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THE IMPLEMENTATION OF SCIENTIFIC APPROACH IN SCIENCE EDUCATION: CHALLENGES AND OPPORTUNITIES

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Abstract

PISA has just released its 2012 report which unfortunately still put Indonesia among the countries with the lowest proficiency level in math and science. It was reported that, in science, a quarter of Indonesian students did not reach the bottom level of proficiency, and a further 42% were mired at level 1 (for those who can't do the maths, that means two out of three kids are unable to draw conclusions based on simple investigations). In other words, no Indonesian managed to score at level 5 in science. The educational system in Indonesia has long been criticized as one of the factors which contribute to the students' failure. As a response to this phenomenon, the ministry of education has released the curriculum 2013 to be implemented in all schools and in all level of education. One of the characteristics of the 2013 curriculum is the use of scientific approach in teaching all subject matters including in the teaching of science. The use of scientific approach is expected to be able to improve the quality of the teaching and learning activities at school as it provides more opportunities for the students to develop their thinking skills as well as their behavior. Therefore, this paper will discuss the challenges and opportunities of scientific approach in promoting students' higher level of proficiency, especially in the learning of science.

Key words: scientific approach, science education, science proficiency level, curriculum 2013

INTRODUCTION

The development of science and technology has long been recognized as one of the factors which induce the rapid development of a country in the world. Most countries in the world develop and use very sophisticated technologies in their everyday activities to solve many problems they face as well as to improve the quality of the people's life starting from recycling the garbage, curing the diseases until flying the rocket to the outer space. In other words, the use of technology has been applied to make the life better and help people do things more easily.

As one of the developing countries, Indonesia needs technology to make use all of the natural resources available in order to improve the quality of the people's life. Unfortunately, not all resources have been utilized for the needs of the people because we still depend on the technology developed by some other developed countries. In other words, we are still lack of human resources who can develop and improve the technology to make this country better.

Due to the lack of human resources, more emphasis has been put on education as the institution which is responsible for the development of human resources. It is very important that the school provide good education for their students in order to promote the development of students' quality thinking as the basic nature for the development of science and technology.

Despite of the fact that the school as the educational institution is responsible for preparing the high quality of human resources, over the last two decades the report of Program for International Students Assessment (PISA) still reveal that among the 65 countries participated in the test, Indonesia is among the countries with the lowest proficiency level in reading, science, and math. The latest report of PISA in 2012 showed that Indonesia is in the 2nd lowest position in science. It was reported



that a quarter of 15 year old Indonesian students did not reach the bottom level of proficiency, and a further 42% were mired at level 1 which means two out of three kids are unable to draw conclusions based on simple investigations and no Indonesian student managed to score at level 5 which is the highest level in science. In other words, the outcome of the teaching and learning process at schools are still unable to make the students reach the higher level of thinking skills. This also means that the development of high quality human resources for the development of science and technology is still far from what we expect.

As a response to this kind of situation, Indonesian government has been trying to improve the quality of teaching and learning at school by revising and improving the curriculum of 2004 and 2006 becoming the curriculum of 2013 which emphasis on the integration of some competencies, such as attitude, knowledge, and skill. This is to reach the objective of developing a balance and integrated education for the development of human resources with the hard and soft skills capacity. In order to reach the objective, a specific approach is also applied in the implementation of curriculum 2013 in the teaching and learning process. The approach called scientific approach is intended to support the development of students' thinking skills as well as their creativity. This approach consists of several teaching steps, such as observing, questioning, associating, experimenting, and networking. The implementation of these steps are expected to provide the students with more opportunities to develop their thinking skills and be more ready for the higher level of teaching and learning objectives in the future, especially in the teaching of science.

Regarding the importance of the implementation of scientific approach in the implementation of curriculum 2013, this paper will discuss further on the students' perception on the teaching of science, science literacy proficiency level, and how scientific approach can eventually help students to reach their potential in learning especially in science.

Students' Perception on the teaching of science

The teaching of science has been perceived as a difficult and boring subject at school. A research on the young peoples' perception toward science education conducted by Trust Welcome in 2010 revealed that the majority of the 240 pupils in 20 schools in UK perceived science as being content heavy with more work involved than for other subjects. Equally, the assessment strategy used in science was felt to be particularly examination focused and set at a very high standard. In addition, the current research also confirms that pupils, whilst agreeing that science education is important, have difficulties in making direct links and associations between what they learn at school, and how they apply this in everyday situations. Similar cases happen in Indonesia. A research conducted in Pekan Baru showed that 25% of the sample does not like science (Zulirfan et al., 2014). Although this is not the whole majority of the Indonesian students, this number of students might be the representative of a greater number of students who might have similar problems in learning science. It implies that students tend to perceive science as a difficult subject and perceive test as the main goal of the teaching and learning of science at school. In addition, the teaching of science also gives them less motivation as it has no relevant with their everyday needs. In other words, students' tend to give negative perception toward the teaching of science.

Despite of the students' negative perception toward the teaching of science, the result of the Wellcome Trust research (2010) also revealed some of the key elements underpinning pupils' engagement with science, such as individuals' levels of personal interest in learning science, and perceptions of teachers' engagement, commitment and enthusiasm. Furthermore, hands-on practical



activities, when seen to be relevant to and integrated into the theoretical element of lessons, were a particularly appealing element. Among these elements, giving students hands-on experience is one of the key elements which can make the students more engaged in the learning of science as this kind of teaching will make the learning of science more interesting and easier to understand (welcome Trust, 2010). In addition, young people would also be more engaged with science if it were more applicable and relevant to contemporary life. In other words, the teaching of science should provide more opportunities for the students to get involved in hands-on experience as well as relevant activities with their everyday needs.

Students' Science Literacy Level

Hazen (2002) cited in Searce (2007) defines scientific literacy as a mix of concepts, history, and philosophy that help you understand the scientific issues of our times." In addition, AAAS (1993) and National Commissions on Mathematics and Science Teaching for the 21st Century (200) cited in Bruning et al. (2004) defines science literacy as not only knowing the big ideas and major principles of science, but also being able to use science-related knowledge in our everyday lives, being able to analyze scientific issues by asking questions and proposing explanations based on evidence, and having a sufficient understanding of science to be informed citizens. The issues on the importance of having high level of science literacy skill is getting more significant in the last two decades as the ability to improve the quality of peoples' life through the use and the development of science and technology might be influenced by the level of scientific proficiency the peoples' have (Searce, 2007). Therefore, the major goal of science education today is for all students to achieve scientific literacy, which encompasses much more than big ideas curriculum (Linn et al., 1996 in Bruning et al., 2004).

The Proficiency Standard for Science Literacy was established after 2003 sample testing to provide parents, educators and the community with a clear picture of the proficiency in science literacy that students are expected to demonstrate by the end of Year 6 (Acara, 2011). To identify the proficiency standard, an expert group of university science educators, curriculum officers and experienced primary teachers in all states and territories, from government, Catholic and independent schools were brought together. The members of this expert group used their classroom experience and knowledge of the science curricula in the various states and territories to examine the test items from the NAP Sample Assessment. This standard informed the development of the tests for the 2006 and 2009 sample assessments.

Five levels of proficiency (levels 2, 3.1, 3.2, 3.3, 4) have been defined for NAP (National Assessment Program)—Science Literacy, and are described in the table below (Acara, 2011). The Proficient Standard in Science Literacy has been determined to be at level 3.2. This means that students achieving at level 3.2 are considered to have a sound understanding of Year 6 science. The followings are the description of the science proficiency level:

Table 1. Science Proficiency Level

Proficiency Level	Level descriptors
Level 2 or below	Describes a choice for a situation based on first-hand concrete experience, requiring the application of limited knowledge.
	Identifies simple patterns in the data and/or interprets a data set containing some



interrelated elements.

Makes measurements or comparisons involving information or stimulus in a familiar context.

Level 3.1 Selects appropriate reason to explain reported observation related to personal experience.

Interprets simple data set requiring an element of comparison.

Makes simple standard measurements and records data as descriptions.

Level 3.2 Interprets information in a contextualized report by application of relevant science knowledge.

Interprets data and identifies patterns in – and/or relationships between – elements of the data.

Collates and compares data set of collected information.

Gives reason for controlling a single variable.

Level 3.3 Applies knowledge of relationship to explain a reported phenomenon.

Extrapolates from an observed pattern to describe an expected outcome or event.

Demonstrates an awareness of the principles of conducting an experiment and controlling variables.

Level 4 and above Explains interactions that have been observed in terms of an abstract science concept.

Conclusions summarize and explain the patterns in the data in the form of a rule and are consistent with the data.

When provided with an experimental design involving multiple variables, can identify the questions being investigated.

(Source: Australian Curriculum Assessment and Reporting Authority, 2011)

Table 1 above reflects the proficiency level that the students must achieve in science by the end of year 6 (Acara, 2011). Each level requires the students to achieve certain level of thinking skill which is varied from the lowest to the highest level. Based on the table, the lowest level of proficiency in science is level 2 or below. At this level, the students are expected to be able to apply basic thinking skills in a very simple way. Based on PISA in Pisani (2012), this is the proficiency level where most Indonesian students are now at. In other words, most of 15 year old Indonesian students are still unable to perform or involve in higher level of thinking skills as it is required in the science proficiency level. Therefore, this should be one of the concerns of the educational institution in Indonesia to find more appropriate way in putting more emphasis on the development of students' thinking skills.



The Application of Scientific Approach in Science Education

According to Jones (2014) "the scientific method is a set of techniques used by the scientific community to investigate natural phenomena by providing an objective framework in which to make scientific inquiry and analyze the data to reach a conclusion about that inquiry." Delp (2014) states that "Teaching the scientific method is essential to teaching science as this method gives students the foundation for which all scientific inquiry is based." Based on curriculum 2013, the concepts of scientific approach are related with the followings: (1) the teaching materials used are based on the fact or phenomena which is accepted logically, (2) Teachers' explanation, students' response, and the interactions between the teacher and students should be objective and free from prejudice, (3) students are encouraged to think critically, analytically, and accurately in identifying, understanding, solving the problems, and applying the teaching materials, (4) students are encouraged to think hypothetically in looking at differences, similarity, and able to see the connection among them, (5) students are encouraged to understand, apply, and develop the rational and objective thinking framework in responding the teaching materials, (6) (It) should be based on concept, theory, and empirical fact, and (7) the teaching objectives are formulated in a simple way but it should be presented interestingly.

Based on those definitions and concepts of scientific approach, it is obvious to see that the approach focuses on the development of the students' thinking skills as they are involved in questioning any fact or phenomena and find or provide the data in order to be able to answer or give explanation to the questions. In other words, the students will need to find and verify any information that they need through some research or experiments because they need to have some data to support their conclusion. This will require the students to follow the scientific procedures which most scientists used, such as observing, questioning, associating, experimenting, and networking (Curriculum, 2013). According to Wieman (2014) this kind of teaching will lead to effective teaching of science as the students are involved in an expert-like way of thinking and make the students more engaged in the process of learning. This is in line with Bruning et al., (2004, p. 349) who state that "to develop competence in science, students must be taught to think like more like experts than novices." Wieman (2014) also emphasize further that "*People learn by creating their own understanding.*" Therefore, effective teaching facilitates that creation by getting students engaged in thinking deeply about the subject at an appropriate level and then monitoring that thinking and guiding it to be more expert-like.

As the main goal of the teaching of science nowadays is to develop the students' science literacy competence (Bruning, 2004, p. 349), the application of scientific approach in the teaching of science will definitely fit with that purpose. As it is shown in the table of science proficiency level above, each level requires the learners to develop certain level of thinking skills which is varied from the lowest until the highest level of proficiency. Scientific approach will provide opportunities for the students to get involve in higher order thinking skill development as they involve in the process of observing, questioning, experimenting, associating, and networking (Curriculum, 2013).

In observing, the students are involved in the process of building the connection between the object that they are going to learn with the theory or the information they have got before. In this way, the students will get involved in a meaningful learning as they have a comprehensible input both from the theory and the reality of the object being learnt. In questioning, the students are encouraged to ask questions related to the topic being discussed whether to verify the information from the topic being discussed or to add and develop a broader understanding toward the topic being discussed. This stage



is expected to develop the students' critical thinking skills as they are encouraged to ask questions. In experimenting, the students are involved in doing the experiment related to the topic being discussed in order to get involved in a deeper learning process. Doing an experiment provide opportunities for the students to also see the connection between the theory being learnt and the reality of the topic being discussed. In associating, the students gather all the information they get from the experiment and make their own conclusion on the issue being discussed. This stage lead the students to develop their own understanding toward the topic being discussed and will also lead the students to deep learning process. The last step which is called networking will encourage the students to be able to communicate or share their understanding toward the topic being discussed. This is also a very important step as the students are given an opportunity to develop their self-confidence as they are reporting their findings to other students. In conclusion, the implementation of scientific learning as it is required in curriculum 2013 will provide opportunities for the students to develop their thinking skills which hopefully will also help the students to reach a higher level of science proficiency level.

Despite of the opportunities which scientific approach could offer in developing the students' thinking skill especially in learning science, the challenges remain obvious since the implementation of this approach requires high commitment both from the teacher and from the school. Teachers need to be more creative as well as critical both in preparing the lesson as well as in presenting the lesson. As the nature of scientific approach is expert-like way of teaching, teachers need to be sure that the activities they design will help the students to get through the stages of scientific teaching successfully. The role of the schools will be more significant as they are required to provide teaching media and anything needed in the teaching and learning process as most of the activities will be based on observation-and experiment-based teaching and learning. The role of the teachers as well as the school will significantly influence the students' quality of learning as they will be more engaged in a learning process if the teachers show great enthusiasm in teaching (Welcome Trust, 2011). Finally, the implementation of scientific approach in the teaching of science is expected to provide opportunities for the development of the students' higher level of thinking skill. However, the success of this approach still depends on how serious the teachers and the school in accommodating all the things needed for the success of the scientific approach implementation.

CONCLUSION

The implementation of scientific approach as it is required by curriculum 2013 is expected to be able to promote the students' higher proficiency level of science literacy. This is because the implementation of scientific approach will involve the students in an expert-like way of teaching as they are involved in doing an observation, questioning, experimenting, associating, and networking. This kind of teaching and learning process will lead the students to a deeper learning process as the students are more engaged. Therefore, it is expected that the students will have a better understanding toward the topic being discussed. However, the teachers and the schools need to improve their support as to ensure the success of the students' learning process under the implementation of scientific approach.



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