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Pengembangan Instrumen Tes Fisika Untuk Mengukur Keterampilan Pemecahan Masalah di Kelas XI SMA

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Abstrak.
Penelitian ini bertujuan untuk mengetahui kemampuan pemecahan masalah siswa pada materi fluida statistik. Jenis penelitian yang digunakan adalah R&D dengan model pengembangan ADDIE (Analysis, Design, Development, Implementation, dan Evaluation). Penelitian ini dilaksanakan di SMA Swasta Persiapan 2 Padang Tualang pada kelas XI yang berjumlah 15 siswa untuk tes skala kecil dan 35 siswa untuk tes skala besar. Hasil penelitian diperoleh berdasarkan hasil validasi ahli terhadap tiga aspek penilaian yaitu konstruk, materi, dan bahasa diperoleh nilai rata-rata sebesar 95,8% dengan kategori sangat valid. Pada tes skala kecil kemampuan pemecahan masalah siswa memperoleh rata-rata skor 34,00 dengan kategori rendah, sedangkan pada tes skala besar siswa memperoleh rata-rata 59,00 dengan kategori rendah. Jadi dapat disimpulkan bahwa instrumen tes yang dikembangkan dapat mengukur dan meningkatkan kemampuan pemecahan masalah siswa.
Kata kunci: Pengembangan, Instrumen Tes, Pemecahan Masalah, Fluida Statis

Development Of Physics Test Instruments To Measure Problem Solving Skill In Class XI Senior High School

Abstract
This study aims to determine the problem-solving abilities of students with statis fluid material. The type of research used is R&D with the ADDIE development model (Analysis, Design, Development, Implementation, and Evaluation). The research was conducted at SMA Swasta Persiapan 2 Padang Tualang in class XI, Which amounted to 15 students for the small scale test and 35 students for the large scale test. The results of the study were obtained based on the results of validation by experts on three aspects of assessment, namely construct, material, and language, which obtained an average value of 95.8% with a very valid category. In the small scale test, students' problem solving ability obtained an average score of 34.00 with a lower category, whereas in the large scale tets, students obtained an average of 59.00 with a lower category. So it can be concluded that the test instrument developed can measure and improve students' problem solving skills.
Keywords*: HKI, UMKM*

1. INTRODUCTION

Human life is undergoing a profound transformation, drive by the widespread integration of technology. One of them is education, which is changing significantly. Wise utilization of technology in education can create a more inclusive, interactive, and revelatory learning environment in accordance with the demands of the times (Usmaedi, 2021). One of the preparations for balancing the presence of technology in the field of education is to adopt the 2013 curriculum. This curriculum integrates four pillars, namely communication, collaboration, cretivity, critical thinking and problem solving. The existence of this can train students to be adaptive, creative, and able to think critically (Helaluddin & Fransori, 2019).

The focus of the curricukum assesment is on cognitive assesment obtained from the results of students' knowledge of learning. This cognitive assessment aims to measure students' understanding of learning materials, their' ability to apply concepts that have been learned, as well as their ability to solve problems and apply this knowledge in real-life contexts according to facts in everyday life. The tool to measur learners' compliance is using test instruments. One from of test instrument that can be used is a problem solving based test instrument (Widana, 2020).

Problem solving skills have on been well development at the high school level, especially in physics learning. In accordance with research conducted by Alfika & Mayasari (2018) students' problem solving ability has an average value of 50.12% in the low category. This value show an urgent need to improve physics learning in the field of problem solving through effective and more structured learning preparation strategies. Steps that can be taken include applying physics concepts in everyday life. Heller, (2010) states that problem solving is the process of identifying, analyzing, and finidng solutions to overcome these problems. There are five stages to problem solving: indentifying problems, separating problems, designing solutions, implementing solutions, and evaluating solutions.

SMA Persiapan 2 Padang Tualang is on of the schools that is still implementing the 2013 curriculum. Based on the observation to assess students' knowledge, it was found that students' understanding of problem solving based questions was, with a percentage of 72.2%. This shows a signiticant challenge in developing problem solving based test instruments in physics at the school. Thus, an in depth evaluation of the learning methods applied in the school is needed to improve students' understanting and problem solving skill in physics learning. In addition, teacher training on developing better problem solving based question may also be a necessary step to improve the situation.

Based on the above problems, researchers need to develop test instrument to measure students' problem solving skills on static fluid material in class XI IPA. Problem solving based test instrument show an urgent need to evaluate students' understanding and ability comprehensively. The development of appropriate test instrument to meet learing needs will improve more accurate assesment of students' problem solving abilities in physics learing. The test instrument developed is expected to be an effective measuring tool for measuring and improving students' problem solving skill especially in the context of physics learing.

2. METHODS

The research uses a type of development research with the ADDIE model, which has five stage: analysis, design, development, implementation, and evaluation (Sugiyono, 2019) Ths research was condected at SMA Swasta Persiapan 2 Padang Tualang with the research subject of class XI IPA.

The stages of the ADDIE development model are as follows:

Analysis

The analysis stage aims to obtain the necessary information related to the existing problems, at this stage, needs analysis, curriculum analysis, learner analysis, taks analysis, and material analysis are carried out. Information obtained from interviews with physics teachers and distributing questionnaires to students related to physics learning conditions in the classroom.

Design

This stage aims to design test instrument products that will be developed through the stages of format selection, determining the form of instruments, compiling instrument grids, and designing instruments.

Development

This stage aims to make the test instrument products to be developed. The activities carried out include making problem solving based questions and assessing the validity of instruments for validators.

Implementation

This stage is a trial carried out with two stages, namely a small scale trial of 15 respondents and a large scale trial of 35 respondents.

Evaluation

The evaluation stage is carried out at each stage of the ADDIE development in order to obtain a test instrument product that is suitable for use.

Data acquisition is done by using the distribution of test instruments that have been designed for students to determine the level of students' problem-solving ability through the final score obtained by students. The equation used to measure students' problem-solving ability is as follows:

$$Mark = \frac{Number\ of\ Scores\ Obtained}{Maximum\ Score} \text{ x } 100$$

3. RESULTS and DISCUSSION

RESULTS

The analysis stage is the initial stage in the development of test instruments conducting several stages of analysis, namely needs analysis, learner analysis, task analysis, and material analysis. The results of the analysis were obtained by interviewing and distributing questionnaires to students regarding physics learning activities at SMA Swasta Persiapan 2 Padang Tualang. In the needs analysis, information was obtained that the teacher had not implemented a test instrument to measure students' problem solving skills in physics learning.

This result is due to the teacher's understanding of the process of making test instruments to measure problem-solving ability. At the curriculum analysis stage, namely knowing the curriculum used at the school, it is adjusted to the syllabus. The curriculum used is the 2013 curriculum. At the student analysis stage, students still think that physics learning is difficult, so they have not been trained in solving problem-solving-based problems. Based on the task analysis, the problems given still use a low level of thinking, so that students' problem-solving skills are not created. There are examples of test instruments used in Table 1.

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Table 1. Questions used in schools

No	Questions
1	Hydrostatic pressure occurs due to...
2	Insects can walk on the surface of the water because...
3	A vessel made of glass is filled with 80 cm of water, if the cross-sectional area of the bottom of the tube is 100 cm^2, calculate the hydrostatic force at the bottom of the vessel...

Furthermore, the material analysis stage is adjusted to the existing learning at school, namely in the even semester of the 2023–2024 school year in class XI, so that researchers choose static fluid material.

The design stage is the stage carried out as a test instrument development process. The test instrument developed is in the form of an essay on static fluid material. The design of instruments was developed in the form of validation sheets, scoring guidelines, question and answer sheets, and answer keys. The questions designed are 25 questions that refer to the problem-solving indicators. The instrument grids are designed in Table 2.

Table 2. Test instrument grid

Basic Competencies	Problem Solving Aspects	Sub Material	Question No
3.7 Apply the laws of static and dynamic fluids in everyday life	1. Focusing the problem 2. Describing the problem in the context of physics 3. Developing a problem solving plan 4. Executing the problem solving plan pemecahan masalah 5. Evaluate the results obstained	Hydrostatic pressure	1,3,8, 6, 2, 22, 15, 25
		Pascal's Law	10, 11, 19
		Archimedes' Law	5, 7, 14, 17, 18, 20
		Surface Tension	12, 13, 16, 21, 23
		Viscosity	9, 24
		Capillarity	4

The development stage is the product development stage of the test instrument, which consists of 25 essay questions on static fluid mechanics, which are then validated by the three validators. Aspects of validation assessment include aspects of construct, material, and language. Validators consisted of 2 physics lecturers at Medan State University and 1 physics teacher at SMA Negeri 1 Padang Tualang. Based on the validator's assessment, the 25 questions designed were declared valid with a percentage of 95.8%. However, at the testing stage, the researcher only took 15 questions to develop. The reason researchers designed as many as 25 questions is as a form of anticipation when the questions are invalid when tested by validators.

The implementation stage involves conducting two stages of testing: a small-scale test of 15 students and a large-scale test of 35 students taken from class XI IPA. The results of the analysis on a small scale are as follows:

a) Validity of question items

The results of the validity test in small groups analyzed with the help of Microsoft Excel using the product moment correlation formula showed that 10 valid questions were obtained from 15 questions tested. The validation results are in Figure 1.

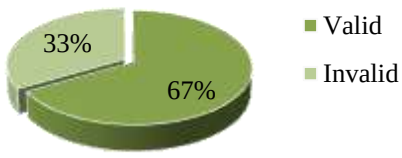

Figure 1. Percentage validity of small-scale instruments

b) Reliability

In the small-scale reliability test, a value of 0.72 was obtained in the high reliability category.

c) Item difficulty level

In the level of difficulty test, it was stated that 7 questions were difficult and 8 questions were in the medium category. Percentage of difficulty level on a small scale in Figure 2.

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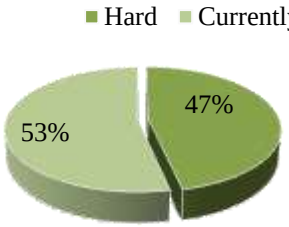

Figure 2. Percentage of difficulty level in small scale test

d) Differentiating power

In the distinguishing power test, the results obtained were 5 questions in the poor category, 3 questions in the sufficient category, 4 questions in the good category, and 3 questions in the very good category. Percentage of differentiating power test results in Figure 3.

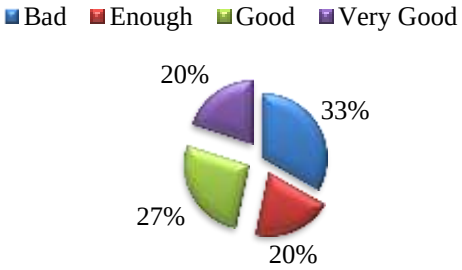

Figure 3. Percentage of small-scale discriminating power test

e) Students' problem solving ability

Students' problem solving ability in the small-scale test obtained an average score of 34.00 with a category of less. The percentage of students' problem solving ability is shown in Figure 4.

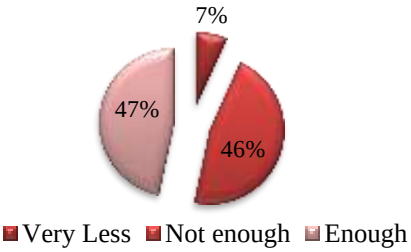

Figure 4. Percentage of students' problem solving ability in the small-scale test

Valid questions in the small-scale test, namely 10 questions, will be used in the next test stage, namely the large-scale test with 35 respondents. The results of the large-scale test are as follows:

a) Validity of question items

In the large-scale validity test, 9 questions were valid and 1 question was invalid.

b) Reliability

Reliability in the large-scale test obtained a value of 0.76 with a high reliability category.

c) Level of difficulty of question items

In the test of the level of difficulty of the items, the results obtained 4 questions in the difficult category and 6 questions in the moderate category. The percentage of large-scale difficulty levels in Figure 5.

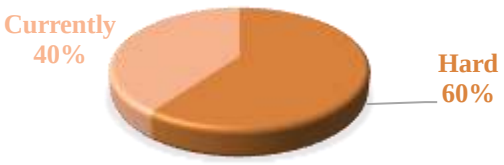

Figure 5. Percentage of item difficulty on the large-scale test

d) Differentiating power of question items

In the differentiating power test, 2 questions were obtained in the poor category, 2 questions in the sufficient category, 1 question in the good category, and 5 questions in the very good category.

e) Students' problem solving ability

Students' problem solving ability in the large-scale test has increased, namely on average 59.00 with a sufficient category. The percentage of the results of students' problem solving ability is shown in Figure 6.

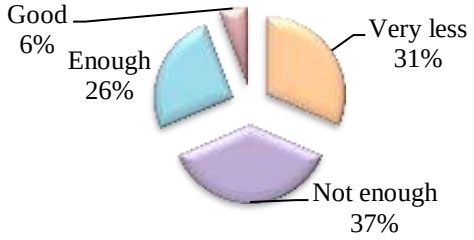

Figure 6. Percentage of students' problem solving ability in the large-scale test

DISCUSSION

This research was conducted at SMA Swasta Persiapan 2 Padang Tualang in the even semester of the 2023/2024 school year with the research subjects of class XI IPA students. The development model used is ADDIE which consists of five stages: analysis, design, development, implementation, and evaluation. The result of the research product is a test instrument that can measure students' problem solving ability. Test instruments are considered feasible if they meet the eligibility standards (validity, reliability, difficulty level, and differentiating power). In line with Arikunto's (2018) view, a good test instrument must meet the requirements of validity, reliability, objectivity, practicality, and economy. In line with Arikunto's (2018) view, a good test instrument must meet the requirements of validity, reliability, objectivity, practicality, and economy.

This test instrument has gone through the validation stage by validity consisting of 3 validators. Validator assessment using a 4-level Likert scale. The results of the validator's assessment obtained an average score of 95% on the construct aspect, 95.4% on the material aspect, and 97% on the language aspect. So that the average assessment of the three validators is 95.8% with a very valid category. According to (Yuliantaningrum & Sunarti, 2020) in their research stated that the test instrument can be said to be valid if the validity presentation reaches> 61% in this case the researcher designed 25 questions, and of all these questions were declared valid. Then, in line with research conducted by Patimah et al., (2022), they obtained the results of validation tests on material aspects at 100%, construction aspects at 98.6%, and language aspects at 100%. However, only 15 questions will be developed. Researchers designed 25 questions to minimize the occurrence of invalid questions when validated by validators.

The validation test of the questions in the small-scale test obtained 10 out of 15 questions declared valid. Invalid questions are located on question numbers 2, 4, 5, 6, and 15. The test instrument that has been proven valid in the small-scale test is then used as a large-scale trial involving 10 questions. The results of the item validity test on a large scale involving 35 respondents showed that 9 questions were valid and 1 question was invalid, namely question number 5.

The results of the reliability test on a small scale showed a value of 0.72 with a high reliability category. Meanwhile, the large-scale test obtained a reliability value of 0.767648244, also with a high reliability category. So it can be concluded that the instrument developed is consistent and reliable. . Reliable test instruments can be relied upon and used to measure students' problem solving skills (Fitrianty et al., 2022).

The test instrument is considered good if the level of difficulty is in the medium category, with a difficulty index between 0.30 and 0.70. The results of the test of the level of difficulty on a small scale showed that 8 questions were in the moderate category, namely in question numbers 1, 3, 4, 8, 10, 12, 13, and 15, while 7 questions were in the difficult category, namely in question numbers 2, 5, 6, 7, 9, 11, and 14. Meanwhile, the results of the large-scale difficulty test showed that 6 questions were in the moderate category, namely question numbers 1, 2, 4, 7, 9, and 10, and 4 questions were in the difficult category, namely question numbers 3, 5, 6, and 8.

Based on the analysis of the differentiating power of the small-scale test, five questions with poor categories were found in question numbers 2, 4, 5, 6, and 15, three questions with sufficient categories in question numbers 12, 13, and 14, four questions with good categories in question numbers 1, 8, 10, and 11, and three questions with excellent categories in question numbers 3, 7, and 9. In the large-scale discriminating power test, two questions were found in the poor category in question numbers 3 and 5, two questions in the fair category in question numbers 2 and 8, one question in the good category in question number 6, and five questions in the excellent category in question numbers 1, 4, 7, 9, and 10. Items that

have sufficient, good, and excellent categories can distinguish the cognitive abilities of students, while items with poor categories cannot be used because they are unable to distinguish the cognitive abilities of students (Fitrianty et al., 2022).

The results of the ability of students in the small-scale test obtained an average score of 34.00 with the category less. In the large-scale test, the ability of students to solve problems obtained a score of 59.00 with a sufficient category. It can be proven that students' problem-solving skills can increase when students are trained in working on problem-solving-based problems. Ayumniyya & Setyarsih, (2021), namely the problem solving ability of students is classified as sufficient with an average score of 52.1. The test instrument used is considered valid and effective for measuring students' problem solving skills.

4. CONCLUSION

Based on the results of research from 15 questions developed, only 9 questions are said to be valid, reliable, have differentiating power, and have a good level of diffi culty so that they can measure the problem solving skills possessed by students. Based on the average score of problem-solving skills that increased, it shows that the development of problem-solving-based test instruments is important to help students get used to thinking and being able to solve a problem.

For future researchers, it is necessary to conduct training in the preparation of test instruments to measure students' problem solving skills to teachers. So that teachers can apply problem-solving-based test instruments in schools and can train students in solving and answering questions with problem-solving reasoning levels.

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