abilities, students demonstrated moderate ability in the purpose of science, whereas in the other six components, students have low ability of scientific thinking.

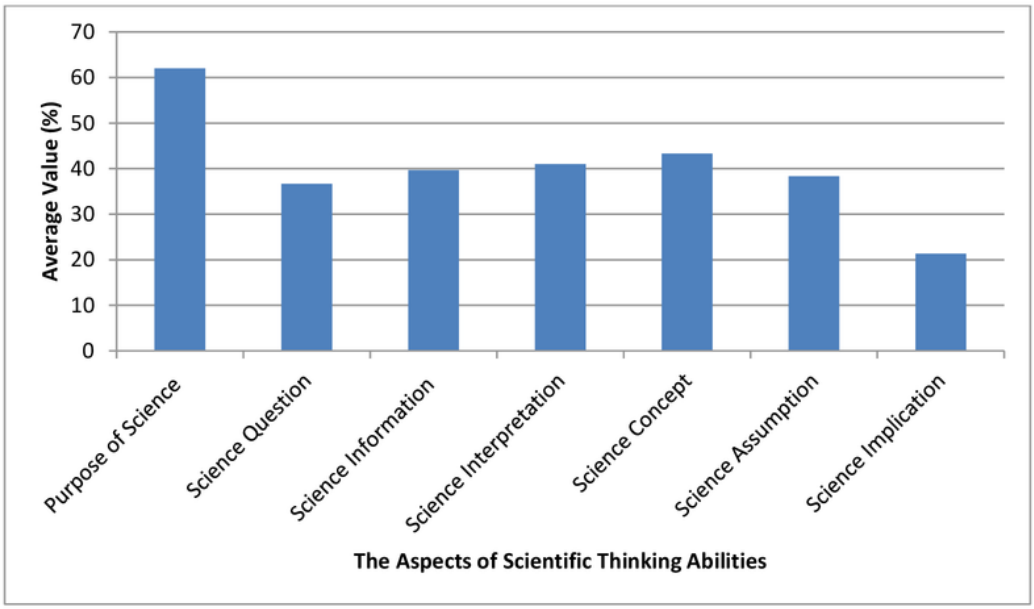


Figure 1: Students' Competence in Seven Aspects of Scientific Thinking Abilities

The data analysis showed that the students' scientific thinking ability profile can be categorized low. Meanwhile, from the observation data showed that teachers have not implemented a scientific approach in learning optimally. Teachers still dominate learning process and tend to be teacher centered. This is supported by the results of interviews with teachers that 75% of them declared a lack of understanding of scientific approaches, especially with regard to its implementation. This condition is also supported by the research done by Restami et al., (2013) which showed the average score of teachers' ability to implement a scientific approach was between 45% -50%. The teachers explained that they required more training, especially in terms of scientific approach concept and its practice in teaching and learning. Thus it can be argued

that the lack of teachers' competence in implementing of scientific approach, will result in weak students' scientific thinking ability empowerment, since learning is a system that includes: input, process, output. Learning environment that merely involving transfer of knowledge from the teacher to the students will not provide meaningful experiences to students, thus encouraging students toward rote learning.

Meanwhile, according to Ausubel learning through experiences with contextual and meaningful activities, can make learning become engaging and having longer retention (Dahar, 2011. The process of learning through observation has a high significance (Ary, et al., 2002). The data observation showed that the activity of "asking" was generally initiated by the teacher rather by the student. Thus students' scientific thinking ability is not developed. This is relevant to Sa'ud (2011) opinion that the activity of asking questions (asking) can be viewed as a reflection of the curiosity of an individual, while answering questions is reflecting of students' thinking ability. If the activities to tackle the ability of scientific thinking (investigation, analysis, inference, arguments through a series of scientific process stages such as: hypothesis testing, systematic experiments, data interpretation related to hypothesis, and a more general understanding of the nature of science are not properly planned and implemented extrinsically, then do not expect students' scientific thinking ability to thrive (Kuhn, 2004; Koerber, et al., 2015). This is supported by Osman's (2013) opinion that inquiry learning can train students to improve their ability to explore, so they can find their own knowledge. By not accustoming students to learning through inquiry, students' scientific thinking skills are low. The following are examples of student work that support evidence that students' scientific thinking skills are low.

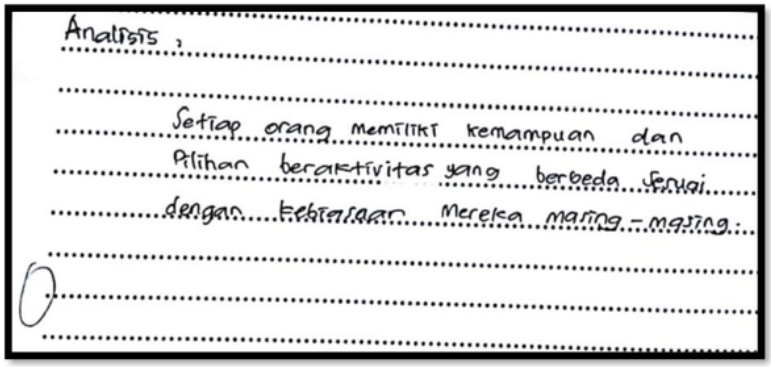


Figure 2: Example of Student Work on Scientific Purpose Aspect

The data in Figure 2 shows students are not careful in analyzing based on the images presented. It should be based on the presentation of observed images that can guide students to understand the purpose of the activity specified. This supports the fact that the student's scientific purpose is low.

Figure 3: Examples of Student Work on Aspects in Formulating Problems

The data in Figure 3 shows students are less careful in identifying problems based on image presentation. The problems raised by students have not used the question sentence, but in the form of narrative. This shows that students are less able to make scientific questions.

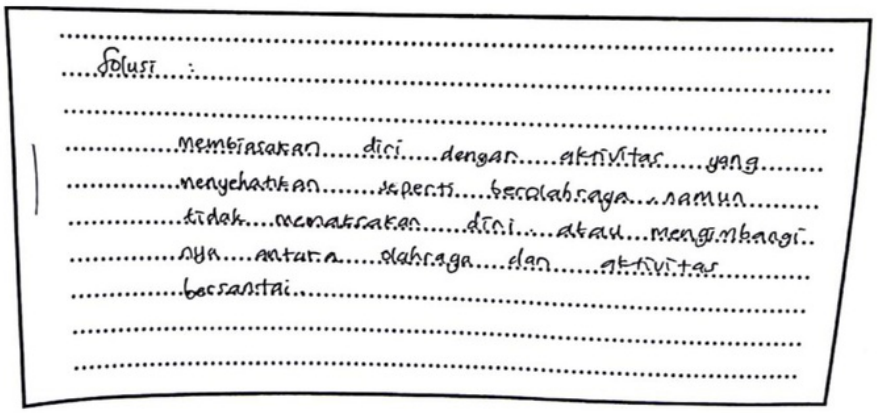
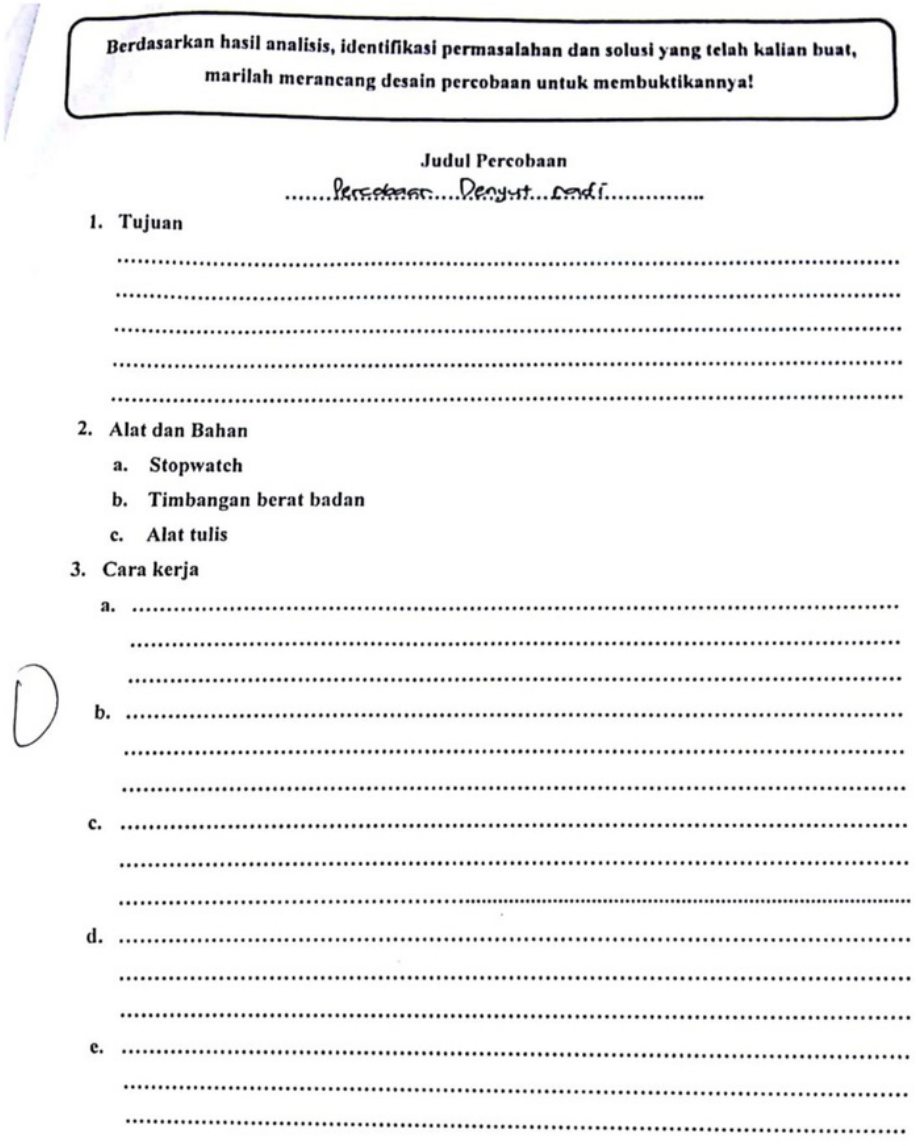


Figure 4: Examples of Student Work on Aspects of Developing Hypotheses

The data in Figure 4 shows the solutions proposed by students not answering the problems they have formulated previously. Ideally the hypothesis made must be relevant to the formulation of the problem proposed



Berdasarkan hasil analisis, identifikasi permasalahan dan solusi yang telah kalian buat, marilah merancang desain percobaan untuk membuktikannya!

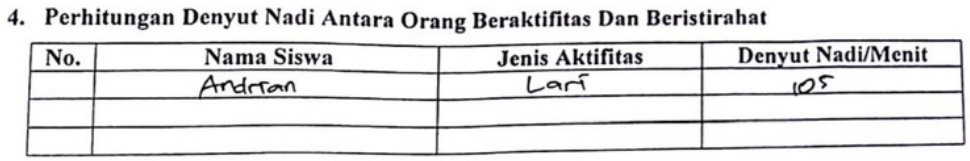
Judul Percobaan

.....Percobaan....Denyut...nadi.....

1. **Tujuan**
   .....
   .....
   .....
   .....
   .....
2. **Alat dan Bahan**
   a. **Stopwatch**
   b. **Timbangan berat badan**
   c. **Alat tulis**
3. **Cara kerja**
   a. .....
   .....
   .....
   b. .....
   .....
   .....
   c. .....
   .....
   .....
   d. .....
   .....
   .....
   e. .....
   .....
   .....

Figure 5: Example of Student Work in Designing Experiments

The data in Figure 5 shows that students have not been able to make experimental designs well even though they have been given clue. Student work on an empty worksheet. This seems to indicate that the scientific concept aspect of students is low.

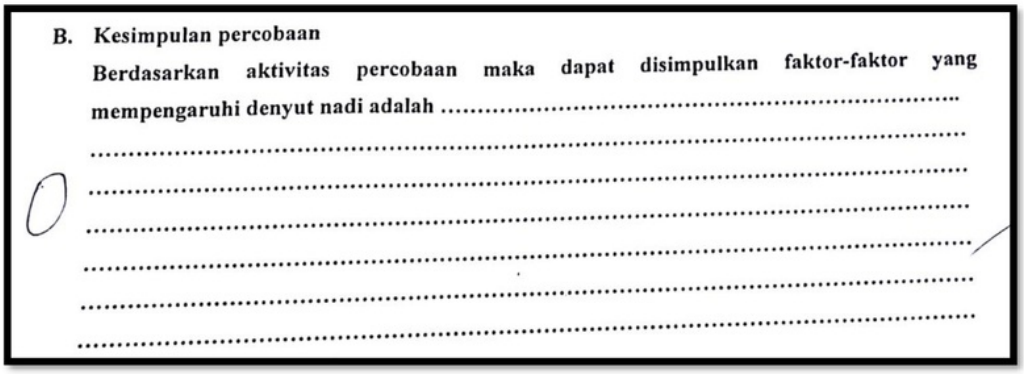


4. **Perhitungan Denyut Nadi Antara Orang Beraktifitas Dan Beristirahat**

No.	Nama Siswa	Jenis Aktifitas	Denyut Nadi/Menit
	Andrian	Lari	105

Figure 6: Example of Student Work in Data Organizing

The data in Figure 6 shows that students do not understand the command to compare the number of pulses between people who move and rest. As a result, data is difficult to be analyzed.



B. **Kesimpulan percobaan**

Berdasarkan aktivitas percobaan maka dapat disimpulkan faktor-faktor yang mempengaruhi denyut nadi adalah .....

.....

.....

.....

.....

.....

.....

Figure 7: Example of Student Work in Making Conclusions

The data in Figure 7 shows that students cannot conclude well. This can be seen from an empty worksheet

CONCLUSION

Based on the result of the study, it can be concluded that the profile for XI grade students' scientific thinking abilities on the implementation of scientific approach was at low category. It's suggested that learning model based scientific approach be conducted to further develop students' scientific thinking abilities.

SUGGESTION

Based on the conclusion its mean that students' scientific thinking abilities was low, so it is feared that in the future they will have difficulties in solving the problems that arise in daily life. Thus we need to develop and apply scientific-based learning design to enhance the ability of scientific thinking, especially for students of IX grade.

.

PROFILE OF XI GRADE STUDENTS' SCIENTIFIC THINKING ABILITIES ON SCIENTIFIC APPROACH IMPLEMENTATION

ORIGINALITY REPORT

7%	0%	3%	6%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Submitted to Universitas Muhammadiyah Surakarta Student Paper	4%
2	Submitted to Pascasarjana Universitas Negeri Malang Student Paper	1%
3	Wardono, B Waluya, Kartono, Mulyono, S Mariani. "Development of innovative problem based learning model with PMRI-scientific approach using ICT to increase mathematics literacy and independence-character of junior high school students", Journal of Physics: Conference Series, 2018 Publication	1%
4	M L Nasution, Y Yerizon, R Gusmiyanti. "Students' Mathematical Problem-Solving Abilities Through The Application of Learning Models Problem Based Learning", IOP Conference Series: Materials Science and Engineering, 2018	<1%

Publication

5	www.minnehahaacademy.net Internet Source	<1%
6	M T C Gerhana, Mardiyana, I Pramudya. "The experimentation of learning models viewed from interpersonal intelligence", Journal of Physics: Conference Series, 2017 Publication	<1%

Exclude quotes	On	Exclude matches	< 3 words
Exclude bibliography	On		