

# Development of Science Learning Tools Oriented to Next Generation Science Standard

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**Abstract**—Next Generation Science Standard (NGSS) is a science standard used in the United States. This standard is important because it's especially for science learning tools oriented to NGSS develop 21st century skill and has like Curriculum 2013. This standard is adapted in science learning because it is expected to easily measure students' processing skills in a specific theme. Science learning by a process must be measured by students' specific skills and comprehension feasibility of NGSS-oriented science learning tools. The tools are lesson plans, science worksheets, and assessments. This is Research and Development (RnD). The data was obtained by validation of learning tool by expert dan use the conversion of score to analyze the data. The result of this study show that average of lesson plan validation reaches 3.5 with very good category, the validation of science worksheet is 3.4 with good category and the validation of assessment is 3.7 with very good category. The validation result show that NGSS-oriented science learning tools is feasible using in science class.

**Keywords**—*science learning tool, next generation science standard*

## I. INTRODUCTION

The development of science and globalization have a significant influence on education. A high-quality education science means that learners will develop an in-depth understanding of the content and develop the communication, collaboration, inquiry, problem-solving, and flexibility skills that will serve them throughout their educational and professional life. To achieve it each country makes its own standards according to the conditions that exist in the country. One of the new and eminent standards is the Next Generation Science Standard (NGSS). NGSS is a science-learning standard applied in the United States. This standard is formed because the background of the desire of the United States to take the lead in science. Attempts to be at the forefront of this science are based on the 2007 TIMSS and PISA 2006 surveys, where data on student literacy skills in the United States are relatively low. Therefore, the United States seeks to create new standards in the field of science so that the quality of education in the country to be a leader again. This standard is based on research on countries with high scores based on the 2007 TIMSS and PISA 2006

ranking. These standards are known as NGSS. The objective of developing this standard is to establish a set of science-based research standards. This standard provides the flexibility to design a classroom learning experience that stimulates students' interest in science and prepares them for local lectures, careers, and citizenship of educators.

The main feature of NGSS is the integration of science from several frameworks, namely science and engineering practices, disciplinary core ideas, and crosscutting concepts. Science and engineering practices describe the activities that scientists are doing to investigate nature and what engineers do to design and build systems. This activity is a skill and knowledge that will be developed. In practice, this activity is more emphasized on the activity of inquiry (inquiry) where not only skill is needed but also need to combine with knowledge. The strengthening of this aspect will clarify students about the relevance of science, technology, engineering and mathematics (four areas of the STEM) to everyday life.

Disciplinary core ideas are materials that combine several disciplines into a holistic and profound product. This material deals with the interests and life experiences of students or links to social or personal issues requiring scientific or technological knowledge. This needs to be studied for the purpose of the depth and sophistication of students in the mastery of the material.

Crosscutting concept is a concept that links science and engineering practices and the discipline of core ideas. Crosscutting concepts help students explore relationships across the four domains of science, including Physical Sciences, Biology, Earth and Space Science, and Engineering Design. Crosscutting concepts made explicit and specific can help students develop their world-based, coherent and scientific outlook.

In the education system in Indonesia apply Curriculum 2013 (K-13). This curriculum is a curriculum applied by the government to replace the 2006 Curriculum (Education Unit Level Curriculum). Curriculum 2013 emphasizes learning to be directed to student-centered learning that can be achieved using a scientific approach that is packaged into 5M that is observing, asking, experimenting, associating, and

communicating. So to teaching Curriculum 2013 needs to be packaged in an interesting, clear, and not biased. However, in teaching science, teachers are still not holistic, integrative, and profound. This is because most science teachers do not come from the field of science but come from other disciplines such as physics and biology.

If studied more deeply, NGSS and Curriculum 2013 have some similarities, which both emphasize learning towards student-centered learning. Using this approach, students are expected to explore their own knowledge, discuss, and transfer knowledge better. Second, both NGSS and Curriculum 2013 include cognitive, affective, and psychomotor domains. The three domains in the NGSS are contained in 3 frameworks of science and engineering practices, disciplinary core ideas, and crosscutting concepts, while in the Curriculum 2013 is poured into the Core Competencies and Basic Competencies. Thirdly, there are characteristics of inquiry-based learning both in NGSS and in the Curriculum 2013.

Scientific inquiry produces data to be analyzed for meaning. Once analyzed then there is the interpretation of data. Ability to analyze and interact prettifying the data presented in tables, graphs and diagrams is a common requirement in many management and professional jobs. In science lessons that emphasize inquiry activities, there must be data on the investigation that needs to be analyzed and interpreted. However, based on the results of observations obtained data that the ability of students in analyzing and interpreting data is still low. This is certainly a problem that needs to be solved because through analysis and interpretation can determine what conclusions will be taken. If there is an error in analyzing and interpreting, it will certainly have an error in the conclusion.

Core ideas that are appropriate for improving the skills of analysis and interpretation of data are the properties of matter (matter and it's interactions). In the material students are trained to analyze and interpret data on the properties of substances before and after the interacting substances, both physical and chemical interactions. Crosscutting concepts that connect core ideas (the material and their interactions) with practices (analyzing-interpreting data) are patterns. In the discussion of matter and interaction cannot be separated from the concept of patterns about the properties of matter microscopically (atomic structure). So that the concept of patterns (patterns) can also be developed at once through the material.

Teaching science that integrates the 3 frameworks in NGSS of course supported by science learning devices that refer to NGSS standards. Therefore, this study is focused on developing NGSS-oriented learning tools to improve the skills of analyzing-interpreting data and pattern.

The rest of this paper is organized as follow: Section II describes the proposed research method. Section III describes the proposed result. Section IV describes the discussion. Finally, Section V concludes this work.

**II. PROPOSED METHOD**

This research is a type of research development or commonly called Research and Development (RnD). Research and development are a research method used to

develop or test the effectiveness of products used in education and learning in order to be accountable [1].

As for which will be developed in this research is instructional device oriented directed. The development model used in this research is the 4-D (four-D) development model [2]. This model consists of 4 stages of development, namely determining, designing, developing, and disseminating. Four stages of the 4-D model according to Thiagrajan, *et al.* in [2] for general use can be illustrated in Figure 1.

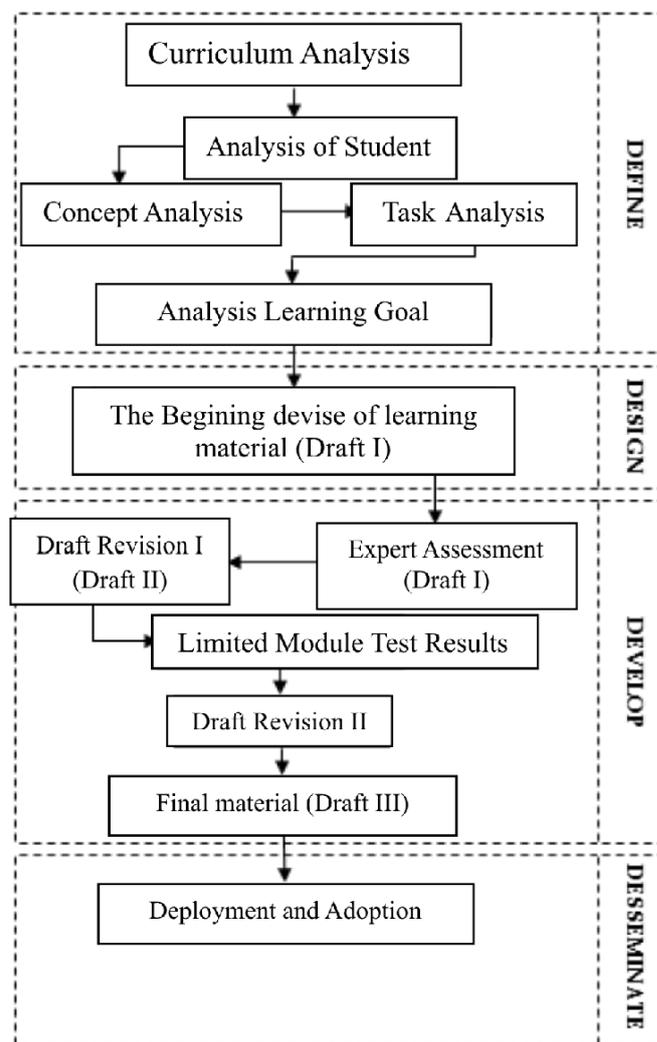


Fig. 1. 4-D model

Research location in SMP N 1 Piyungan. data collection techniques used in this study in the form of questionnaires validation feasibility science learning media oriented on next generation science standard developed. The data analysis included the feasibility analysis of learning tools by two expert lecturers, one science teacher, and fifteen students in a limited field trial to determine the response of learners to the developed student worksheet. Expert validation is carried out to obtain an assessment of the experts on the learning device product developed. Validation aims to get suggestions and inputs of learning

device products developed. Products that have been assessed valid can be used in a limited trial.

Methods of data analysis using score conversion. The analysis of product validation result of NGSS oriented learning apparatus is done by searching for an average assessment between two or more assessors. The average acquisition obtained is then converted to a value with the five-point reference category questionnaire validation of lesson plan and student worksheet using 5 scale conversions as shown in Table I [3].

TABLE I. 5 SCALE CONVERSIONS

| No | Score  | Value | Category       |
|----|--|-------|----------------|
| 1  | $X > X_i + 1.80 \text{ SDI}$                             | A     | Very Good      |
| 2  | $X_i + 0.60 \text{ SDI} < X \leq X_i + 1.80 \text{ SDI}$ | B     | Good           |
| 3  | $X_i - 0.60 \text{ SDI} < X \leq X_i + 0.60 \text{ SDI}$ | C     | Fairy Good     |
| 4  | $X_i - 1.80 \text{ SDI} < X \leq X_i + 0.60 \text{ SDI}$ | D     | Deficient      |
| 5  | $X \leq X_i - 1.80 \text{ SDI}$                          | E     | Very Devicient |

Assessment analysis uses scale conversion by category [4]. Learning tools in the form of lesson plan and student worksheet are feasible to be used in science learning in schools if the average validation score of devices developed  $>2.8$ . Skill-analyzing-interpreting data and crosscutting concept skills are considered feasible to use if the validation score is in good category with percentage 76-85%.

### III. RESULTS

The results of the lesson plan validation assessment by expert lecturers and science teachers are presented in Table II.

TABLE II. RECAPITULATION OF LESSON PLAN VALIDATION RESULTS

| Value                | Average | Criteria    |
|----------------------|---------|-------------|
| 1 <sup>st</sup> Step | 2.7     | Fairly Good |
| 2 <sup>nd</sup> Step | 3.5     | Very Good   |

The results of the student worksheet validation assessment by expert lecturers and science teachers are presented in Table III.

TABLE III. RECAPITULATION OF STUDENT WORKSHEET VALIDATION RESULTS

| Value                | Average | Criteria    |
|----------------------|---------|-------------|
| 1 <sup>st</sup> Step | 2.5     | Fairly Good |
| 2 <sup>nd</sup> Step | 3.4     | Good        |

The results of the analyzing-interpreting skills observation data sheet validation assessment by expert lecturers and science teachers are presented in Table IV as follow.

TABLE IV. RECAPITULATION DATA VALIDATION OF ANALYZING-INTERPRETING SKILLS OBSERVATION DATA SHEET

| Value                | Average | Criteria  |
|----------------------|---------|-----------|
| 1 <sup>st</sup> Step | 83.4%   | Good      |
| 2 <sup>nd</sup> Step | 94.6%   | Very Good |

The results of the analyzing-interpreting skills and crosscutting concept ability test validation assessment by expert lecturers and science teachers are presented in Table V.

TABLE V. RECAPITULATION DATA VALIDATION OF ANALYZING-INTERPRETING SKILLS AND CROSSCUTTING CONCEPT ABILITY TEST

| Value                | Average | Criteria  |
|----------------------|---------|-----------|
| 1 <sup>st</sup> Step | 80.6%   | Good      |
| 2 <sup>nd</sup> Step | 87.3%   | Very Good |

### IV. DISCUSSION

The science-developed learning apparatus developed by the Next Generation Science Standard is said to be worthy of use in classroom learning determined by the assessment of the validator. Validators that will assess the developed device are two expert lecturers, one science teacher, and fifteen students. Expert lecturers who become validators are materials experts and media experts who can assess the feasibility of science learning tools developed. Science teachers were also asked to assess whether developed science learning tools are appropriate for use in classroom learning. Learners are also asked to assess how student worksheet developed the Next Generation Science Standard. The tool is assessed using a validation assessment questionnaire that researchers have prepared.

The results of the lesson plan validation assessment by expert lecturers and science teachers are presented in Table I.

Validation of lesson plan oriented on Next Generation Science Standard developed through two stages. The average assessment of lesson plan by expert lecturers and science teachers in the first stage get a score of 2.7 with good criteria. This score is not enough to categorize that the developed lesson plan is worth using ( $> 2.8$ ). Therefore, revision is needed so that the developed lesson plan can be re-assessed by the validator through a second stage assessment. Revisions made by lesson plan include the following sections: (1) learning objectives should be in accordance with ABCD guidelines (audience, behavior, condition, and degree), (2) learning materials made more complete, (3) cognitive assessment, remedial program, and enrichment not listed in the lesson plan, (4) the learning steps should reflect the referred standard (Next Generation Science Standard) and the aspect of the assessment to be measured (analyzing-interpreting data and crosscutting concept).

The revised lesson plan is then given back to the validator and science teacher for reassessment. The second stage validation results obtained a score of 3.5 which is the very good category. The results of the lesson plan assessment at this stage have shown that the lesson plan oriented on Next Generation Science Standard developed feasible to 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 skills of analyzing-interpreting data and the ability of crosscutting concept learners.

Learning tools developed in the form of student worksheet oriented on Next Generation Science Standard is expected to improve the skills of analyzing-interpreting data and ability to crosscutting the concept of learners. student worksheet also undergoes two stages of revision by expert lecturers and science teachers. The student worksheet validation assessment is presented in Table II.

Based on the above Table II, the validation score of stage 1 of the developed student worksheet obtained 2.5 results that are in the category quite well. 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 of student worksheet's revisions are: (1) addition of drawings that support student worksheet more interesting, (2) sentences used in student worksheet adjusted to the cognitive level of learners, (3) references presented in student worksheet should be included (4) background image on cover tailored to the material.

The revised student worksheet is then given back to the validator to review whether student worksheet developed the Next Generation Science Standard developed properly for measuring the data analyzing-interpreting skills and crosscutting concepts of learners. The result of an assessment by the validator shows the validation score of 3.4 which is in either category. These results indicate that the student worksheet developed has been feasible to be used to improve the skills of analyzing-interpreting data and the ability of crosscutting concepts of learners.

Learning tool developed next is assessment in the form of observation sheet to assess the skills of analyzing-interpreting data learners. Moleong in [5], explains that data analysis is the process of arranging the sequence of data, organizing it into a pattern, category, and basic description unit. After data analysis, so that data can have meaning then the next step is to do interpretation (interpreting data). Interpretation or interpretation is nothing but a search for a broader understanding of the findings. Interpretation of data cannot be separated from the analysis, so interpretation is a aspect of analysis and is not part of the analysis. Interpretation of data needs to be done to give meaning to the results of data analysis that has been done before.

The feasibility of an observed skill-analyzing-interpreting data sheet is also through two stages of revision. The questionnaire to be used by the validator to assess the observation sheets of the analyzing-interpreting skills of this data contains some indicators that match the skill of analyzing-interpreting the data to be measured. The validator will assess whether the indicator formulated in accordance with aspects of the skills analyzing-interpreting data to be measured. Recapitulation of the result of the validation of the observed skill observation skill data is presented in Table III.

Based on the above Table III, the validation score of the observation sheet to assess the first-tier analyzing-interpreting skills of the learner obtained a percentage of 83.4% with the good category. Obtaining scores that have reached the appraisal rating eligibility standard should still be corrected according to the advice and feedback provided by the validator. At the second validation assessment stage, the scoring eligibility score increased to 94.6% in a very good category. This means that according to experts some formulated indicators have been in accordance with aspects of skills analyzing-interpreting data to be measured.

Assessment tools are further developed in the form of questions used to measure the skills of analyzing-interpreting data and the ability of crosscutting concepts of

learners. Crosscutting concept taken in this research is pattern. The patterns are ubiquitous in form or structure that occurs regularly and in repeating events and relationships. For example, patterns can be seen in the symmetry of flowers and snowflakes, seasonal cycles, and recurrent base DNA pairs [6].

The feasibility of the skills of analyzing-interpreting data and the ability of crosscutting concepts is also through two stages of revision. The validator will assess whether the indicator is formulated in accordance with aspects of data analyzing-interpreting skills and crosscutting concepts capabilities to be measured. Recapitulation of validation assessment result of the skill of analyzing-interpreting data and crosscutting concepts capability is presented in Table IV.

Based on the above Table IV, the validation score about the skills of analyzing-interpreting data and the ability of crosscutting concepts in the first stage get the percentage of 80.6% which is the good category. The results of this assessment should still be revised according to suggestions and input validator. In the second validation phase, the scores on the skills of data analyzing-interpreting and the ability of crosscutting concepts developed increased to 87.3% with a very good category. Based on the validation assessment that has been done, the assessment tool is a question that is used to measure the skills of analyzing-interpreting data and the ability of crosscutting learners' concepts to be eligible to be used in science learning.

## V. CONCLUSION AND SUGGESTION

Based on the results of research and discussion can be concluded science learning tools oriented on Next Generation Science Standard developed categorized appropriately for use in science learning according to expert lecturers and science teachers.

The suggestion in this research is in developing student worksheet the selection of drawing should be chosen the most interesting and colored so that can motivate learners in using the developed learning tools.

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