



Bringing Local Wisdom into Mathematics: Developing a Culturally-Based Problem Posing Assessment

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Abstract

This study aims to develop a local culture-based *problem-posing* test on linear programming material for eleventh-grade high school students and determine the content validity of the developed test based on expert judgment. The study employed a *Research and Development (R&D)* approach using the Four-D (4D) model. The developed test was designed to measure students' abilities in three types of *problem-posing* activities: *pre-solution posing*, *within-solution posing*, and *post-solution posing*, by integrating local cultural contexts such as economic and agricultural activities around the Sembalun area of Mount Rinjani. The validation was conducted by two mathematics education experts and one local culture expert. The results showed that the developed test achieved a high level of content validity with an average score of 3.75, categorized as *very valid*. Therefore, the local culture-based *problem-posing* test developed in this study is considered feasible and valid to be used in assessing students' abilities to formulate, develop, and solve contextual mathematical problems.

Keywords: problem posing; 4-D Thiagarajan; local wisdom; assessment

Abstract

This study aims to develop a *problem posing* test based on local culture on linear program materials for grade XI high school students and determine the validity of the content of the test developed based on expert assessment. This research uses a *Research and Development (R&D)* approach with a *Four-D (4D)* model. The test developed is designed to measure students' ability in three types of *problem posing activities*, namely *pre-solution posing*, *within-solution posing*, and *post-solution posing*, by integrating local cultural contexts such as economic and agricultural activities around the Sembalun area, Mount Rinjani. Validation was carried out by two experts in mathematics education and one local cultural expert. The validation results showed that the developed test had a high level of content validity with an average score of 3.75 which was included in the *very valid* category. Thus, the local culture-based *problem posing* test developed is declared feasible and valid to be used in measuring students' ability to formulate, develop, and solve contextual problems.

Keywords: problem posing; 4-D Thiagarajan; local wisdom; assessment

1. INTRODUCTION

The *Merdeka Curriculum* emphasizes the importance of developing critical and creative thinking skills in mathematics learning. Both of these abilities can be fostered through the development of problem-posing skills. Problem posing requires students to evaluate information, formulate questions, and explore different solutions collaboratively, which promotes critical thinking. It encourages active engagement and meaningful learning as students think critically and express their ideas during the problem formulation process (Sapta, 2019). Furthermore, problem posing also significantly enhances creativity by providing students opportunities to construct their own problems and think divergently (Hendrajaya, 2019). It stimulates mathematical creativity and creative thinking, supporting students in expressing and developing their own ideas and solutions (Winarso, 2020).

Silver and Cai (1996) classify problem posing into three forms of mathematical cognitive activity: pre-solution posing, within-solution posing, and post-solution posing. Pre-solution posing refers to the activity of formulating new problems based on given data or situations before solving any problem. Within-solution posing involves creating supporting or guiding questions during the process of problem-solving, while post-solution posing focuses on generating new or extended problems after finding the solution to an initial problem (Kertiyani, 2022).

In addition, Abu-Elwan (1999) categorize problem posing into three levels of structure, namely free problem posing, semi-structured problem posing, **and** structured problem posing. This study emphasized that the level of structure in problem posing activities influences the cognitive demands placed on students. Free problem posing allows students full autonomy to generate problems without any constraints; semi-structured problem posing provides partial guidance or specific contexts; and structured problem posing requires students to modify or reformulate given problems according to certain conditions.

In the realm of assessment, Silver and Cai also studied how to assess students' problem posing skills. Students' ability to make questions can be seen from two aspects, namely student responses and problem difficulty. Student responses can be grouped into three types, namely math questions, non-math questions, and statements. Meanwhile, the difficulty level of the questions made by students is grouped based on mathematical structure (semantics). The higher the difficulty level that students make, the higher the score obtained (Silver & Cai, 2005).

Multiple studies demonstrate the importance of problem posing assessment. Rosli et al. (2013) argue that traditional assessment methods cannot truly reveal students' learning, advocating for authentic assessment tools. Mishra et al. (2014) specifically aimed to develop a validated assessment instrument for problem posing skills, recognizing the need

to evaluate students' ability to generate meaningful questions. The assessment is critical because problem posing develops higher-order thinking skills (Nardone et al., 2010), allows students to become more responsible for their learning, and helps teachers understand students' conceptual understanding (Lin et al., 2004). Notably, Sutji Rochaminah et al. (2024) found that 65% of mathematics teachers rarely apply problem-posing tasks, highlighting a significant gap in current educational practices that underscores the urgent need for systematic problem posing skill assessment.

In linear program material, this problem posing ability is very relevant because students are not only asked to solve problems related to maximum or minimum values, but are also encouraged to create and formulate linear program problems themselves that depart from real situations. Through this activity, students learn to identify decision variables, arrange the function of goals and constraints, and understand the relationship between the real-world context and the mathematical model. Thus, problem posing is a means to foster deeper conceptual understanding as well as critical and creative thinking skills in the context of linear programs.

In addition, the potential of local culture as a learning context has often not been utilized optimally. For example, local community activities such as selling tobacco and life on Mount Rinjani can be used as a context in formulating a linear program problem. The integration of local culture not only increases the relevance of learning, but also fosters a sense of identity and cultural pride of students (Sembiring, 2019).

Therefore, the development of a problem posing test based on local culture is important as an alternative assessment that not only measures cognitive aspects, but also fosters appreciation of the surrounding culture and high-level mathematical thinking skills. Considering the urgency of the research, this study aims to a) develop a problem posing test based on local culture on linear program materials for grade XI high school students, and b) determine the validity of the content of the test developed based on expert assessment.

2. RESEARCH METHOD

This research is a research and development that aims to produce a local culture-based problem posing test on the linear program material of class XI SMAN 1 Suela. The development model used refers to the 4D model proposed by Thiagarajan, Semmel, and Semmel (1974), which consists of four stages, namely Define (define), Design (design), Develop (development), and Disseminate (disseminate). However, this research is limited to the Develop stage because the product has not been widely tested.

The first stage, namely Define, is carried out to identify and analyze the need for the development of problem posing tests. This activity includes curriculum analysis, student

analysis, and concept and assignment analysis. Based on the curriculum analysis in the mathematics subject of grade XI of high school, it was found that students are expected to be able to understand the concept of maximum and minimum grades through mathematical modeling in a real-life context. However, in practice, students are more often faced with routine problems that focus on solving problems, rather than creating new problems. Therefore, an instrument is needed that can measure students' ability to formulate linear program problems from real situations. The analysis of students also showed that students still rarely ask questions due to the lack of stimulus given to ask questions. Meanwhile, the analysis of concepts and tasks shows that linear program materials have great potential to be developed in the context of local culture, such as tobacco cultivation activities and agricultural processing products at the foot of Mount Rinjani.

The second stage is Design. At this stage, the initial design of the problem posing test based on local culture was prepared. This test is designed to measure students' abilities in three forms of problem posing activities, namely pre-solution posing (making problems from real situations), within-solution posing (modifying problems during the solving process), and post-solution posing (creating new problems based on the results of the solution). The combination of questions with mathematical situations such as graphs and the context of the local culture was chosen to bridge the gap between mathematical concepts and students' life experiences so that the problems they create feel authentic and meaningful. In addition, at this stage, assessment grids and rubrics are also prepared that contain indicators of problem posing ability, as well as the design of the display of the instrument so that it is easy for teachers and students to use.

The third stage is Develop, which focuses on the process of validating and refining the instrument. Validation was carried out by three experts, consisting of two mathematics education experts and one local cultural expert. The experts assessed aspects of content suitability, language clarity, accuracy of indicators and rubrics, and relevance of cultural context on a scale of 1 to 4 (1 = invalid, 4 = very valid).

The data obtained from expert validation is then summed and then averaged. Then, the average score is converted to categories as in Table 1. (Ratumanan & Laurens, 2016) . An instrument is used if the instrument has been validated with category valid and has been revised.

The validation results are used as a basis for revising the product, both in terms of question writing, clarity of instructions, and suitability of cultural context. This revision aims to ensure that the instrument is truly in accordance with the objectives of the problem posing capability assessment.

Table 1. Categories Test Quality

Interval Score	Category	Information
$1 \leq P \leq 1.75$	Very invalid	Not yet usable
$1.75 \leq P \leq 2.75$	Invalid	Can be used with multiple revisions
$2.75 \leq P \leq 3.25$	Valid	Can be used with intermediate revision
$3.25 \leq P \leq 4.0$	Very valid	Can be used with minor revisions

Note: P= average score of two validators

3. RESULT AND DISCUSSION

This research produced a product in the form of a local culture-based problem posing test on the linear program material of class XI high school. This test was developed based on three forms of problem posing activities, namely pre-solution posing, within-solution posing, and post-solution posing. Each form is designed to measure students' ability levels to formulate and create mathematical problems that are meaningful, logical, and contextual to their lives.

In the preparation of the test grid, each indicator of problem posing ability is associated with the relevant local cultural context. Table 2 presents the results of the problem posing skill test grid.

Table 2. Problem Posing Skill Test Grid

Number	Types of Posing Problems	Learning Objectives	Competency Achievement Indicators	Stimulus/Question Description	Task Form	Types of Expected Responses
1	Pre-Solution Posing	Students are able to create mathematical models of the given problems using the concept of maximum and minimum values.	Students can formulate questions using all the information provided in the questions	Situation: Given the situation in the problem in the form of two straight line equation graphs in the Cartesian plane and the three regions formed from the intersection of the graph.	Students are asked to create possible problems from the situation by utilizing the whole situation and relating to the concept of maximum or minimum value and its solution	The pre-solution type math question posed using the concepts of maximum and minimum values.
2	Post-Solution Posing	Students are able to create and develop new questions	Students can ask follow-up questions of existing solutions as	Examples of problems are given by teachers and	Students create new questions that modify the condition or expand on the problem.	Post-solution posing type math questions.

Nu mb er	Types of Posing Problems	Learning Objectives	Competency Achievement Indicators	Stimulus/Qu estion Description	Task Form	Types of Expected Responses
		related to linear programs based on the solutions obtained.	well as modify new problems.	their students.		
3	Within-Solution Posing	Students are able to solve contextual problems using linear program steps.	Students can explain relevant questions to help with the completion process (determining the corner point, optimal grade).	Given problems in the form of story questions related to the local context of culture containing several vehicles	Students explain questions to help solve them until they find the optimal solution.	Within-solution type math questions.

The problem posing test grid in this linear program material was developed based on three types of problem posing activities, namely pre-solution posing, within-solution posing, and post-solution posing. These three types represent the stages of thinking students in understanding, investigating, and creating mathematical problems. This approach was chosen because it is able to assess students' high-level thinking skills more comprehensively, starting from the ability to understand situations, ask relevant questions during the resolution process, to creating new problems based on the solutions that have been obtained.

In the pre-solution posing type, students are given a mathematical situation in the form of two straight line equation graphs that form several regions in the Cartesian plane. The goal is to see the extent to which students can analyze the available information and convert it into meaningful math problems. In this context, students are expected to formulate questions involving the concept of maximum and minimum values of objective functions, as well as determine their mathematical models. This type is very important because it describes the student's initial ability to identify important elements of a real situation and formulate new problems logically. This activity trains students to think divergently, find relationships between variables, and construct problems that can be solved using linear program concepts.

Furthermore, in the within-solution posing, students are faced with contextual problems rooted in local culture, such as resource management in the production of woven fabrics, agricultural products, or regional crafts. In this stage, students are asked to ask small,

relevant questions to help the problem-solving process, such as determining the corner points of the solving set area or finding the optimal value of the objective function. This type of problem posing encourages students to think reflectively during the problem-solving process, so that they not only follow the procedure, but also understand the reasoning behind each step. Thus, within-solution posing serves as a bridge between the student's conceptual understanding and procedural abilities.

The third type, post-solution posing, focuses on the student's ability to develop new problems based on previously acquired solutions. In this activity, students are asked to modify the condition of the problem, change the parameters, or expand the scope of the problem. For example, after finding the maximum value of the profit of a linear program model, students can be asked to think about how the outcome would change if one of the constraints were modified or if economic conditions were different. This activity hones students' evaluative and creative abilities because it requires them to think critically about the results obtained and create new and meaningful variations of problems.

To assess the results of student work, a problem posing assessment rubric was also prepared which is presented in Table 3.

Table 3. Problem Posing Assessment Rubric

Number	Types of Posing Problems	Aspects Assessed	Description of Student Performance	Score
1	Pre-Solution Posing	1. The relevance of the question The context of the problem. 2. Complete use of information in the given situation 3. Accuracy of the solution of the question made	0 = Irrelevant answer 1 = Descriptive statement 2 = Question relevant, but does not use information on a given situation; 3 = Relevant questions, but use some of the information in a given situation 4 = Relevant questions using all the information on the problem and logical 0= solution does not exist; 1=Partially correct solution; 2=complete and correct solution	0-6
2	Post-Solution Posing	1. The relevance of the question to the resolution step. 2. The logic of the reason for making the question.	0 = Irrelevant question and answer 1 = Irrelevant question or question made in line with the previous question and the reason for choosing a logical question 2 = Question made is different from the previous problem but still uses information from the question; Reasons for choosing logical questions 4 = Questions that are made complex and contextual using problems from the previous with the correct solution; Reasons for Creating Logical Questions	0-4

Number	Types of Posing Problems	Aspects Assessed	Description of Student Performance	Score
3	Within-Solution Posing	1. The relevance of the question to the context of the problem. 2. Logic of question selection	0 = Not answering 1 = Irrelevant question 2 = Relevant question but reason for choosing an illogical question 3 = Relevant question and logical choice reason 4 = Relevant questions and reasons for choosing logical and in-depth questions	0–4

The assessment rubric in this problem posing test is designed to provide clear and objective guidelines in assessing the quality of student work based on three types of problem posing activities: pre-solution posing, within-solution posing, and post-solution posing. Each type has a different aspect of assessment according to the characteristics of the thinking process being measured. In general, this rubric assesses students' abilities in three main dimensions, namely relevance to the context of the problem, reasoning, and accuracy of solutions.

In the type of pre-solution posing, the aspects assessed include the relevance of the context of the problem, the completeness of the use of information, and the accuracy of the solution of the questions made. These three aspects reflect the student's ability to construct new problems from a given situation comprehensively and logically. Students who are able to use all the information from the stimulus and relate it to the concept of maximum or minimum values demonstrate a strong conceptual understanding of linear program models. The highest score is given to students who can generate relevant questions, use all the information on the questions, and provide complete and correct solutions. On the other hand, students who only make descriptive statements without building mathematical relationships get low scores because they have not shown real problem posing skills.

In within-solution posing, the assessment rubric focuses on the relevance of the question to the context of the problem and the logic of the question selection. This type assesses students' ability to think reflectively during the problem-solving process, i.e. how they ask questions to help find optimal solutions. Questions relevant to the local cultural context, for example related to the use of weaving materials or the distribution of crops, show that students are able to understand real problems while integrating mathematical elements in them. The highest score is awarded to students who not only ask relevant questions, but are also able to explain the reasons for their selection logically and in depth. This shows critical thinking skills and high metacognitive abilities.

Meanwhile, in post-solution posing, the rubric is designed to assess the relevance of the question to the solution step and the logic of the reason for making the question. The main focus of this assessment is the student's ability to develop or modify new problems based

on the results of previous completion. High scores are given to students who are able to ask complex and contextual questions, use information from previous questions, and provide logical reasons for creating the new problem. This type of ability shows a higher level of creative thinking because students not only understand the completion procedure, but are also able to experiment and create new meaningful situations. Thus, post-solution posing plays an important role in measuring students' ability to synthesize and innovate ideas.

The expert validation process was carried out by two mathematics education lecturers and one local cultural expert. The validators assessed aspects of content, language, construct, and cultural relevance using a four-level scale (1 = invalid to 4 = very valid). The validation results showed that this local culture-based problem posing test obtained an average score of 3.75 which is included in the very valid category. The aspect with the highest score is the relevance of local culture (3,9), which indicates that the cultural context used is considered to be very appropriate to the characteristics of the region and can help students understand the concept of linear programs in a more meaningful way. The content suitability aspect obtained a score of 3.8, the language clarity aspect 3.6, and the rubric accuracy aspect 3.7.

The validator also provided some constructive input. Table 4 presents the input of the two validators.

Table 4. Feedback from the Validator

Validator	Input
Validator 1	It is better that the cultural context should not only focus on economic sectors such as tobacco distribution, but also include activities involving activities around Mount Rinjani.
Validator 2	Some question instructions are made more explicit so that students do not interpret the context of asking too broadly to facilitate assessment, for example question number 1. Question number 2 should be made more contextual to make it easier for students to make questions.

Based on input from the validator, revisions were made related to the test instrument. Figures 1 and 2 show the results of the revisions made. Question 1 revision is based on input to make specific question creation commands related to maximum or minimum values. Meanwhile, the second question was revised based on input from the validator to add activities around Mount Rinjani and make the question more contextual. Therefore, question number two was changed by using story questions related to strawberries and edamame that are often found in the area around rinjain, namely Sembalun.

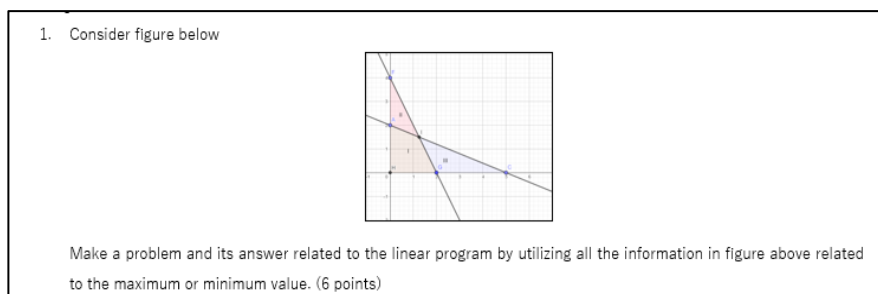
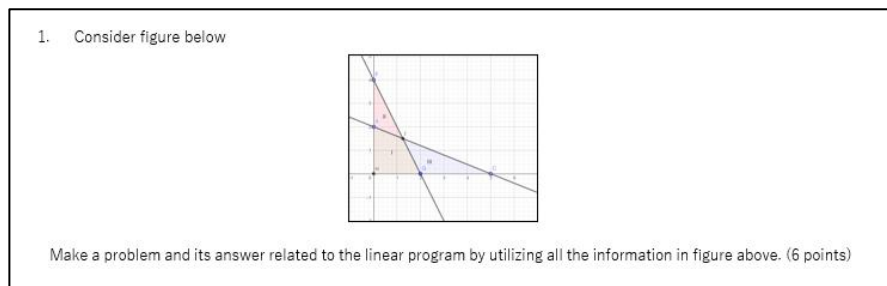


Figure 1. Revised Question for Question Number 1

2. The teacher previously gave practice questions to students. "Specify the maximum value on the following set of inequality solutions $z = 3x + 4y$; $x + 2y \leq 104$; $x + 3y \leq 24$; $x \geq 0$; $y \geq 0$." The answer is "The maximum value of is 23.6 at the corner $(\frac{18}{5}, \frac{16}{5})$. Suppose you as a student are asked to make another question as a development of this question by replacing the information from the previous question. What questions will you make? Why? (4 points)



The teacher previously gave practice questions to students. "Rizki is on vacation to a fruit orchard tour in Sembalun. Rizki bought a few kilograms of strawberries and Edamame. The amount purchased is at least 5 kilograms, where Edamame is a maximum of 3 kilograms. The price per kilogram of Strawberry and Edamame fruit is Rp. 50,000 and Rp. 25,000, respectively, and Riki has Rp. 650,000. How many kilograms maximum of each Strawberry and Edamame can Rizki buy? Suppose you as a student are asked to make another question as a development of this question by replacing the information from the previous question. What questions will you make? Why? (4 points)




Figure 2. Revised Question for Question Number 2

The results of this development show that the local culture-based problem posing test has the potential to be an authentic assessment instrument that not only measures mathematical ability, but also encourages students to think critically and creatively. Problem posing activities require students to observe real situations, identify mathematical elements, and create new relationships between variables. In the process, students naturally train high-level thinking skills, such as reflection, analysis, and

creation. This finding is in line with the view of Silver (1994) who stated that problem posing is one of the most complex cognitive activities in mathematics learning, because it involves understanding concepts, logical reasoning, and imagination in formulating new problems.

In addition, the use of local cultural contexts makes learning mathematics more meaningful. When students create problems based on the realities in their environment, they not only master mathematical concepts, but also foster a sense of belonging and appreciation for the local culture. This supports the opinion of Haka et al that learning materials presented in a contextual manner can create more meaningful learning experiences for students (Haka et al., 2020). Contextual teaching materials involve elements from students' immediate environment, such as local culture and regional potential, which are more specific than the general textbooks available on the market (Gayatri et al., 2018; Gusweri & Rifai, 2019). Thus, the development of local culture-based problem posing tests not only contributes to assessment innovation, but also to efforts to preserve cultural values through mathematics education.

4. CONCLUSION

The results of the development showed that the problem posing test that was prepared contained three types of problem posing, namely pre-solution posing, within-solution posing, and post-solution posing, each of which was designed to assess students' ability to formulate and develop contextual mathematical problems. The integration of the local cultural context, such as the problems in the economic activities of the Sembalun community, makes the questions more meaningful and relevant to the lives of students. In addition, the results of validation by experts show that the test instrument has high **content** validity, both in terms of material suitability, question construction, and the integration of local cultural context in measuring problem posing ability. Thus, it can be concluded that the local culture-based problem posing test in this linear program material is suitable for use as a tool to measure students' problem posing ability.

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6. RECOMMENDATION

Based on the findings of this study, several recommendations can be proposed. First, the developed local culture-based problem posing test can serve as an effective assessment tool to measure students' abilities to formulate and extend mathematical problems in meaningful, contextual situations. Second, future researchers are advised to conduct wider implementation and empirical validation of this test across different schools and

regions to strengthen its reliability and generalizability. Further studies could also explore the effectiveness of problem posing assessment in improving students' higher-order thinking skills through experimental or quasi-experimental designs.

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