The Development of Physics Test Instrument Based on PISA for Optical Topic in High School

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Abstract. The purpose of this study is to develop a PISA-based physics test instrument for optical topic in high school with a valid category. This study is a type of research and development (Research & Development). The concept used is the development of Analysis, Design, Development, Implement and Evaluation (ADDIE). This research is limited to the development stage, namely expert validation. The stage of needs analysis and material analysis with literature study, it was found that there was minimal variation in the assessment and students still find it difficult to find references to PISA-based physics questions, especially on optical material. The material for developed physics problems includes optical phenomena, light reflection, light refraction and optical tools. At the design stage, 40 items were obtained based on the PISA scientific literacy competency, which were classified into three competency standards, namely: explaining scientific phenomena; evaluate and design scientific research; interpret scientific data and evidence. Furthermore, at the development stage, the validity test was carried out with three expert validators. The results of expert validation show that 35 items meet the content and construct validation with the valid category with revision and very valid, while 5 items are invalid and cannot be used.

1. Introduction
The 21st century is marked by the very rapid development of information technology, of course there is a need for readiness to face these developments. Every technological advancement presents theoretical constructs and realistic insights in the development and enhancement of knowledge, skills and attitudes between students and teachers (Abao et al., 2015). A series of problems covering the world of education today still need the attention of all parties. Facts on the ground, the problems are much more complex in our educational environment. One of the important components in educational activities and the learning process is the educator or teacher. The level of quality and competence of teachers can be said to be the main obstacle, starting from teachers who do not have the appropriate competence to teach certain subjects, to the low level of professionalism of the teachers themselves. Even though technological advances have provided various kinds of tools to increase the effectiveness of the learning process, the teacher’s position cannot be completely replaced. This means that teachers are an important variable for the success of education. Teachers must be professionally sensitive to global education issues in a variety of subjects and be able to relate teaching to other subjects and with real life situations (Edwards, 2010). Teacher competencies must be developed to address the needs and demands of students in this 21st century.
One of the competencies that teachers must do is assessment. It is important for the teacher to conduct an assessment in the learning process to find out the extent to which the student's ability to receive the knowledge that has been given. Assessment can be carried out with the instrument. The teacher must prepare an instrument in the form of tests to determine the ability of students and provide an assessment of the tests to be given. Through tests, a teacher can measure the desired construct (Sukardi, 2008).

Through observation, the researcher found that from the learning process that occurred in schools, there were things that were still considered difficult by the teacher, namely making assessment instruments. Teachers still face obstacles in making good assessment instruments to measure the level of student success in understanding the material being taught. The difficulty of finding references in making questions that refer to scientific literacy also has an impact on the assessment instrument developed to measure the achievement of student success in the learning process which seems to be still invalid and not reliable. Students also still have difficulty solving questions that refer to scientific literacy, because most students are still familiar with questions that require memory and memorization. In addition, the assessment instruments used by the teacher have not been able to meet the criteria in the 21st century, where one of the students is required to have scientific literacy skills.

One of the international organizations that measure students' literacy skills is the PISA (Program for International Student Assessment) which is held every 3 years. PISA emphasizes the ability of students obtained from school and can be used to solve problems faced in everyday life (OECD, 2010).

PISA has conducted several tests and based on the results of the PISA tests that were held, Indonesia has consistently scored an alarming result. Testing in 2015 was ranked 45th out of 48 countries with a score of 397 (OECD, 2016). The results of the scientific literacy study conducted by PISA show that the ability of Indonesian students to compete at the international level is still low. This is because the PISA test questions are not applied in Indonesia. Meanwhile, the questions applied in PISA do not only assess students' factual mastery, but emphasize more on how students are able to solve and clarify a case based on data sources to draw rational conclusions (Wasis, 2015; Siregar et al. 2020). So the most important thing needed in solving these problems is the ability to think and consider everything to decide what to do.

The thinking ability of Indonesian students in solving real-life problems is still low and has not been able to compete with students from other countries. A student is said to be able to solve problems if he is able to apply previously acquired knowledge into new unfamiliar conditions. The development of PISA-based tests needs to be done to be able to train and accustom students to face various challenges in the 21st century. In addition, the PISA model test also demands students' ability to solve problems and reasoning (Setiawan et al., 2014, Jonny et al. 2020). The reality in the field is that the questions test more aspects of memory which are included in LOT (Lower Order Thinking). Many books present material by inviting students to learn actively, the presentation of concepts is very systematic, but often ends with evaluation questions that do not train students' scientific literacy skills.

The development of this test instrument aims to analyze students' abilities in solving PISA questions, but it is limited to one aspect of ability, namely students' scientific literacy abilities. The test instrument developed by researchers used optical material on the grounds that misconceptions were often found in optical material based on findings made by Galili & Hasan (2000) which suggested that the misconceptions of prospective teachers and high school students on the topic of light, formation of shadows, reflection and refraction. This research is focused on identifying students' scientific literacy skills in solving PISA questions, especially in optical materials, so that researchers are interested in conducting a research entitled “The Development of Physics Test Instrument Based on PISA for Optical Topic in High School”.
2. Method
The type of research used in this research is development research (R&D). The concept used is the development of Analysis, Design, Development, Implement and Evaluation (ADDIE) by Robert Maribe Branc. The analysis phase includes needs analysis, topic analysis, and literature study. The stage design includes the design of an objective test instrument based on PISA. The development stage includes content validation with expert validators. This research is limited only to the development stage, namely expert validation.

3. Results and Discussion
3.1 Analysis
The results of the needs analysis are based on the results of interviews with the physics teacher at SMA Negeri 3 Langsa that the teacher has never made an assessment using the PISA test instrument to measure students' scientific literacy. The lack of variation in assessment makes students less able to recognize PISA-based questions and students also less able to develop scientific literacy skills. The results of the topic analysis based on relevant research indicate that previous research, the topics discussed had not addressed the topic of optics.

3.2 Design
This stage is the initial design of the preparation of a PISA-based test instrument on the topic of optics in high school. The draft instrument consists of a grid of test questions, 40 items, and an assessment guide. Based on the topic analysis and literature study, the results of the Optical Topics PISA-Based Test Instrument in SMA with characteristics and indicators referring to the Pisa literacy-based competence for optical phenomena and topics are shown as in Table 1.

| Competency Level       | Indicator Problem                                                                 | Item |
|------------------------|-----------------------------------------------------------------------------------|------|
| Reflection of Light    | Students are able to assess and select correct information about the phenomenon of light reflection | 1    |
| Evaluating and designing experiments | Students are able to predict to design experiments based on the tools and materials provided | 12   |
| Interpret data and scientific evidence | Students are able to relate variables to one another based on the data provided | 20   |
| Optical Phenomena      | Students are able to make correct predictions according to facts                   | 15   |
| Explain phenomena scientifically | Students are able to detect the principles of optical instrument application on parabolic antennas | 2    |
|                        | Students are able to categorize the advantages of a parabolic antenna              | 3    |

Table 1. PISA-Based Test for Optical Topic at High School
| Competency Level              | Indicator Problem                                                                 | Item |
|------------------------------|-----------------------------------------------------------------------------------|------|
| Explain phenomena scientifically | Students are able to choose the appropriate scientific phenomenon                  | 16   |
|                              | Students are able to remember and apply scientific knowledge about the eye         | 23   |
| Evaluating and designing experiments | Students are able to predict the diameter of objects placed in large vessels filled with clear liquid | 32   |
|                              | Students are able to choose scientific phenomena according to the experiments being carried out | 24   |
| Interpreting data and scientific evidence | Students are able to interpret data from the phenomenon of waste pollution in rivers | 13   |
|                              | Students are able to relate variables to one another based on the data provided   | 25   |

**Refraction of Light**

| Competency Level              | Indicator Problem                                                                 | Item |
|------------------------------|-----------------------------------------------------------------------------------|------|
| Explain phenomena scientifically | Students are able to make and justify correct predictions                      | 5    |
|                              | Students are able to evaluate scientific arguments based on the tables provided   | 10   |
| Evaluating and designing experiments | Students are able to identify the assumptions if light moves from air to glass | 11   |
| Interpret data and scientific evidence | Students are able to calculate the angle of refraction of light                  | 6    |
|                              | Students are able to calculate the value of the building height                   | 7    |
|                              | Students are able to identify the value of the propagation velocity of the medium | 8    |

**Optical Tools**

| Competency Level              | Indicator Problem                                                                 | Item |
|------------------------------|-----------------------------------------------------------------------------------|------|
| Explain phenomena scientifically | Students are able to make correct predictions according to the article            | 17   |
|                              | Students are able to identify the same function between the camera and the eye    | 26   |
|                              | Students are able to identify the focus between the camera and the eye            | 27   |
|                              | Students are able to assess and choose the right information based on articles    | 29   |
|                              | Students are able to analyze and choose according to the scientific phenomena     | 30   |
| Competency Level | Indicator Problem                                                                 | Item |
|------------------|-----------------------------------------------------------------------------------|------|
|                  | Students are able to assess and select appropriate information about the image    | 28   |
|                  | formed by the camera lens                                                        |      |
|                  | Students are able to assess and select information based on the table provided    | 40   |
|                  | Students are able to evaluate scientific arguments from available sources         | 31   |
|                  | Students are able to compare convex mirrors with other mirrors in everyday life    | 33   |
|                  | Students are able to predict to design experiments based on the tools and materials| 34   |
|                  | provided                                                                            |      |
|                  | Students are able to select and sort the stages according to the information given| 22   |
|                  | Students are able to evaluate various ways that scientists use to ascertain the    | 4    |
|                  | correctness of data and objectivity on a parabolic antenna                         |      |
|                  | Students are able to select and evaluate correct information about observations on | 14   |
|                  | a microscope                                                                        |      |
|                  | Students are able to relate variables to one another based on the data provided    | 19   |
|                  | Students are able to predict and calculate the value of the mirror focus           | 18   |
|                  | Students are able to predict and calculate the average focus value of the convex   | 21   |
|                  | lens                                                                                |      |
|                  | Students are able to calculate and organize the results of the experiment according | 37   |
|                  | to the data obtained                                                                | 38   |
|                  | Students are able to calculate and organize the results of the experiment according | 35   |
|                  | to the data obtained                                                                | 36   |
|                  |                                                                                     | 39   |

The results of the design of the PISA-based test instrument on Optical Topics in SMA obtained the results of 40 PISA-based Optical Tests in SMA, along with the answer keys, filling instructions and scoring guidelines.
3.3 Development

At the development stage, content validity was carried out, namely validation with three experts. Content validity was carried out by evaluating instruments based on the scientific literacy competency of PISA [8], namely (1) explaining scientific phenomena; (2) Evaluating and designing scientific research; and (3) Interpreting scientific data and evidence. Based on expert reviews, the instruments developed were categorized as valid with revisions.

The suggestions given by some experts include that the content of the questions must be adjusted to the indicators and scientific literacy competencies in PISA, as well as the use of effective sentences and easy to understand by readers. The category of expert validation results can be seen in the table.

**Table 2. Category of Validation Results Contents**

| Category | Question | Number |
|----------|----------|--------|
| Received | 1, 2, 3, 4, 8, 9, 10, 11, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 35, 36, 37, 38, 39, 40 | 35 |
| Rejected | 5, 6, 7, 12, 34 | 5 |
| Total Number of Questions | | 40 |

Based on the results shown in Table 3 it can be concluded that the evaluation instrument developed is very valid.

**Table 3. Validation Results by Validators Expert**

| Validators | Aspect | Percentage | Category |
|------------|--------|------------|----------|
|            | Material | Constructive | Language |          |          |
| Validators 1 | 84      | 81         | 72       | 79%      | Very Valid |
| Validators 2 | 91      | 80         | 75       | 82%      | Very Valid |
| Validators 3 | 68      | 86         | 83       | 79%      | Very Valid |
| Average ideality | | | | 80 % | Very Valid |

4. Conclusion

Based on the analysis of the PISA-Based Test items in Optics in SMA through the expert validation process, the analysis results showed that 35 items were accepted (valid), and 5 items were rejected (invalid) with an ideal percentage of 80%. This means that experts agree that the PISA-Based Test Instrument on Optical Topics in SMA is relevant to PISA indicators and scientific literacy competencies.

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