

ASSESSMENT OF PROBLEM-SOLVING SKILLS IN THE TOPIC OF ENVIRONMENT: ITS VALIDITY AND RELIABILITY

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ABSTRACT

This study aims to determine the validity and reliability of the instrument for assessing problem-solving skills in the topic of environment. This research includes in a research and development of test instruments with the ADDIE model, namely analysis, design, development, implementation, and evaluation. The instrument that had been made was then tested on 31 students at the Islamic Boarding School of Jagad 'Alimussirry, Surabaya. The data were analyzed for its validity and reliability. The validity was measured using the Pearson product-moment correlation coefficient test. The reliability test used Cronbach's alpha test. The results of the study show that all items are valid and reliable in the high category. The percentage of eligibility from experts (material experts, education experts, and education practitioners) is 89% with a very decent category so this instrument is declared suitable to be used to measure problem-solving skills. This instrument contains five stages of problem-solving, namely identifying problems, determining solutions, planning solutions, implementing solutions, and evaluating the results of problem-solving. The problems identified consist of two kinds, namely social problems and physical problems in Islamic boarding schools. To conclude, the problem-solving skills assessment can be used by students to improve the abilities in analyzing problems.

Keywords: *assessment, environment, problem-solving skills, reliability, validity*

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Introduction

Problem-solving skills are one of the skills that have to be mastered by students in the 21st century (Greenstein, 2012). This is stated in the goal of education in Indonesia, namely to produce students who can analyze and solve complex problems. Problems arise when there is a gap between what is expected to happen and what happens. Furthermore, the problems faced by students during the learning process are a lack of language skills, a lack of information about cultural norms and values, and difficulty adapting to the learning environment (Merenkov & Antonova, 2015).

Indonesian education aims to provide students with analytical and problem-solving skills. Students' learning gains allow them to evaluate the effects of science's progress and application in order to come up with a solution. Students need to be able to create procedural problem solving, adapt to the problem-solving environment, and direct others in choosing from a range of potential solutions (Lutfaizah et al., 2020).

Lutfauziah et al. (2020) stated that problem-solving skills are taught to students through several strategies, namely: a) linking material to everyday problems, b) discussing concepts that have not been understood to formulate problems, c) discussing useful problem-solving strategies, d) organizing exercises so that students can make plans to solve problems, e) provide direct examples in daily practice, and f) provide new problems so that students can evaluate problem-solving.

Problem-solving is the stage of accepting the problem and trying to solve the problem. Problem-solving is an effort to find a way out of a difficulty and includes high intellectual activity (Nur & Ibrahim, 2000). In general, problem-solving is defined as a process of eliminating differences or discrepancies between the results obtained and the desired results (Pramana, 2006). Dakir (2004) explains that achieving the expected results is not easy so it is necessary to know the gap between reality and hope. Adair (2007) explains that the main strategy at the stage of understanding the problem is to find the point of deviation and then identify the cause of the problem.

The process of identification, analysis, and implementation of the best solutions are all aspects of problem-solving abilities. A person with strong problem-solving abilities is both a self-starter and a cooperative team member; they take the initiative

to identify the source of an issue and collaborate with others to evaluate a variety of alternatives before selecting how to proceed. The capacity to rapidly and easily resolve any given difficulty is referred to as problem-solving. Convergent and divergent thinking are needed for this. The goal of convergent thinking is to arrive at a specific solution to a problem. Divergent thinking is the term for the practice of considering every alternative in order to think creatively and examine the results (Shafina et al., 2020).

In fact, having good problem-solving abilities benefits society. The ability to solve problems is essential for thinking development. These skill sets are also highly valued in this cutthroat society and are crucial for success in both the general world and the workplace. The ability to solve problems effectively is a crucial 21st-century skill since it affects one's potential for personal growth, career opportunities, and societal impact (Lutfaizah et al., 2020).

Problem-solving skills which are included in student-centered process is fundamentally important. Learning that is focused on the needs of the individual students is referred to as student-centered learning. A student-centered approach recognizes this diversity in classrooms by giving students some degree of control over their learning and making them active participants in the learning process. Students learn at varying paces, have their own unique strengths, and even more so, have their own interests and motivations. Including problem-solving in the curriculum is a great way to make learning more student-centered because it requires students to interact with material by asking questions and considering explanations and solutions critically, as opposed to expecting them to learn through written memorization.

As it is already stated that the problem-solving skills are taught from Elementary to College level although in different levels of difficulty and complexity of problem-solving. These skills taught in learning process need to be measured whether these skills have been mastered by students. The tool to measure a variable (problem-solving skills) is called an instrument (Matondang, 2009). When someone develops an assessment instrument, it is necessary to use the principle that the assessment process is an inseparable part of the learning process (Putri, 2021). Therefore, it is also important to make an assessment instrument of problem-solving skills.

A diverse skill set is needed for effective problem-solving so that people, teams, and organizations may move closer to their goals. It

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entails having the skills to characterize an issue, deconstruct it into smaller, more manageable problems, come up with solutions to the (sub)problem using originality and analytical thought, and execute successfully. Students should be exposed to typical problem-solving scenarios during the test of their problem-solving abilities, such as scheduling under a variety of conditions, choosing the best course of action based on a variety of business rules, and drawing conclusions from textual and numerical data (Lutfazah et al., 2020).

As it is already stated that problem-solving is an essential part of the science learning process and can be used to investigate scientific ideas, solve complicated science problems, and draw conclusions about specific topics. Even outside of the classroom, 82.9% of employers respect problem-solving abilities highly, making it one of the most critical skills for students to highlight on their resumes. Students who learn to apply their problem-solving techniques to the problems they see in their local communities or even worldwide will have the abilities necessary to alter the course of history and leave a lasting impression on the globe. Any content area can teach problem-solving, and it can even use cross-curricular ideas to connect knowledge from various subject areas (Shafina et al., 2020). Due to the fact that addressing problems frequently requires teamwork, students also develop a variety of crucial interpersonal skills. Clear communication, a sense of personal responsibility, empathy for one's teammates, goal-setting, and organization are all necessary for effective teamwork. These skills are crucial in both the business and higher education.

At this time, problem-solving skills test instruments have been developed, such as vibration, waves & sound topic in junior high school (Hidayat et al., 2017), business & energy topic in senior high school (Lestari et al., 2019), straight motion topic in senior high school (Yuliantaningrum & Sunarti, 2020), and dynamic electricity topic in university (Wardani et al., 2020). In addition, a non-test instrument has been developed in the form of a discovery learning-based project assessment to measure problem-solving skills in science at junior high school (Sukmasari & Rosana, 2017). Based on the description above, it can be seen that the instrument for assessing problem-solving skills in the environment topic in Islamic boarding schools has not been developed.

The assessment instrument that has been developed needs to be checked whether it is valid

and reliable to use (Matondang, 2009). Therefore, it is necessary to test the validity and reliability of the instrument test of the environment in Islamic boarding schools. Based on its importance, this study has the title "Problem-solving Skills Assessment in the Environment Topic: Its Validity and Reliability". This study aims to produce a valid and appropriate problem-solving skills instrument that can be used in the learning process.

Research Methods

Research Design and Procedures

This research includes development research. This development research uses the ADDIE model, namely analysis, design, development, implementation, and evaluation. The development stage is validated by several experts, namely material experts, education and learning experts, and education practitioners. The validation is based on aspects of conformity with learning outcomes, content, and language.

Data Collection

The method used to collect data in this study was tests and questionnaires. The test method is used to measure the validity and reliability of the instrument. The questionnaire method serves to explore in more detail the students' answers when answering the test instrument.

Participants

The instrument that had been made was then tested on 31 students at the Islamic Boarding School of Jagad 'Alimussirry Surabaya. These respondents came from 3 Islamic boarding schools, i.e., women's boarding schools, men's boarding schools, and combined (male-female).

The demographic characteristics of respondents are presented in Table 1. Respondents consist of 39% male and 61% female.

Table 1. Demography of Respondents

Respondents	n (%)	Mean	SD
Male	39	0.39	0.50
Female	61	0.61	0.50

Data Analysis

The data obtained were then analyzed for its validity and reliability. The validity was measured using the Pearson product-moment correlation coefficient test. Furthermore, the reliability test was measured using Cronbach's alpha test. Items are concluded to be valid if r

count > r critical (0.30). Furthermore, items are stated to be reliable if r count > r critical (0.30).

Result and Discussion

1. Result of Instruments Validity from Experts

The problem-solving instrument consists of 12 questions. Aspects assessed on problem-solving skills are identifying problems, determining solutions, planning solutions, implementing solutions, analyzing data, making conclusions, and evaluating problem-solving results. Each aspect consists of two questions (one on physical problems and one on social problems). All questions are in the form of description questions. The instruments that have been developed are validated by experts. The percentage of the feasibility of the problem-solving instrument is 89% with a very feasible category so that it can be used to measure problem-solving skills. The results of expert validation of this research instrument can be seen in Table 2.

Table 2. Theoretical Feasibility of the Instrument Based on Expert Validation

Aspect of Validation	Score			Average (%)
	V ₁ (%)	V ₂ (%)	V ₃ (%)	
The suitability of the questions with the learning achievement	100	94	100	98
Content	88	81	88	85
Language	75	94	81	83

Note:

- V₁ (Validator 1) = Expert on Environmental Education
- V₂ (Validator 2) = Expert on Education and Learning
- V₃ (Validator 3) = Expert on Environmental Education Practitioner at Islamic Boarding School

2. Validity and Reliability of Problem-Solving Skills Instrument

The results of the study indicate that all the questions are valid so they are appropriate to be used in measuring students' problem-solving skills. There are five stages of problem-solving, namely identifying problems, determining solutions, planning solutions, implementing solutions, and evaluating the results of problem-solving. Two items represent the stages of identifying problems, determining solutions, planning solutions, and evaluating. In addition, four questions represent the implementation phase of the solution. The validity of the problem-solving skills instrument can be seen in Table 3.

Table 3. Validity and Empirical Reliability

Number	Problem-Solving Aspect	r Count	Validity	Criteria	Description
1a	Identify the problem	0.61	Valid	high	Question used
1b	Identify the problem	0.42	Valid	moderate	Question used
2a	Planning a solution	0.67	Valid	high	Question used
2b	Planning a solution	0.81	Valid	very high	Question used
3a	Implementing the solution	0.68	Valid	high	Question used
3b	Implementing the solution	0.42	Valid	moderate	Question used
4a	Implementing the solution	0.65	Valid	high	Question used
4b	Implementing the solution	0.63	Valid	high	Question used
5a	Implementing the solution	0.61	Valid	high	Question used
5b	Implementing the solution	0.54	Valid	moderate	Question used
6a	Evaluating the results of problem-solving	0.74	Valid	high	Question used
6b	Evaluating the results of problem-solving	0.63	Valid	high	Question used
Reliability of All Items		0.85	Valid	high	Question used

Note:

- Items in the form of a description of the question.
- Items are said to be valid if r count > r critical (0.30).
- Items are said to be reliable if r count > r critical (0.30).

3. Revision of Instrument

In the process of developing this instrument, there were slight improvements for the perfection of the instrument of problem-solving skills. The form of this improvement includes: 1) the reference for developing items needs to be compiled based on indicators and written systematically, 2) learning outcomes are arranged coherently and separately, and 3) it is necessary to provide sufficient space for students' answers. Based on the results of the validation the instrument's feasibility sheet has been improved and tested on students. After validation was carried out, the instrument's feasibility sheet was improved as shown in Table 4.

Table 4. Revision of Problem-Solving Instrument

Before revision	After revision
a. Systematics of instrument development reference with column order:	a. There is a change in the order of the columns, namely:
1. Number	1. Number
2. Research variables	2. Indicators of achievement.
3. Variable achievement indicators	3. Question item number
4. Code sheet	4. Question points
	5. Types of questions
	6. Realm
	7. Answer key (attached)
	8. Score

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Before revision	After revision									
instrument 5. Question points (attached) 6. Question item number (attached item) 7. Answer key (attached) 8. Score (attached) b. Learning outcomes by achievement indicators are made into a table with other variables. c. It is necessary to provide sufficient space for students answers. Write some alternative solutions to environmental problems in Islamic boarding schools related to the formulation of the problem supported by the arguments of the Qur'an, hadith, or atsar!	b. Annexes on learning outcomes by achievement indicators are compiled separately. c. The place where the students' answers are made is in the form of a table.									
	<table border="1" style="margin: auto; border-collapse: collapse;"> <thead> <tr> <th style="width: 10%;">No</th> <th style="width: 70%;">Alternative Solution to Proof of Problems</th> <th style="width: 20%;">Dalil</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">1</td> <td>Physical environment a..... b.....</td> <td></td> </tr> <tr> <td style="text-align: center;">2</td> <td>Social environment a..... b.....</td> <td></td> </tr> </tbody> </table>	No	Alternative Solution to Proof of Problems	Dalil	1	Physical environment a..... b.....		2	Social environment a..... b.....	
No	Alternative Solution to Proof of Problems	Dalil								
1	Physical environment a..... b.....									
2	Social environment a..... b.....									

The problem-solving instrument consists of 12 questions in the form of an essay. The instrument contains aspects of identifying problems (social problems and physical problems), determining solutions, planning solutions, implementing solutions, analyzing data, making conclusions, and evaluating the results of problem-solving. This is following the opinion of Greenstein (2012) that the problem-solving stage consists of identifying the problem, determining all alternative solutions, drawing up a plan, implementing the plan, and evaluating the results of problem-solving. CPTP (2014), explains in more detail that problem identification activities include: 1) analyzing facts, determining causes, stating the problem explicitly, 2) avoiding stating problems as vague solutions, and 3) identifying standards or norms that are violated by the problem. This is in line with Adair's (2007) opinion that the problem identification stage can be carried out by: 1) identifying important factors and salient facts, 2) obtaining further information about relevant policies, rules, limitations, or procedures, and 3) simplifying the problem.

Problem-solving is the stage of accepting the problem and trying to solve the problem. Problem-solving is an effort to find a way out of a difficulty and includes high intellectual activity (Nur & Ibrahim, 2000). In general, problem-solving is defined as a process of eliminating differences or discrepancies between the results obtained and the desired results (Pramana, 2006). Dakir (2004) explains that achieving the expected results is not easy so it is necessary to know the gap between reality and hope. Adair (2007) explains that the main strategy at the stage of understanding the

problem is to find the point of deviation and then identify the cause of the problem.

Based on the results of expert validation, the percentage of the feasibility of the problem-solving skill instrument is 89% with a very feasible category. It shows that this instrument can be used in research or classroom learning. This result is in line with the statement of Matondang (2009) that the assessment instrument that has been developed needs to be checked for validity. The criterion of a valid instrument is to have internal validity (rational) which is when the test items rationally (theoretically) already reflect something that is being measured (Sugiyono, 2010). The use of valid and reliable instruments is an important component in the measurement (Kimberlin & Winterstein, 2008). The instrument validation of problem-solving abilities includes expert validation and empirical validation (Kurniawan & Taqwa, 2018). The problem-solving skill test instrument was validated by experts and teachers from the aspect of content, language, and clarity with very valid criteria (Ngang et al., 2014).

The results of the test of the instrument empirically indicate that all items are valid and reliable so that they are appropriate to be used in measuring problem-solving skills. These results are by the Sugiyono (2010) statement that a good instrument is an instrument that has external validity (test items are compiled based on proven empirical facts). Making good test items needs to pay attention to aspects of theory and facts in the field. Greenstein (2012) explains that the criteria for assessing problem-solving skills are a) the problem is described supported by detailed information on the phenomenon, b) several alternative solutions that deserve to be described clearly, c) the chosen solution plan is described in detail, d) skills problem solving is demonstrated well and successfully overcomes the problem, e) the solution chosen is evaluated with logical reasons accompanied by suggestions so that further problem solving can be more optimal.

The instrument test aims to determine the validity and reliability of the items. A valid and reliable test instrument means it can be used to study. If it's not valid-not reliable means it's discarded (not used in the study). This is under the statement of Purnakanishtha et al. (2014) and Docktor & Heller (2009) that the assessment instrument is measured based on aspects of validity and reliability. The validity of the instrument shows that the test items can be used to measure something that should be measured (Sugiyono, 2010). For example, the meter is a valid tool for measuring the length and is not valid if it is used to measure weight. A reliable instrument is a test item

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that, when used several times to measure the same object, produces the same data. The problem-solving ability test instrument in online learning was analyzed based on the level of validity, reliability, discriminatory power, and level of difficulty (Setiayawan & Wijayanti, 2020). Instruments in the form of questions and questionnaires of problem-solving skills have high internal validity and reliability (Ngang et al., 2014). These results are in line with the research of several experts who showed that the problem-solving ability test instrument was declared valid and reliable with good categories in mathematics Kurniawan & Taqwa (2018) and advanced calculus material (Subekti & Widiyanti, 2014).

As it is already described that it is very important to gauge and improve the problem-solving skills. These skills are needed in this 21st century that have to be taught from Elementary to College level although in different levels of difficulty and complexity of problem-solving. These skills taught in learning process need to be measured whether these skills have been mastered by students. A diverse skill set is needed for effective problem-solving so that people, teams, and organizations may move closer to their goals. It requires the ability to define a problem, break it down into smaller, more manageable difficulties, develop creative, analytical solutions to the problem, and carry them out effectively. Students should encounter common issues throughout the evaluation of their problem-solving skills, including scheduling under various conditions, selecting the optimal course of action based on various business rules, and drawing inferences from textual and numerical data (Lutfauziah et al., 2020).

As with any ability, problem-solving requires practice, and the more students do it, the more at ease they become with the kind of analytical and critical thinking that will be used in various areas of their academic careers. Students gain more self-assurance in their ability to adapt problem-solving strategies to other subject areas, and even outside of school in their daily life, by learning how to approach subjects they are unfamiliar with or problems they do not know the solutions to. In addition, the goal in teaching problem-solving is for it to become second nature, and for students to routinely express their curiosity, explore innovative solutions, and analyze the world around them to draw their own conclusions.

Learning problem-solving techniques may help students remember and recall knowledge better. It specifically aids in reinforcing their comprehension of the subject matter when students

are asked to share their ideas and data they have investigated to explain how they arrived at their findings at the time of learning. Small-group discussions during problem-solving activities can be particularly helpful because they provide students the chance to ask and respond to questions about the novel ideas they are discovering (Haryani et al., 2021).

As it is already reported that the ability to solve problems improves metacognitive abilities as well. Metacognition which is the capacity to examine and comprehend one's own mental processes, is frequently referred to as thinking about thinking. Problem-solvers can choose the optimum course of action by considering the results of several plans of action when making decisions thanks to metacognition. Higher metacognitive abilities have also been strongly associated with better learning outcomes and better study techniques. In order to better comprehend themselves and the world around them, metacognitive students are able to reflect on their educational experiences (Shafina et al., 2020).

It can be concluded that there are the justifications for why problem-solving skills are crucial for students. By mastering problem-solving skills, it can assist students in differentiating between problems that can be resolved and issues that cannot be resolved. It is also essential for training students to deal with challenging interpersonal and academic issues. Learning how to solve problems helps students develop a greater understanding of causality. Students also grow more resilient when they work together or separately to tackle difficulties. Students gain the ability to approach issues differently, and therefore take more measured risks as a result.

Conclusion

This study aims to produce a valid and appropriate problem-solving skills instrument that can be used in the learning process. The results of the study indicate that all items are valid and reliable in the high category. The percentage of eligibility from experts (material experts, education experts, and education practitioners) is 89% with a very decent category so this instrument is declared suitable to be used to measure problem-solving skills. This instrument contains five stages of problem-solving, namely identifying problems, determining solutions, planning solutions, implementing solutions, and evaluating the results of problem-solving. The problems identified consist of two kinds, namely social problems and physical problems in Islamic boarding schools. By

mastering problem-solving skills, it can assist students in analyzing between problems that can be resolved and issues that cannot be resolved.

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