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Adapting Next Generation Science Standard to Improve Using Mathematics Computational Thinking in Science Learning

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Abstract. This study aims to determine the feasibility science learning tools oriented Next Generation Science Standard (NGSS). The science learning tools which develop in this study are lesson plan, science worksheet, and assessment using mathematics-computational thinking. This study using Research and Development 4-D models. The result of this study includes the validation of science learning media oriented NGSS based on expert lecture and science teacher. The average of lesson plan validation reach 3.39 with excellent category meanwhile the validation of science worksheet is 3.37 with excellent category. The validation result shows this science learning tools oriented NGSS are feasible using in science class.

Keywords: science learning tools oriented next generation science standard, feasibility

INTRUDUCTION

Education is a measure of a nation's progress, with education, the Indonesian people are expected to have qualified human resources intellectually, spiritually, and self-contained so that ultimately expected our society able to compete with other countries where globalization is now increasingly felt presence. In the National Education System Law number 20 of 2003, it is mentioned that education is a conscious and planned effort to create an atmosphere of learning and learning process so that learners actively develop their potential to have spiritual power of religion, self-control, personality, intelligence, noble, as well as the skills required of himself, society, nation and State.

One of the developments that must be considered is the development of science education in the world. Science education is one indicator of the level of progress of a State that studies about natural phenomena with a scientific method. At TIMMS in 2007 obtained the result that the interest of Japanese students on the saintek and math is very low compared to the international score. Only 39% of junior high school students interested in math, and 58% of students interested in science. While the world average, 67% interest in mathematics, and 78% interest in science (Hasegawa, 2010).

Ogura (2008) mentions that at TIMMS 2003, Japanese students' interest in science is even lower, with only 20% of Japanese students wanting to work in science. In addition, the periodic survey conducted by MEXT show that the interest of students to study math and science tend to decline with increasing age and their grade level. This fact forced the Japanese government to overhaul the curriculum of mathematics and science education at the primary and secondary levels. At the level of basic education, experimentation and observation activities were

increased and equip schools with access to laboratory facilities and research data more widely through the support of JST. At the junior level, implemented science learning through the medium of science expert, and training teachers of SMP in order to carry out the learning of science more encouraging interest and enthusiasm the students.

The problems faced by Indonesia related to the young generation's interest in saintek and mathematics are similar to those in Japan as well as some other countries. Saintek and mathematics learning in school has not been able to raise their interest in science, and this is evident by the lack of scientific literacy and math students Indonesia in the PISA and TIMMS. The result is of course concern. These reasons can be used as input how should the Human Resources (HR) Indonesia developed through education, especially in science lessons.

Communities must be able to act more quickly and appropriately, able to solve problems effectively, and be able to adapt to the changes that occur in order to face this era of globalization. In 2013 an association of the National Research Council, National Science Teachers Association, in the United States sparked a change in science education standards framework called Next Generation Science Standards (NGSS) (Rousseau & Khomenko, 2014). The association conducts research for 3 years in 26 countries in the United States on the basis of this standard is a document from the National Research Council (NRC) entitled A Framework for K-12 Education.

NGSS is the result of a development in the field of education that is influenced by the flow of globalization and the development of science and technology. This is a challenge for a teacher to prepare students who will become the next generation. Create learning to produce learners who achieve NGSS framework is a challenge for a teacher (Pellien and Rothenburger, 2014). Teachers should be able to lead their students to face a global future demands they will face for a better life.

International education standards are required to prepare qualified human resources, the Next Generation Science Standard (NGSS) formulated by the National Science Teacher Association (NSTA) and published by the United States government. The Next Generation Science Standard (NGSS) is an international standard of integration that integrates the three dimensions that characterize the NGSS of Science and Engineering Practices (SEPs), Crosscutting Concepts (CCs), and Disciplinary Core Ideas (DCIs). NGSS stressed the importance of providing opportunities all learners to build and improve their knowledge and skills through their involvement in SEPS. Then the students are expected to gain an understanding of the material in-depth learning associated DCIS which became the basis for SEPS, and ultimately NGSS can improve the ability of learners in SEPS by involving the three dimensions that exist in NGSS.

NGSS is a standard, not a curriculum. NGSS is a standard, a goal, which reflects what a student should know and is capable of doing so. There are many approaches in science learning that can be in line with the vision of the NGSS. One of them, the NGSS explained that the most effective way of conveying learning is through investigation, collecting and analyzing data, logging, and communicating information (Bybee, 2013). One approach to learning that facilitates this activity is the approach of scientific approach that is in the curriculum of 2013 which is a 5M process in learning that includes observing, asking, exploring, reasoning and communicating.

Education in Indonesia is currently using curriculum 2013, which has the same purpose as NGSS on science learning is to maximize learners to practice skills, so that learning on the learner-centered classroom. However, in the 2013 curriculum the skills to be cultivated are too complex, so that teachers have difficulty in learning in the classroom and difficulty in measuring students' abilities. While at NGSS, each skill has been divided into eight items so that the teacher is easier to measure the ability of the student's skills.

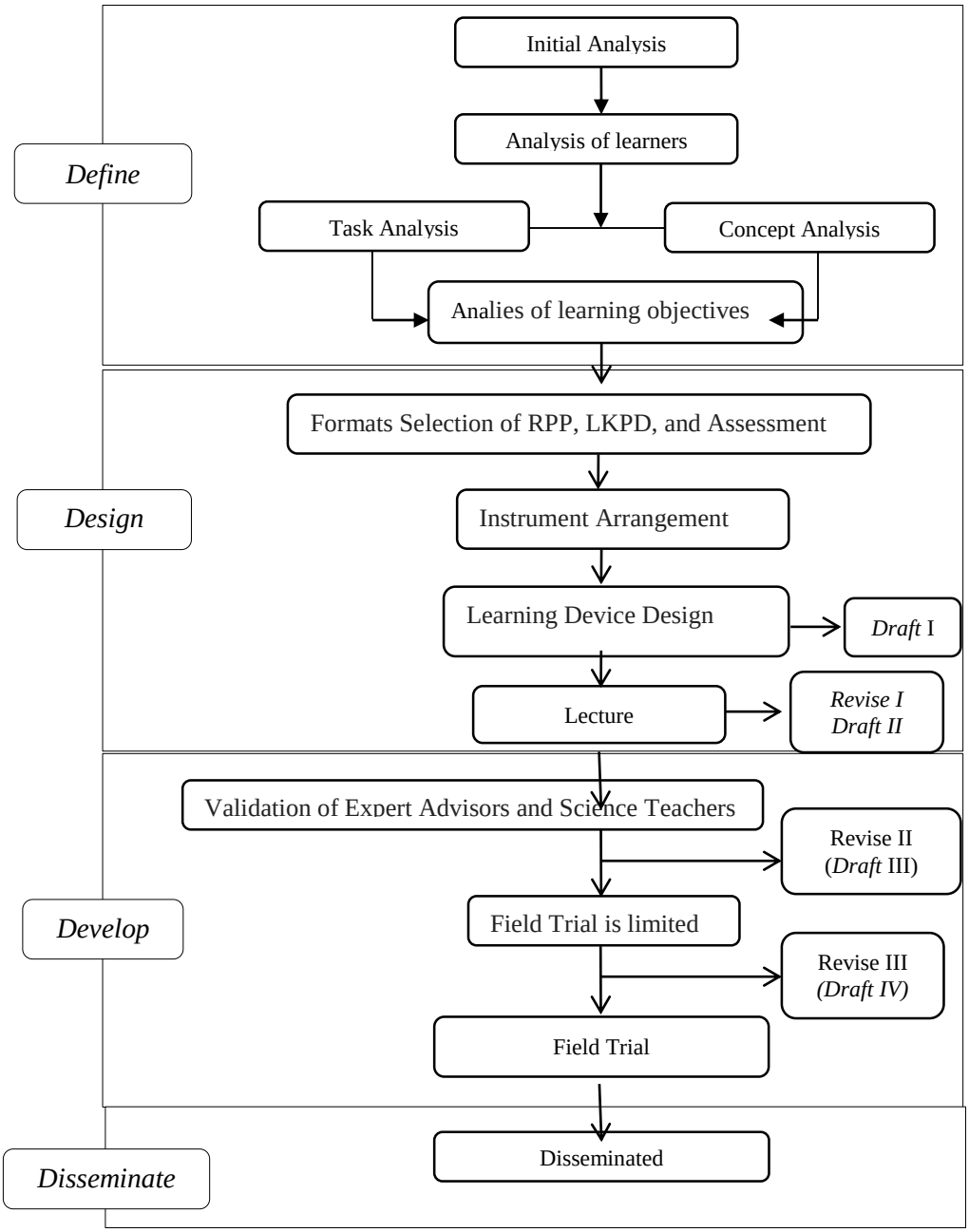
Implementation NGSS in learning to achieve the goals set NGSS requires a systematic process that requires considerable time. In addition the students still find it difficult to do SEPS in Using Mathematics and Computational Thinking. Difficulties of students in doing this SEPs become one of the teachers challenge to overcome them. Therefore, the NGSS-oriented learning, learners requires a development of learning that require classroom atmosphere that supports the vision NGSS in science learning. So teachers should be able to align learning approaches, learning tools, and learners' activities with the vision of NGSS (NGSS Lead States: 2015).

Efforts to educate learners in accordance with NGSS to improve the skills of using mathematics-computational thinking and understanding crosscutting concepts then required a learning tool. Learning tool that will be developed in this research take from one of science material that exist in SMP class VIII that is Vibration and Waves. The capture of this material is tailored to the SEPs expected to appear in the lesson. In NGSS, this material is contained in DCIs MS-PS4 ie Waves and Their Applications in Technology for Information Transfer. In NGSS the concept of integration is contained in crosscutting concepts. Crosscutting concept is the basis of something that bridges the antari of matter with skill. One of the crosscutting concept that suits the skills of Mathematics and Computational Thingking (SEPs) and DCIs MS-PS4 is vibration and wave that is scale,

proportion and quantity. Thus, in this research we will develop NGSS-oriented learning tools to improve students' skills in Using Mathematics and Computational Thinking (SEPs).

RESEARCH METHOD

This research is a research development (Research and Development 4-D). Research location in junior high school 1 Imogiri. Data collection techniques used in this study in the form of questionnaires validation of feasibility of learning science developed oriented NGSS. The data analysis included feasibility study of learning tools by two expert lecturers, two science teachers, and nine students in a limited field test to find out the learners' response to the developed learning tool. Questionaire validation of lesson plan and students worksheet using scale conversion 4 (Mardapi, 2008: 122). Assessment analysis uses scale conversion by category (Purwanto, 2012: 102). Learning tools in the form of lesson plan and students worksheet are feasible to be used in science learning in schools if the average validation score of devices is developed > 2.5. The assessment tool using mathematics-computational thingking is said to be appropriate if the validation score is in good category with the percentage of 76-85%.



RESULT AND DISCUSSION

Science learning tools developed is feasible to use in the classroom is determined by the judgment of the validator. Validator will assess device developed by two lecturers are experts, two science teachers and nine students. Expert lecturers who become validators are materials experts and media experts who can assess the feasibility of learning tools developed in science. Science teacher also asked to assess whether learning science developed a device fit for use in the classroom. Learners were also asked to rate how students worksheet oriented NGSS developed. The tool is assessed using a validation assessment questionnaire that researchers have prepared. The results of the assessment validation lesson plan by expert lecturers and science teachers are presented in Table 1.

Table 1. Recapitulation of Lesson Plan Validation Assessment Result

Data Rate	Average	Criteria
Stage 1	2.5	Good
Stage 2	3.39	Excellent

Assessment of lesson plan oriented NGSS developed in two stages. The average assessment of lesson plan by expert lecturer and science teachers in the first stage gets a score of 2.5 with good criteria. This score is not enough to categorize that the developed lesson plan is feasible to use (> 2.5). This is why the need to be revised so that the lesson plan developed can be re-assessed by the validator through the second stage of assessment. Revisions were made in the lesson plan includes sections: 1) the characteristics of the lesson plan oriented NGSS should be clear, 2) instructional materials are selected adapted to the skills used, 3) writing in the table should be typed left flat, 4) cognitive assessment, remedial programs, and enrichment is not listed in the lesson plan, 5) the learning steps should be adjusted to the NGSS characteristics and the assessment aspects to be measured using mathematics-computational thinking.

Lesson plan that has been revised and then given back to the validator for re-assessment. The second stage validation result obtained score 3.39 which is in excellent category. The results of the lesson plan assessment at this stage have shown that the lesson plan oriented NGSS developed is appropriate for use in science learning. Lesson plan products can be considered feasible because it has been in accordance with the purpose of the development of this tool is to improve the skills of using mathematics-computational thinking.

The learning tools developed in the form of student worksheet oriented NGSS are expected to improve the skills of using mathematics-computational thinking. Student worksheet also experienced two stages of revision by expert lecturers and science teachers. The student worksheet validation assessment is presented in Table 2.

Table 2. Recapitulation of Students Worksheet Validation Assessment Result

Data Rate	Average	Criteria
Stage 1	2.62	Good
Stage 2	3.37	Excellent

Based on the above table, the validation score of stage 1 of the developed student worksheet obtained 2.62 results that are in good category. This means that the developed student worksheet is not yet feasible to use. This is what underlies the need to revise student worksheet in order to meet the expected score. Some revisions student worksheet conducted: 1) student worksheet adapted to the characteristics of NGSS, 2) material is highlighted on crosscutting concept that can explain the scale, proportion and quantity, and 3) the flow of activities should be tailored to the skills expected in NGSS, 4) design of student worksheet is made even more interesting.

The revised student worksheet is then given back to the validator to review whether the developed student worksheet oriented NGSS has been feasible for measuring using mathematics-computational thinking of the learner. The result of the assessment by the validator shows the validation score of 3.37 which is in excellent category. These results indicate that the developed student worksheet has been feasible to be used to improve the skills of using mathematics-computational thinking.

CONCLUTION

Based on the results of research and discussion can be concluded science learning tools oriented NGSS developed learning categorized appropriate for use in science learning according to expert lecturers and science teachers. Suggestion in this research is in science learning tools oriented NGSS more emphasize of NGSS characteristic.

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