



## Designing Contextual Mathematical Literacy Task to Enhance Junior High School Students' Understanding of Statistics

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ARTICLE INFO	ABSTRACT
<b>Published Online:</b> 21 November 2025	This study aims to develop a contextual, stage-structured design of mathematical literacy tasks, starting from routine and familiar problems to build basic understanding, and gradually progressing to problems that require higher-level reasoning. The research employed the Design and Development Research (DDR) method, involving three stages: analysis, design, and development. The study produced two tasks that each represent the mathematical literacy process aspects within the statistics content area (uncertainty and data). The tasks were developed based on mathematical literacy indicators, including the processes of formulating, employing, and interpreting. These progressively structured tasks are designed to bridge the gap between commonly taught routine problems and complex literacy problems such as those in PISA, and are expected to reduce cognitive load in solving contextual mathematical literacy tasks. This study contributes to the development of contextual assessment instruments that align with students' stages of thinking. However, the limitation of this study lies in the fact that it only reached the development stage and has not yet included an evaluation of its effectiveness.
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<b>KEYWORDS:</b> Mathematical Literacy; Statistics; Task Design	

### I. INTRODUCTION

Students' mathematical literacy skills in Indonesia in PISA 2022 fell by 13 points to 366 from the previous year's score of 379. This figure is far from the international average score of 472 [1]. However, the role of mathematical literacy is very important because mathematical literacy is one of the keys to success in learning mathematics [2]. Defines mathematical literacy as the knowledge to understand and apply basic mathematics in everyday life. Thus, literacy skills are very important for individuals to solve problems related to their daily lives. In addition, the importance of mathematical literacy is also explained by Christiansen because it can help students apply mathematical concepts in their daily lives. According to the OECD in the PISA Framework, the mathematical literacy thinking process includes three types of processes, namely: Formulated; Employ; Interpreted [4].

The mathematics literacy questions tested in PISA examine three aspects, namely content, context, and process. The OECD divides the content aspect into four parts, namely change and relationships, space and shape, quantity, and uncertainty and data. The content of uncertainty and data is related to statistics material at the junior high school level.

Mathematical literacy in statistics can also be referred to as statistical literacy. This is because statistical literacy is the ability to read and interpret data or the ability to use statistics as evidence in arguments. In addition, statistical literacy also includes the competence to think critically about statistics [5].

Statistical literacy generally examines the development of students' statistical knowledge [6] or defines how to use statistical knowledge in the real world [7]. However, in line with the importance of statistics in real life, many studies have highlighted aspects of statistical literacy and critical thinking habits regarding data. For example, research by Yotongyos et al., shows that students tend to have low statistical literacy and suggests the importance of strengthening statistical concepts from an early age [8]. In line with the study by Watson and Moritz which shows that statistical understanding develops gradually from elementary to middle school age, but many students still show misconceptions or unstable understanding, so the ability to think critically about data needs to be developed earlier and systematically [9].

Research conducted by Kurnia et al., also shows that most Indonesian ninth-grade students are still at the "consistently non-critical" level in responding to statistical

information, and almost none have reached the highest level of mathematical critical thinking [10]. This shows that students are not yet sufficiently equipped to be competent and reflective data consumers. This poses a major challenge in the skill of interpreting statistical graphs such as line graphs, highlighting the need for more meaningful and targeted learning interventions. Although Bailey and McCulloch have developed the Critical Statistical Literacy Habits of Mind (CSLHM) framework, which emphasizes the importance of critical thinking habits in understanding and evaluating data, the research is still limited to the context of teachers and has not touched on its implementation in the design of learning tasks for secondary school students [11].

In Indonesia, many researchers have developed mathematical literacy questions, such as the research conducted by Amalia & Malasari on the development and analysis of students' abilities in solving PISA model statistics questions [12]. The results of this study show that many students still have difficulty solving mathematical literacy questions, and most students feel confused in understanding the questions, so it is recommended that more intensive practice be carried out in mathematics learning. In addition, the lack of specially designed questions that match students' potential and character means that students' potential to use reasoning in answering questions has not been developed [13]. The results of the study show that weak conceptual mastery and students' lack of familiarity with solving story problems are the main causes of students' mistakes in solving problems and their lack of literacy skills [14]. The results of previous studies indicate that students' statistical literacy skills can be improved through certain processes [15]. In this case, various real-world problems are recommended to explore the statistical value of data, so that this type of data can support statistical interpretation skills [16].

Based on several previous studies, there have been many studies that develop mathematical literacy questions, especially on statistics. However, most of these developments tend to refer to the characteristics of PISA questions, which are complex in nature. This is certainly very good in encouraging students' higher-order thinking skills. However, researchers assume that students who are accustomed to working on procedural questions, such as those in examples, will experience confusion and hindered understanding when directly confronted with PISA questions. This is in line with Sweller, who explains that the cognitive load incurred by a person when using complex problem-solving strategies such as means-ends analysis may be a more important factor in disrupting the learning process when solving problems [17].

Therefore, this study aims to develop a contextual-based mathematics literacy question design that is structured in stages, starting with routine and familiar questions to build basic understanding, then gradually increasing to questions that require students to develop their reasoning skills. This approach is expected to bridge the gap for students to be

better prepared to face non-routine questions without sacrificing their confidence and motivation to learn.

## II. RESEARCH METHODS

This study uses Design and Development Research (DDR). DDR is a systematic study of the design, development, and evaluation processes with the aim of building an empirical basis for the creation of products, instructional tools, non-instructional tools, and new or improved models that regulate their development [18]. The research design applied in this study was through a cycle of designing mathematics literacy questions on junior high school statistics material, which involved the processes of analysis, design, and development. This study used three instructional development steps to create question designs, namely Analyze, Design, Development (ADD) [19].

The analysis stage involves developing sample questions that have been planned in advance. It begins with an analysis of the urgency of mathematical literacy skills in mathematics learning. This is followed by exploring examples of questions about mathematical literacy that have been developed previously so that they can be used as preliminary knowledge for developing mathematical literacy questions in this study. The design stage of this study involves writing a design for contextual mathematical literacy questions based on statistics material. An important aspect of the literacy questions in this study is that they are designed in stages in terms of their solution process, in order to develop students' thinking skills. The development stage involves creating questions and discussions.

## III. RESULTS AND DISCUSSION

The stages discussed in this study include analysis, design, and development. The following are the stages that have been carried out.

### Analysis

Statistics is one of the essential subjects in the junior high school curriculum in Indonesia, as it provides students with the opportunity to develop critical thinking skills in collecting, organizing, analyzing, and interpreting data. Understanding statistics requires not only basic mathematical knowledge such as number operations and data representation, but also the ability to interpret information in real-life contexts. In the context of mathematical literacy, the content of uncertainty and data is used to interpret and evaluate data, understand probabilities, and draw conclusions from uncertain phenomena [4]. Data representation in statistics can be presented in the form of tables, graphs, diagrams, and narratives. Understanding the relationship between data and the ability to communicate findings are important aspects in designing contextual-based mathematical literacy questions, which enable students to relate mathematical concepts to real-world situations.

## “Designing Contextual Mathematical Literacy Task to Enhance Junior High School Students’ Understanding of Statistics”

### Design

This stage aims to design mathematics literacy questions on statistics. The steps in this design stage are to adjust the material, ensure that the questions consist of a context domain that is in line with the components of the mathematics literacy process, and ensure that the questions are related to everyday life and in line with the mathematics literacy indicators. The mathematics literacy indicators can be seen in Table 1 below.

**Table 1. Indicators of Mathematical Literacy Process Components**

No.	Process Components	Mathematical Literacy Ability Indicators
1.	<i>Formulate</i>	Presenting situations in mathematical form by utilizing relevant mathematical models.
2.	<i>Employ</i>	Designing and implementing strategies to obtain mathematical solutions.
		Using rules, procedures, algorithms, and mathematical frameworks in the search for solutions.
3.	<i>Interpret</i>	Evaluating mathematical solutions in relation to context.
		Provide an explanation of why a solution is considered logical or illogical, according to the context of the problem given.

Examples of mathematics literacy questions are often developed based on PISA questions that require students to use higher-order thinking skills. Here is an example of a question similar to a PISA question on statistics.

The following results show the results of a survey on students' study time during the week:

Day	Study time (Hours)
Monday	2
Tuesday	3
Wednesday	2
Thursday	4
Friday	3
Saturday	1
Sunday	1

Have the students studied enough during the week? Compare with the minimum standard of 14 hours per week and provide statistical reasons.

The example question above presents a mathematical literacy question developed in general statistics material that directly refers to the complex PISA question model and requires high reasoning skills, because in this question students are directly asked to argue and draw

conclusions. This results in a cognitive load that causes difficulties for students, so that students with low cognitive abilities will answer these contextual questions according to their individual reality (reality bounded). Therefore, a question design that is structured in stages is needed. For example, the first question is a simple calculation, such as a routine question, starting with routine questions to build students' basic understanding, then increasing to questions that require application, and finally reaching non-routine questions that require reasoning and reflection. By answering these questions in stages, it is hoped that it will be easier for students to answer more complex questions. The presentation of the questions can be seen as follows.

### Question 1:

Please read the information below carefully!

#### OLIMPIADE SAINS NASIONAL (OSN)

The National Science Olympiad (OSN) is a national academic competition held annually by the National Achievement Center. The OSN involves students from all provinces in Indonesia, including elementary, junior high, and high school/equivalent levels. The OSN covers various fields of science such as mathematics, natural sciences, social sciences, informatics, and others. This event was first held in 2002 and has since become a benchmark for the scientific achievements of Indonesian students. OSN winners not only bring home medals, but also often represent Indonesia in international science competitions. The following is data on medal wins in Java in 2024 at the junior high school level.

Province	Types of Medals		
	Gold	Silver	Bronze
Jawa Barat	1	3	2
D.I. Yogyakarta	1	5	3
Jawa Tengah	3	2	4
Jawa Timur	2	5	0
D.K.I Jakarta	3	6	5

source: <https://pusatprestasinasional.kemdikbud.go.id/pen-gumuman/smp/penetapan-pemenang-olimpiade-sains-nasional-osn-smpmtssederajat-tahun-2024-2024-smp>

Based on the information provided, answer the questions below!

- Sarga wants to see the trends in gold, silver, and bronze medals won by provinces on the island of Java at the 2024 National Science Olympiad. Among line, bar, and pie charts, choose the chart that you think is most suitable for illustrating this data, and create the chart!
- Calculate the average number of medals (gold, silver, and bronze) won by each province on the island of Java at the 2024 National Science

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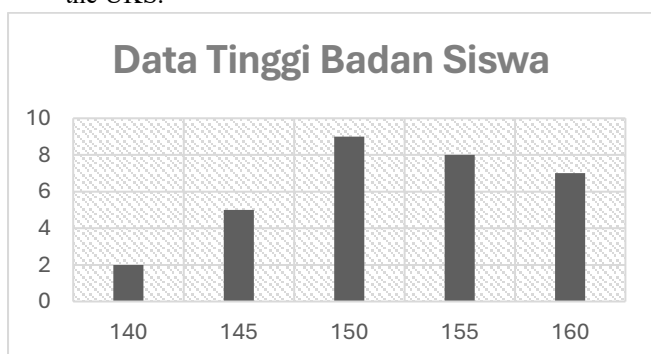
Olympiad. Then, explain what you can conclude from these average results!

- c. From the table above, Sarga states that of the three types of medals, gold medals were the least obtained by provinces on the island of Java at the 2024 National Science Olympiad. Provide your reasons systematically to support or reject Sarga's statement!

Question 1 is designed in stages to develop students' mathematical literacy skills with a long narrative presentation and questions that begin with basic or procedural questions, asking students to convert data from tables to diagrams that are considered suitable for presenting the data. This is followed by questions asking students to find the average, where in this part of the question students begin to use their procedural understanding to find the average medal count. Finally, in question 1c, students are asked to analyze whether the conclusions drawn from the OSN data of students on the island of Java are correct or incorrect and to provide systematic supporting arguments by linking mathematical concepts to real life. This gradual arrangement allows students to progressively build conceptual understanding while honing their reasoning, assessment, and data-based decision-making skills.

### Question 2:

Regular health check-ups at the Harapan Bangsa Junior High School UKS begin at 8:00 a.m. Each student who participates in this activity must first register and have their temperature taken. Next, they undergo weight and height measurements. The measurement data is then recorded by UKS staff and entered into the student health book. After the examination is complete, students are given healthy snacks in the form of milk and fruit. The examination is conducted by 2 UKS staff and 3 accompanying teachers. The following is the height data of students who participated in the health check-up at the UKS.



Based on the information presented, answer the following questions!

- a. How many milk cartons need to be prepared if each student gets one carton? Explain your calculation!

- b. If the students' height data within the interquartile range is ideal, then how many students have ideal height?
- c. What can you conclude about the height of Harapan Bangsa Junior High School students from the data shown in the diagram above?

Question 2 is designed to train students to understand and evaluate statistical data in a real-world context through data representation in the form of diagrams. Question 2 is also designed in stages, beginning with routine questions that ask students to calculate the number of students by reading the bar chart. This is followed by conceptual and procedural questions that ask students to calculate the interquartile range of the height data and the number of students, and to conclude how many students have an ideal height. In part 2b, students need to sort the data first, then find the lower quartile ( ) and upper quartile . Next, students will calculate how many students are within the interquartile range and draw conclusions. Finally, in question 2c, students are asked to conclude or interpret the data from the bar chart provided, where students are given the freedom to draw conclusions using the concepts of mean, median, or mode from the data.

### Development

Researchers developed questions that were designed to present steps of mathematical literacy in solving mathematical problems. Based on the OECD (2023), the process domain includes three subdomains, namely formulate, employ, interpret, and evaluate. Formulate: at this stage, students simplify real-life situations with mathematical models according to their correct understanding. Employ: at this stage, students use mathematical concepts, facts, procedures, and reasoning to solve problems. Interpret and Evaluate: at this stage, students interpret the solutions to problems in an authentic context that corresponds to the problems given.

The following is a solution to a sample math literacy question based on the process domain aspect of uncertainty and data content, specifically statistics, in solving problems related to everyday life. For junior high school students, statistics is a continuation of simple data processing learned at the previous level, namely in the material on data and diagrams, where this material serves as the basis for understanding more complex data presentation and analysis in statistics. More broadly, while studying this topic, students can explore the role of statistics in collecting, presenting, and interpreting data related to everyday life.

**Table 1. Steps for Solving Mathematical Literacy Problems**

<p>1.a Sarga wants to see the trends in gold, silver, and bronze medals won by provinces on the island of Java at the 2024 National Science Olympiad. Among line, bar, and pie charts, choose the chart that you think is most suitable for illustrating this data, and create the chart!</p>																								
<p><b>Answer:</b> Bar chart, with the requirement that there must be a chart title, vertical and horizontal axes, rectangular bars, and differences in bars for each type of medal.</p>																								
<table border="1"> <caption>Data for Perolehan Medali OSN (Bar Chart)</caption> <thead> <tr> <th>Provinsi</th> <th>Jenis Medali Emas</th> <th>Jenis Medali Perak</th> <th>Jenis Medali Perunggu</th> </tr> </thead> <tbody> <tr> <td>Jawa Barat</td> <td>1</td> <td>3</td> <td>2</td> </tr> <tr> <td>D.I.</td> <td>1</td> <td>5</td> <td>3</td> </tr> <tr> <td>Jawa Tengah</td> <td>3</td> <td>2</td> <td>4</td> </tr> <tr> <td>Jawa Timur</td> <td>2</td> <td>5</td> <td>6</td> </tr> <tr> <td>D.K.I.</td> <td>3</td> <td>4</td> <td>5</td> </tr> </tbody> </table>	Provinsi	Jenis Medali Emas	Jenis Medali Perak	Jenis Medali Perunggu	Jawa Barat	1	3	2	D.I.	1	5	3	Jawa Tengah	3	2	4	Jawa Timur	2	5	6	D.K.I.	3	4	5
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<table border="1"> <caption>Data for PEROLEHAN MENDALI OSN (Line Diagram)</caption> <thead> <tr> <th>Provinsi</th> <th>Jenis Medali Emas</th> <th>Jenis Medali Perak</th> <th>Jenis Medali Perunggu</th> </tr> </thead> <tbody> <tr> <td>Jawa Barat</td> <td>1</td> <td>3</td> <td>2</td> </tr> <tr> <td>D.I.</td> <td>1</td> <td>5</td> <td>3</td> </tr> <tr> <td>Jawa Tengah</td> <td>3</td> <td>2</td> <td>4</td> </tr> <tr> <td>Jawa Timur</td> <td>2</td> <td>5</td> <td>6</td> </tr> <tr> <td>D.K.I.</td> <td>3</td> <td>4</td> <td>5</td> </tr> </tbody> </table>	Provinsi	Jenis Medali Emas	Jenis Medali Perak	Jenis Medali Perunggu	Jawa Barat	1	3	2	D.I.	1	5	3	Jawa Tengah	3	2	4	Jawa Timur	2	5	6	D.K.I.	3	4	5
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<p>1.b Calculate the average number of medals (gold, silver, and bronze) won by each province on the island of Java at the 2024 National Science Olympiad. Then, explain what you can conclude from these average results!</p>																								
<p><b>Answer:</b></p> <ul style="list-style-type: none"> <li>➤ Calculating Total Medal Count Gold Medal = 1 + 1 + 3 + 2 + 3 = 10 medal Silver Medal = 3 + 5 + 2 + 5 + 6 = 21 medal Bronze Medal = 2 + 3 + 4 + 0 + 5 = 14 medal</li> <li>➤ Calculating the average number of medals <math>\bar{x} = \frac{10+21+14}{3} = \frac{45}{3} = 15</math></li> </ul>																								
<p>1.c From the table above, Sarga states that of the three types of medals, gold medals were the least obtained by provinces on the island of Java at the 2024 National Science Olympiad. Provide your reasons systematically to support or reject Sarga's statement!</p>																								

<p><b>Answer:</b> Based on 1b, it is known that the total number of gold medals won by the provinces on the island of Java was 10, silver medals was 21, and bronze medals was 14. Therefore, it can be concluded that Sarga's statement is correct because of the three medals won, gold medals were the least.</p>
<p>2.a How many milk cartons need to be prepared if each student gets one carton? Explain your calculation!</p>
<p><b>Answer:</b> Determine the total number of students based on the diagram</p> <ul style="list-style-type: none"> <li>➤ Total students based on height A height of 140 : 2            A height of 155 : 8 A height of 145 : 5            A height of 160 : 7 A height of 150 : 9 Total = 2 + 5 + 9 + 8 + 7 = 31 student</li> <li>➤ Conclusion Since there are 31 students, 31 milk cartons need to be prepared if each student receives one carton.</li> </ul>
<p>2.b If the students' height data within the interquartile range is ideal, then how many students have ideal height?</p>
<p><b>Answer:</b></p> <ul style="list-style-type: none"> <li>➤ Searching <math>Q_1</math> <math>Q_1 = \frac{1}{4}(30 + 1) = \frac{32}{4} = 8</math> The eighth data point is 145.</li> <li>➤ Searching <math>Q_3</math> <math>Q_3 = \frac{3}{4}(30 + 1) = \frac{96}{4} = 24</math> The 24th data is 155</li> <li>➤ Conclusion Since the interquartile range is <math>Q_3 - Q_1</math>, the range between is <math>Q_3 = 155</math> dan <math>Q_1 = 145</math> which has an ideal height of 17 students.</li> </ul>
<p>2.c What can you conclude about the height of Harapan Bangsa Junior High School students from the data shown in the diagram above?</p>
<p>From the diagram presented, it can be concluded that most students are 150 cm tall, namely 9 students, and only a few students are 140 cm tall, namely 2 students. Based on answer 2b, there are 14 students who do not fall into the category of having an ideal height.</p>

Mathematical literacy is an individual's ability to apply their mathematical knowledge in solving problems in their daily lives or contextual problems. The provision of contextual problems in this study aims to measure students' mathematical literacy skills. Students who have a good understanding of statistics can smoothly perform all steps, such as organizing data, calculating measures of central tendency, and interpreting results. In addition, students with

a good understanding of statistics can understand the function of each measure of data central tendency. However, for novice students, even a single step such as understanding the context of the question or choosing the right measure between the mean and the median can be a challenge. If students only understand part of the question or fail to relate the information in the text to visual elements such as graphs or tables, this will affect how they model the situation. As a result, students risk forming incorrect or overly simplified models, leading to errors in interpreting and solving the given mathematical literacy problems.

#### IV. CONCLUSIONS

This study produced two questions regarding uncertainty and data in statistics, which is one of the subjects that must be studied by high school students in Indonesia and one of the subjects that some students find difficult to solve problems in. This study contributes to the development of mathematics literacy instruments that are easier for students to understand because they are presented in stages and are relevant to everyday life. The limitation of this study lies in the research method, which only covers the development stage. In the future, this study is expected to be conducted using a comprehensive method, covering the evaluation stage as well.

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