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BRIDGING CULTURE AND CONCEPTS: EXPLORING STATISTICS COMPETENCY THROUGH JAVANESE *WAYANG* CULTURE

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Abstract: The purpose of this study was to determine how the application of *wayang* culture facilitated the abstraction abilities of junior high school students in learning statistics. The participants of this study were eighth-grade students from a junior high school in Baran Village. Data collection techniques included observation, exploration, tests and interviews. The results of this study indicate that the fundamental mathematical aspects found in *wayang* can be implemented in contextual mathematics learning for junior high school, especially in statistics material. This conclusion is reinforced by the test results where 75% of participants obtained correct answers with scores above 85. This study implies that *wayang* culture-based learning has strong potential for application in formal mathematics education in schools.

Keywords: wayang, ethnomathematics, wayang motifs, wayang inlay, wayang making, grounded theory

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INTRODUCTION

In the teaching and learning process, teachers play a crucial role in enhancing students' abilities and therefore require strong classroom management skills. Integrating cultural concepts is one effective strategy for classroom management in the learning process. Culture refers to a whole way of life-material, intellectual, and spritual (Williams,1983). According to Koentjaraningrat, as cited in Setiawan (2010), culture is the entire system of ideas, actions, and human creations in social life that are acquired and embraced by individuals through learning. Sari (2021) defines culture as the daily activities of a human group passed down through generations, thereby forming habits. One of the learning areas found at all levels of education in Indonesia and considered fundamental content is mathematics.

In Piaget's theory of cognitive development, students aged 11-13 are usually in

the formal operations stage. At this stage, they develop the capacity for abstract thought, deductive logic, and the understanding of more complex concepts. This enables them to recognize that problems may have multiple solutions and to engage in critical thinking. To maximize the use of culture in the learning process, ethnomathematics emerges as a culture-based pedagogical approach. The presence of ethnomathematics can bridge the gap between education and culture (Sasongko, & Rofiki, 2022). Ethnomathematics is 'mathematics practised among identified cultural groups such as national societies, tribes, groups, workers, children and specific groups and professional classes' (D'Ambrosio, 1985). Ethnomathematics is also understood as the study of mathematical aspects within the culture of local communities, where each region possesses unique cultural characteristics that can be associated with mathematics (Marsigit *et al*., 2014). It can be concluded that ethnomathematics can assist educators in maximizing the mathematics learning process in the classroom by simplifying the conversion of abstract mathematics into concrete everyday conditions.

Cultural content that can be used in ethnomathematics-based learning is highly diverse. For instance, a study by Auliya (2018) explored mathematical concepts in calligraphy as a learning resource for elementary schools from an ethnomathematical perspective. Specifically, the process of making calligraphy involves concepts of reflection and rotation, while the calligraphy forms themselves contain flat shapes such as circles, squares, rectangles, and triangles. Another study by Agusdianita, Karjiyati, & Kustianti (2021) showed that Ethnomathematics Ark could improve the mathematical literacy skills of elementary school students. Thus, ethnomathematics makes learning mathematics for students more meaningful, active, innovative, creative, and fun.

Kustijono & Wiwin (2014) define statistics as a science that studies and develops principles, methods, and procedures for collecting, compiling, presenting, analyzing Janna (2020), and drawing mathematical conclusions form statistical data sets (Jusmiana, 2020). Given this comprehensive function, statistics serves as a solution to overcome problems in human life Sholikhah (2016) and forms the basic for the development of science and technology, interpreted procedurally based on phenomena in everyday life, the community environment, and scientific advancement (Lanani, 2016). Therefore, it is crucial for students to learn statistics meaningfully (Santoso, 2017). For example, research conducted by Sari & Rahmawati (2021) developed local culture-based student worksheets to improve statistical thinking skills. The results demonstrated that integrating local cultural contexts into statistics learning can enhance students; understanding and engagement with the material.

Statistics learning for eighth-grade students should focus on the application of concepts through real-world contexts, so that they can see how statistics are used to analyse data in various fields. The use of data-based projects or activities such as small surveys, analyzing test results, or processing data in everyday life can help strengthen their understanding. However, many school students still have difficulty in completing statistical literacy tests and tend to make mistakes (Sari, Sa'dijah, & Sukoriyanto, 2022).

A limitation of ethnomathematics lies in the challenge of finding cultural objects universally relevant across all schools, especially given Indonesias' vast diversity of tribes and their unique cultures. The highly diverse cultural aspects of each region mean that local cultural elements may not necessarily serve as primary learning resources in other regions that lack familiarity with those elements.

One of the cultural elements found in Indonesia that is generally known in Indonesia is *wayang*. *Wayang* has been widely recognized as Indonesia's cultural heritage. The literal meaning of *wayang* is shadow, but over time its meaning has evolved to encompass performance. According to Marwanto (2000, 22 types of *wayang* have developed and spread throughout Indonesia, among which *Wayang Kulit Purwa* is the most popular. Its history and development have been known since at least the 11th century, serving as an object of study for both domestic and foreign students.

This study uses authentic *wayang* as a learning medium in the Baran village study group, aiming to facilitate students in learning statistics based on concrete, culture-based activities. The uniqueness of *Wayang Kulit Purwa* and its popularity can strengthen the assumption that *wayang kulit* is not an alien culture for students.

Based on this explanation, and considering the importance of basic statistics competencies and the effectiveness of ethnomathematics-based learning, it is evident that there is no existing research specially detailing the results of using *wayang* as a learning medium to facilitate students in the statistics learning process. Therefore, it is important to investigate how an ethnomathematics-based learning process, utilizing the process and inlay motifs of *wayang*, can facilitate students' learning of statics content.

METHOD

The purpose of this study was to determine the application of *wayang* culture in facilitating the abstraction of eighth-grade junior high school students learning statistics. The participant of this study were eighth-grade junior high school students from Baran village, selected from a total population of 15 students in that grade. The research subjects

were chosen through an initial interview to assess their willingness to participate in learning activities. Data collection techniques include observation, exploration, test, and interviews.

There are two stages of observation conducted in this study. The first observation involved cultural activities in Baran Village, specifically focusing on Javanese *wayang* performances, as *wayang* shows are held regularly every year. The second observation focused in the learning activities themselves, whit an effectiveness aspect set a minimum level of 75 by the school.

Exploration of *wayang* was carried out based on Bishop's mathematical fundamental activities, complemented by a literature study. Subsequently, the test instrument development stage is based on the purpose of utilizing *wayang* as learning media. The learning objectives addressed in this study included students' ability to present raw data (from the census conducted), calculate the mean, median, mode, and raw conclusions. The instrument developed for this research was a worksheet consisting of eight questions designed to assess mathematical activities. The blueprint (or rubric) of the developed test instruments is presented Tabel 1:

Table 1. The Lattice of Test Instruments

No	Condition	Activity
1.	Presented with a description of the materials used to make *wayang*	Subject are asked to make a table from the data given
2.	Given pictures of *wayang* and inlays. There are Javanese *wayang* as learning media	Subjects will analyse the types of inlay found on *Wayang Purwa* Subject will create a table based on the calculation results of the inlay found on the provided *wayang*. Students determine the mode and mean from the table they make.
3.	Given a table of the making process	Students are asked to calculate the mean median and mode analysis funds from the data provided.

The eight questions were validated by experts and then submitted to the research subjects. Interviews were conducted with students who had passed the written test. The interview was conducted with the aim of knowing students' opinions on ethnomathematics-based learning with *wayang* media. The interview consisted of 14 questions with question aspects presented in the following Table 2:

Table 2. Aspects of Interview

No	Aspects	Questions
1.	Media	10, 11, 12, 13, 14
2.	Content	1, 3, 4, 6
3.	Content compatibility with learning at school	2, 7, 8, 9

RESULTS AND DISCUSSION

In Baran Village, Gunungkidul Regency, a cultural activity known locally as *rasulan* is routinely held annually, believed to commemorate the hamlet's anniversary. This *rasulan* activity includes several sequences such as art performances, a cultural carnival, an *adu jago* procession, and concludes with a nigh-long *wayang* show. While residents are highly familiar with *wayang* shows, and for adults, watching *wayang* remains an enjoyable activity, this is not necessarily the case for school-age children.

Based on the results of interviews with research participants, 37.5% of them reported never having watched *wayang* show. Reasons cited included lack of interest, considering it old-fashioned, or not understanding the language used. These participants preferred to spend their evenings watching television broadcasts or playing gamaes at home. This finding is supported by Herlyana (2013) who stated that the decline of traditional cultural arts is partly due to the proliferation of alternative entertainment media today, whit television being a primary example.

The remaining 62.5% decided to watch due to curiosity, cultural interest, parental invitation, or the opportunity to meet their peers. They realized that *Wayang Kulit* itself is very common and familiar. However, some students still only knew about *wayang* without ever having seen its original form up close. For instance, one student mistakenly believed *wayang* were made of iron, when in fact, *Wayang Kulit* are specifically made from cow, buffalo, or goat leather and fitted with a *gapit* as a handle (Herlyana, 2013). The *wayang* show can be seen in the following Figure 1.

Figure 1. *Wayang* show
Source: JAVA ART TV

One of the efforts to preserve *wayang* among the younger generation is to introduce *wayang* in schools in mathematics learning (Fitriyani & Abdullah, 2022). In this study's learning process, other *Wayang Kulit* were utilized. These *wayang* are typically used by *wayang* puppeteers during performances. This intricate process of *wayang* creation, including inlaying and painting motifs, required precision, skill, and tenacity (Muhammad *et al*., 2021). One of the *wayang* used as learning medium is shown in Figure 2.

Figure 2. *Wayang Werkudara*

The learning process begins with an introduction to *wayang*, and the process of making them briefly based on the results of explorations conducted by researchers and complemented by literature studies from ethnomathematics sources. In the process of making *wayang*, there are many aspects that can be studied. Based on the results of research conducted by Fitriyani & Abdullah (2022) there are aspects of mathematics in *Wayang Kulit* crafts according to Bishop (a) counting includes the length of time to make, the number of *wayang*, the number of tools and materials; (b) placing includes division of fields, boundary lines, placement of motifs; (c) measuring includes the amount of fat content, calculation of size and weight of objects, symmetrical size of motifs, comparison of colour mixing, level of gradation; (d) designing includes the shape of tools and materials, sketches, motifs, and lines; (e) playing includes the steps and processes of making; (f) explaining includes the meaning of motifs, use of inlay, application of colour. In addition, the underlying mathematical aspects of *wayang* craft can be implemented in junior high school in the form of questions.

The statistical material used in this study is focused on to analyse data based on data distribution, mean, median, mode, and data distribution to draw conclusions, make decisions, and make predictions, and to present and solve problems related to data distribution, mean, median, mode, and data distribution to draw conclusions, make

decisions, and make predictions. Thus, through project-based learning, students are expected to be able to 1) Present raw data from the results of a carefully conducted census. 2) Calculate the median, mean, and mode from the data that has been presented appropriately. 3) Conclude the relationship between median, mean, and mode appropriately.

The learning worksheet consists of 8 questions containing the presentation of raw data where learners are asked to process the data into tables and graphs. The learner worksheet also contains mathematical activities where learners will record the number of *wayang* inlays so as to produce structured data and then present it in tabular form so as to determine the mean median and mode elements in the data that has been obtained.

In the learning process, students are asked to record the existence of inlay motif models on *wayang* in order to learn how to analyse the relationship between data and how it is presented (tables, line charts, bar charts, and pie charts). According to Mukaddas (2021) explains that there are 18 types of inlay on *wayang*. In the learner worksheets that have been prepared, researchers use the types of inlay *seritan* and *sembuliyan* as the subject matter that students must look for to obtain data. Learners will add up the types of inlay that exist in each *Wayang Puntadewa, Werkudara, Arjuna, Nakula* and *Sadewa*. his collection of *wayang* is known as *Pandhawa Lima*.The *Pandawa* are a well-known group of brothers in the Mahabharata story.

Figure 3. The *seritan* motif

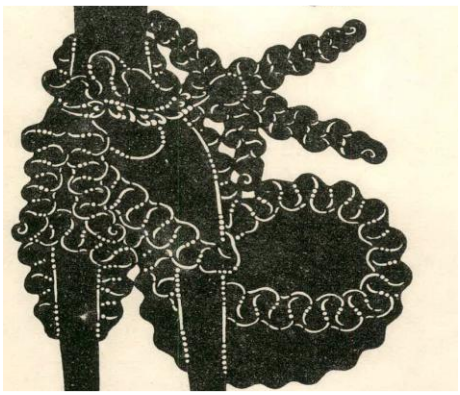


Figure 4. The *sembuliyan* motif

The *seritan* motif in *wayang* is described as a form of curled hair as shown in Figure 3. Meanwhile, the *sembuliyan* motif describes the curve of the *wayang* character's shawl as shown in Figure 4. This shape will vary according to the characteristics of the *wayang* wearing the clothes. Often the *wayang* craftsmen will use the patent form of the motif but not infrequently many provide variations. The number will also vary for each *wayang*. This depends on the creation of the craftsman because there is no patent in the

motif. It cannot be determined with certainty that the number of *seritan* motifs will have a specific number e.g. 200, 210. On the worksheet provided, students are asked to make data in the form of a table according to the number of *seritan* inlay motifs on the *Wayang Pandhawa Lima*. Students will count them one by one as illustrated in Figure 5 and Figure 6.

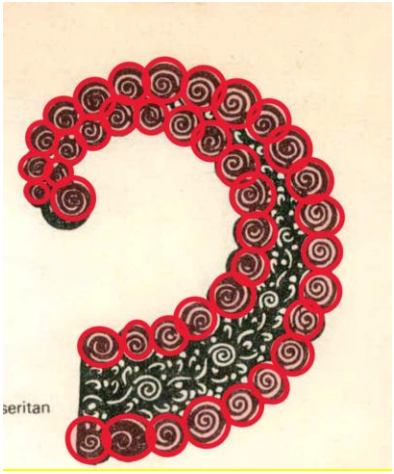


Figure 5. Count *seritan* motif

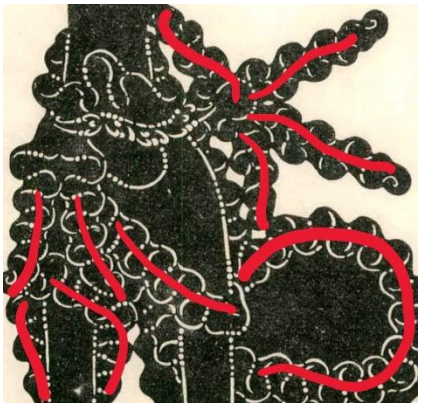
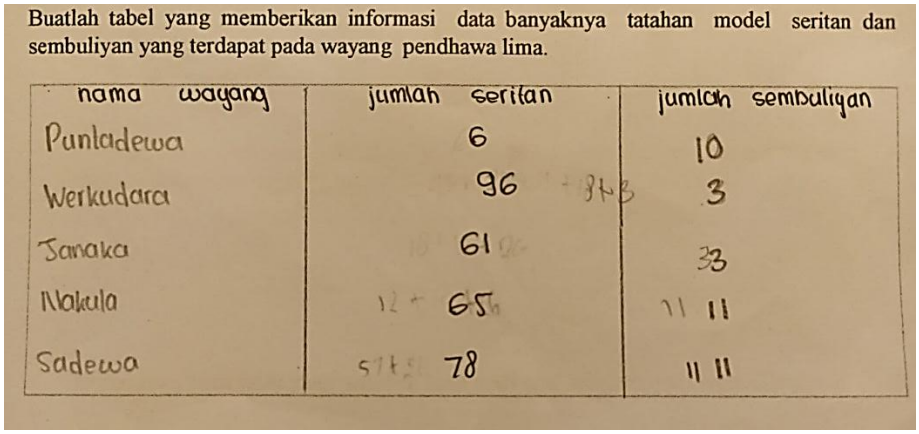


Figure 6. Count *sembuliyan* motif

In the *seritan* and *sembuliyan motif*, students will be asked to calculate in the form of grooves as shown in Figure 5 and Figure 6. The target to be achieved in this question is the student's ability to make a table appropriately. After counting one by one the number of types of *seritan* inlay and *sembuliyan* inlay, students will obtain data in the form of a table. In the next section, students will be asked to process data based on the data obtained in the previous process to fulfil learning outcome indicator 4.8 Present and interpret data in the form of tables, line charts, bar charts, and pie charts. The following is an example of the inlay motif used in the ethnomathematics-based learner worksheet.



Buatlah tabel yang memberikan informasi data banyaknya tatahan model seritan dan sembuliyan yang terdapat pada wayang pendhawa lima.

nama wayang	jumlah seritan	jumlah sembuliyan
Puntadewa	6	10
Werkudara	96	3
Janaka	61	33
Nakula	65	11
Sadewa	78	11

Figure 7. Example of a student's answer to constructing a table

In this question, the worksheet gives students to make a table from the results of their activities in counting the number of *seritan* and *sembuliyan* motifs. Based on Figure 7, which shows one of the students' answers, it can be concluded that students have been able to make a table based on the concrete example given in the form of *wayang*.

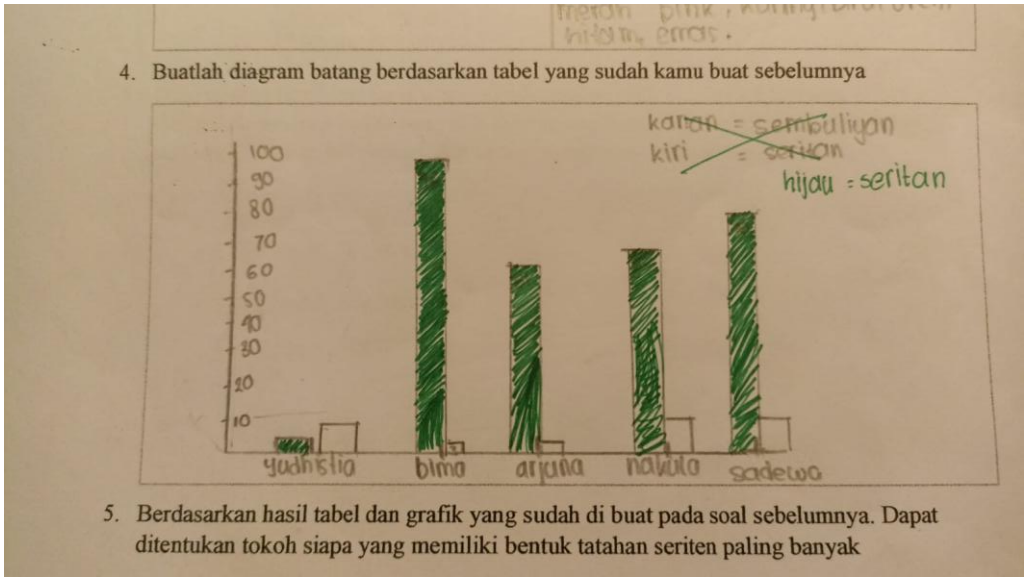


Figure 8. Example of a student's answer to making a bar chart

Based on Figure 8, which shows the data obtained from student answers, students can provide responses that align with the instructions given, including compiling data, creating tables, representing the data in the form of diagrams, and then calculating elements such as the mean, median, and mode within the context of the given problem. Thus, it can be concluded that students are able to understand the context of ethnomathematics-based mathematics learning.

Students attempted to solve problems related to the mean, median, and mode. They have correctly addressed interrelated questions and demonstrated the ability to use the appropriate concepts according to what was asked.

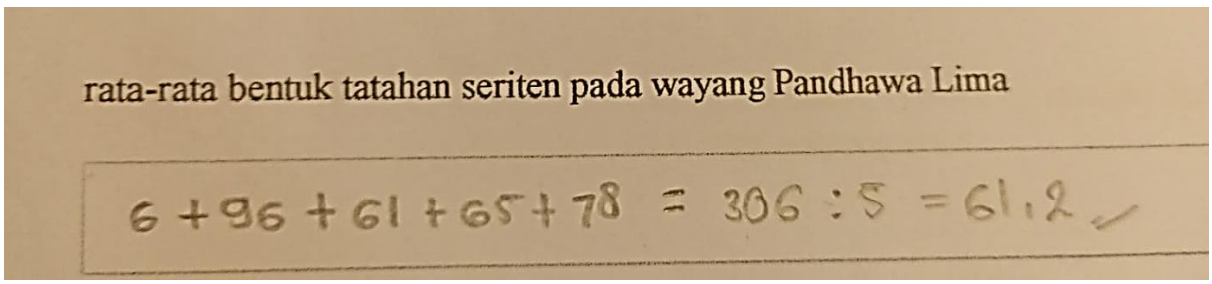


Figure 9. Example of student answers solving the mean problem

Based on Figure 9, the results of the written test tested through the ethnomathematics-based student worksheet for making *wayang*, there are 2 types of

errors made by students. First, the subject misunderstood the essence of the question in the form of a question to find the average. The subject has used the right formula, it is just not correct in calculating the amount of data obtained. This error occurred in 37% of research subjects due to lack of accuracy in adding up.

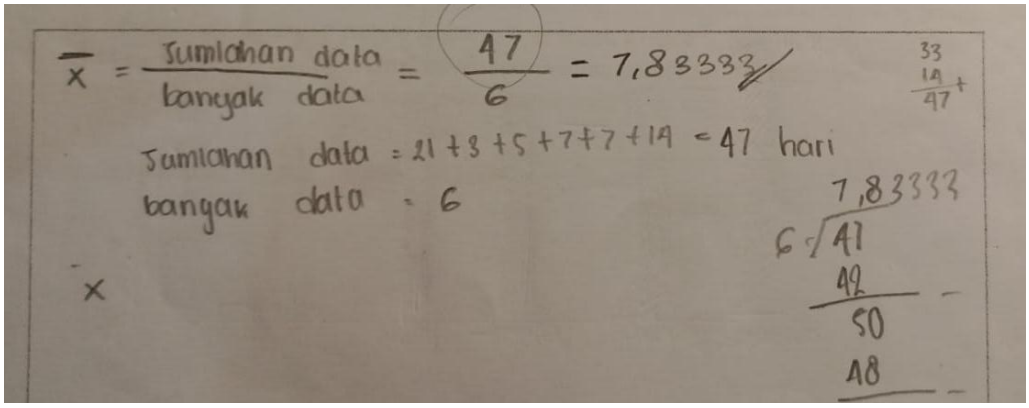


Figure 10. Example of student wrong answers of solving problem

Based on Figure 10, the subject is able to understand the question command given by giving a solution in the form of the right formula. However, at the stage of mathematical operations the subject did not complete it carefully where the amount of data obtained should be 57 but the subject wrote 47 which resulted in the final answer being incorrect. In this case, based on the error indicator theory according to Newman, Fitni, Roza, & Maimunah (2020) the error is included in the Encoding Error. where students make mistakes in writing or presenting the final answer. Another error encountered in working is in the subject's understanding in interpreting the question command. As in the following Figure 11.

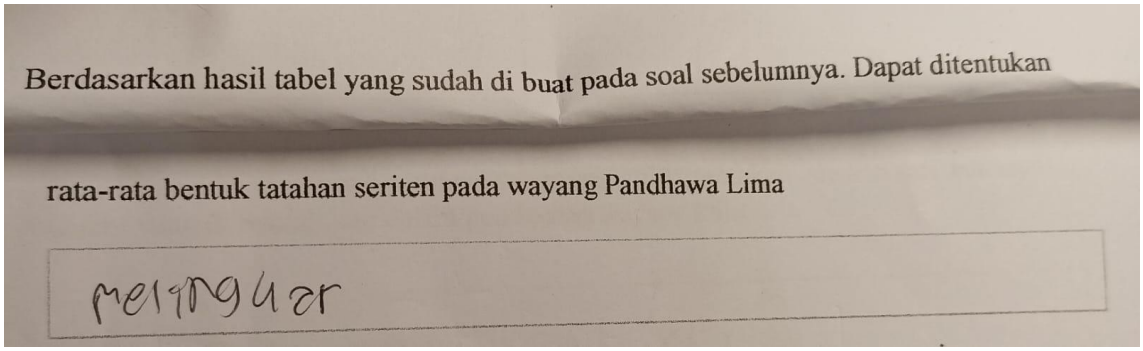


Figure 11. Example of student wrong answers of solving problem

The subject misinterpreted the question command so that he did not use the formula to find the average value. This is a common occurrence, based on the error indicators according to Newman, Fitni *et al.* (2020) this falls into the comparison error category, where students misunderstand the meaning or concept of the question. At the

interview stage the subject explained that his understanding of the question order which causes him to determine the average is to see in general which one has the most data from the results of the previous activity. This confirms that when mentioning ‘average’ students' shadow in general is to see which data has the most values mentioned.

Based on the results of student interviews, in the learning process using ethnomathematics-based student worksheets. All eight subjects had a positive response to the learning process and the use of student worksheets. The aspects measured in the interview include 3 things in the form of material, interest, and media aspects. Most of the students gave positive arguments related to the material provided at school students use everyday contexts in learning statistics. Examples of the context of statistics problems used in learning at school.

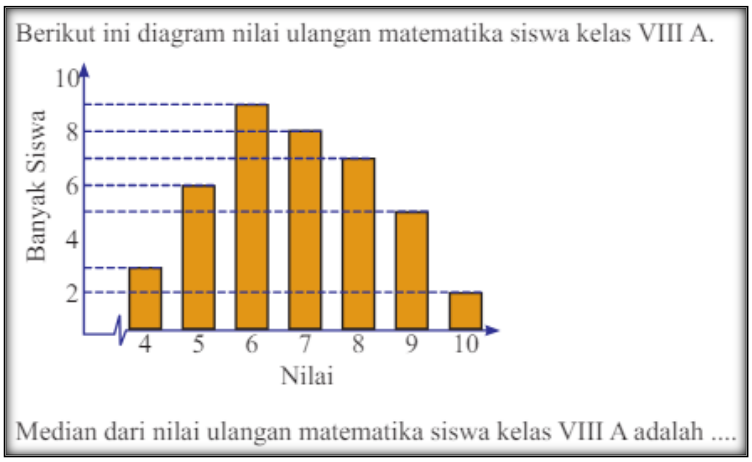


Figure 12. Statistics context in the school book

In Figure 12 obtained from the school contextual book, students are given an everyday context that is completely unrelated to culture. The results of Munthe's research (2023) on the latest learning in statistics students have difficulty in the phase of understanding the problem, the difficulty is understanding the language of the problem and converting the problem sentence into a mathematical sentence. The results of interviews with students explained that the main difficulty in solving mathematical problems is not the operation but the abstraction in the description of the problem into a mathematical model. Based on the results of the interview, providing stimulus with a table like the example above did not give students a meaningful conception because students never had experience recording other students' scores.

Based on the results of the interviews, the students mentioned that the *wayang* ethnomathematics was an advantage for the learning process because they could learn two things at once, namely mathematics and *wayang* culture. This is reasonable as a form of tolerance for the diversity of cultures that exist in Indonesia such as research conducted

by Purnamasari (2017). With cultural differences, it is necessary to have an attitude of tolerance and mutual respect in order to create harmony in it.

The majority of students showed positive results towards the learning process. Subjects responded in the form of asking questions, actively discussing. In general, the written test results through the student worksheets that have been developed provide satisfactory points, 75% of the subjects get the correct answers. The use of ethnomathematics described in this study might be recommended.

CONCLUSION

The results of this study indicate that the fundamental mathematical aspects contained in *wayang* can be implemented in contextual learning of mathematics in junior high school, especially in eighth-grade statistics material. The results demonstrate that learning based on *wayang* ethnomathematics has the potential for implementation in formal schools. The *wayang* ethnomathematics and its motifs can meaningfully provide modified learning content, thereby integrating aspects of surrounding culture into formal schools. Based on the interview results, the research participants responded positively to the learning process. They reported that learning was felt more engaging through activities that facilitated students in the data collection process, supported by students' successful completion of problems and activities outlined in the students worksheet. The research participants actively participated and remianed focused throughout the learning activities. This study suggests that *wayang*-based culture learning has strong potential for application in formal mathematics education in schools.

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