Student needs for developing light waves test based on three-dimensional learning frameworks

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Abstrak. The Framework for K-12 Science Education and NGSS: For States, By States represent a substantial change in science learning standards in the form of a three-dimensional learning framework as the latest science learning standard. The purpose of this study was to analyze the need for a test development based on a three-dimensional learning framework on the topic of light waves in high school. The research subjects were 140 respondents consisting of 20 teachers and 120 students in the high school of Purwakarta area. The research used a 3DLQP questionnaire as an instrument, which accumulates respondent characteristics, prior knowledge of three-dimensional learning, tests used in school, and criticism and suggestions. Data collection was carried out using interviews, questionnaires, national curriculum documents, and NGSS documents. Data analysis utilized the triangulation of data sources. The study results were to elaborate student needs for developing tests and assessment rubrics from the teacher and student perceptions. This research also produces characteristics of test development that are adapted to the national curriculum.

1. Introduction
The science education curriculum has undergone significant changes. Curriculum changes are not only about how students learn but also on assessment standards. One of the changes is a science education framework called the Next Generation Science Standard (NGSS). NGSS suggests a standard or minimum framework that students must achieve in science learning, especially physics [1]. The National Research Council released this framework in 2012, which is known as three-dimensional learning. Next Generation Science Standards: For States, By States [2] makes a three-dimensional learning framework as the latest science learning standard; the framework consists of scientific practice, crosscutting concepts, and disciplinary core ideas science. This framework emphasizes that the three dimensions are essential to be combined into the learning process [3] so that three-dimensional learning can be integrated into every aspect of learners’ learning opportunities to achieve learning goals [4]. Therefore, this framework combines a lot of science learning literature to achieve the goals of science education [5] by supporting students to build knowledge and abilities through science and engineering practices [6]. The three-dimensional learning framework plays an essential role in science learning, including physics, because it can help students have coherent knowledge. Three-dimensional learning explains that in delivering the material, it is not in detail but sufficient in the essence of the material so that it can encourage students to dig deeper and evaluate the material they needed [7].

Demands in today's world of work are increasingly challenging, so students are required to have coherent knowledge to solve various problems in life. Currently, the challenge for teachers is to create innovative learning that refers to the NGSS framework [8]. The application of the NGSS framework has begun to be adopted in Indonesia and focuses on learning tools for increasing student’s knowledge, skills, and
attitudes. One of the studies was founded regarding the suitability of developing practical NGSS-oriented science learning tools to improve student skills [9,10]. In addition, research on the need for NGSS-oriented authentic assessment is applied to junior high school science learning. That study resulted that teachers have not been applied techniques and evaluations to measure student competencies based on NGSS objectives [11]. The NGSS test instrument in the chemical course has been tested for valid and reliable quality [12].

The three-dimensional learning-based test was developed based on previous research. Laverty, et al. (2015) identified a framework and designed criteria for each scientific practice, crosscutting concepts, and disciplinary core ideas in constructing test items [4]. Furthermore, Laverty et al. (2016) developed these criteria into a Three-Dimensional Learning Assessment Protocol (3D-LAP), which is designed to describe and support assessment development and analyze validity and reliability [5]. Cooper (2017) also studied Crosscutting concepts (CCC) as a tool that can help to understand chemical phenomena in the context of three-dimensional learning [13]. In addition, the application of 3D-LAP was carried out to evaluate the level of change in assessment supported by curriculum transformation at all levels of education and subjects [14].

Numerous researches from various disciplines have focused on developing assessments and curriculum adjustments to improve learners' grades. Adjustment of the curriculum regarding assessment standards also applies in Indonesia, where the evaluation of student learning outcomes includes aspects of knowledge, skills, and attitudes [15]. One of the NGSS-oriented PBL assessment instruments is feasible to measure the ability of students to plan and carry out research and design solutions to problems [16]. This is in line with the NGSS-oriented assessment that students are assessed for their understanding separately from the ability to practice science and engineering and can use knowledge to analyze the phenomena around them to solve problems [2].

Nowadays, technology continues to develop increasingly modern. Technology is closely related to science. Therefore, light and sound waves are widely applied in technology [17]. Light is a fundamental concept in science physics learning [18]. Therefore, many studies have been conducted to determine and eliminate student misconceptions regarding light and vision in high school students. One of the studies find out the understanding of light and related concepts at various education levels show that most students cannot explain light-related phenomena in scientific language, even though they know of it [18].

Based on the description above, students need to have coherent knowledge by developing three-dimensional learning, one example is making an evaluation test on light waves with a three-dimensional learning orientation. Therefore, this study was conducted for a needs analysis in developing a three-dimensional learning-based light wave material test.

2. Method
A qualitative study design was carried out in a sample of 140 respondents consisting of 20 teachers and 120 high school students in the Purwakarta area. Data collection was used through interviews, questionnaires, national curriculum documents, and NGSS documents. The instrument used was the 3DLQP questionnaire which consisted of four parts. The first part contains the characteristics of the respondents. The second part is about initial three-dimensional knowledge of learning. The third part discusses the test instruments used in schools, and the fourth section contains criticism and suggestions. The data analysis used in this study was the triangulation of data sources. Data triangulation can be described as using multiple data sources to get a different view of a situation in one study [19] and deepen understanding of the problem being studied [20]. Data triangulation refers to the use of multiple data sources such as interviews, 3DLQP, and documentation. The collected data were analyzed in stages as follows [21,22]:

a. Data collection stage: this process aims to obtain the information needed for research.

b. The reduction stage aims to summarize and determine the essential and central things and look for patterns.

c. Presentation stage: this process aims to present data in the form of text or tables to facilitate understanding of the research

d. Conclusion stage: this process aims to conclude from the results of data analysis.
3. Result and Discussion

3.1 Three-Dimensional Learning Questionnaires of Physics (3DLQP)

Three-Dimensional Learning Questionnaires of Physics (3DLQP) were distributed to 20 teachers and 120 students in the Purwakarta area. 3DLQP is used to analyze the need to develop a light wave test based on a three-dimensional learning framework. Characteristics of Respondents, teachers who filled out questionnaires are teaching at the 11th-grade high school level. Characteristics of the respondent can be seen in Table 1.

| Table 1. Characteristics of Teacher |
|------------------------------------|
| Respondent | Gender | Experience | Total |
| Teacher    | Female | 1 - 10 years | 10    |
|            | Male   | 11-20 years  | 5     |
|            | 66%    | 21-30 years  | 5     |

Based on Table 1, of the 20 teachers, 66% are female and mostly having teaching experience of 1-10 years (n=10). The characteristics of 11th-grade high school students can be seen in Table 2.

| Table 2. Characteristics of Student |
|------------------------------------|
| Respondent | Gender | Physics Skill | Percentase |
| Student    | Female | Poor          | 36%        |
|            | Male   | Sufficient    | 59%        |
|            | 83%    | Good          | 5%         |

Table 2 showed that 83% of the respondents are female and having sufficient physics skills (59%).

a. A primary knowledge of Three-Dimensional Learning

Based on the 3DLQP results, 74% of teachers did not know about three-dimensional learning, so that the tests given focused on cognitive abilities only. Furthermore, they argue that the essential thing in today's physics learning is 100% answering scientific practice, 58% crosscutting concepts, 58% core ideas, and 42% cognitive ability. Meanwhile, the results of the 3DLQP given to students are 55% of students do not know about three-dimensional learning. Students think that essential things in today's physics learning are 57% answering crosscutting concepts, 50% cognitive abilities and scientific practice, and 48% core ideas.

b. Characteristics of tests in learning physics

Based on the results of the 3DLQP, it can be concluded that 50% of the tests involved students in scientific practice, 45.8% of the tests help students apply crosscutting concepts, and 66.7% of the tests help students understand the core ideas of a scientific discipline. The test given by the teacher has not helped students gain coherent knowledge because there is still a lack of involves scientific practice, using cross-disciplinary concepts even though students already understand the core ideas of one field of science. In addition, based on the results of the analysis, 58.3% of the questions given to students on the test were limited to the ability of students to predict from one phenomenon only and barely at choosing or making representations that showed and determined the reasoning of a concept. Another result showed that 35% of students could not analyze association to presenting or predicting phenomena. Whereas the purpose of science education is to prepare students for developing scientific thinking, reasoning, and problem-solving skills [23].

c. Criticism and Suggestions

The teacher explains that learning physics will be more meaningful if students can understand the concept and can relate to real-life because the laboratory of physics is everything around us'. Therefore, learning is not just a question exercise. In addition, physics learning in schools is expected to refer to cognitive knowledge correlated with daily skills in practice. Students not only understand in theory but also practice. Teachers and the academic community must be more enthusiastic about
innovation to create a pleasing physics learning process that can help students have coherent abilities. Student opinion about the process of learning in the physics subject is less attractive, making some students despise the lesson. Therefore, teachers are expected to choose the right learning model to make students excited to learn physics, because not all physic materials are suitable to be taught in an unvarying learning process. Similar to the teacher's suggestion, students hope that physic teaching activity is to be more practical and innovative to create a pleasingly learning process.

3.2 Interview
The interview results showed that in making test instruments, the questions given were limited to measuring cognitive abilities. The tests given were taken from science textbooks, national exams, and last year's final exam tests. In addition, even though the assessment rubric was made to assess various aspects, its application was not maximized. It was still limited to seeing cognitive abilities.

3.3 Document Analysis
Based on the results of standard assessment document analysis as a basis for educational assessment, which contains criteria regarding objectives, benefits, mechanisms, procedures, and assessment instruments [15]. The primary purpose of the evaluation is to determine the value of students in their learning (summative assessment) and designed to provide evidence of achievement that can be used in grouping students based on their level of understanding [24], besides that the review is about assessing the quality of students [25].

Adjustment of the curriculum regarding assessment standards also applies in Indonesia, written in the 2016 Minister of Education and Culture. The assessment of student learning outcomes includes aspects of knowledge, skills, and attitudes. This is in line with the NGSS-oriented review that students are assessed for their understanding separately from their ability to practice science and engineering but can use knowledge to analyze the phenomena that occur around them to solve problems [18].

Based on previous study, three dimensional learning oriented test instrument was developed to design and characterize assessment items in all disciplines such biology, chemistry, and physics. Then, it also developed to determine that the test given can involve students in scientific practice, crosscutting concepts, and core ideas of scientific discipline. Three-Dimensional Learning Assessment Protocol (3D-LAP) is designed to describe and support assessment development and analyze validity and reliability [5]. The application of 3D-LAP is carried out to evaluate the level of change in assessment supported by curriculum transformation at all levels of education and subjects [14]. The main component of the 3D-LAP is a predefined set of criteria for each dimension. The assessment maker can use this criterion to help modify or produce items that conform to the three dimensions. The criteria for the Three Dimensional Learning Assessment Protocol (3D-LAP) are presented in table 3 as follows:

| Criteria 3D-LAP |  |
|----------------|---|
| Questions contain events, observations, or phenomena so that students can make predictions. |  |
| Questions contain representations, or students choose representations. |  |
| Questions ask students to choose explanations or predictions about events, observations, or phenomena using representations. |  |
| Questions ask students to choose explanations or predictions about events, observations, or phenomena using representations. |  |
| Questions ask students to choose the reasoning that links their representations or predictions. |  |

4. Conclusion
In conclusion, it shows that the test given to students is only limited to measure cognitive abilities and it does not help students get coherent knowledge because there is still a lack in involving scientific practice and using cross-disciplinary concepts, even though students already understand the core ideas
of one field of science. The assessment used by the teacher is not entirely based on the NGSS-oriented assessment, which refers to a three-dimensional learning framework, so it is necessary to develop a three-dimensional learning-oriented test—framework for three-dimensional learning as a standard for modern science learning.

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