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Kesalahan Siswa Sekolah Menengah Atas dalam Menyelesaikan Tes Literasi Statistis Serupa Asesmen Kompetensi Minimum (AKM)

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Abstrak

Pentingnya penguasaan statistika oleh siswa didukung dengan dimuatnya materi ini pada kurikulum matematika sejak Pendidikan dasar dan menengah. Peran dari statistik itu sendiri telah merambah ke berbagai profesi dan bidang ilmu pengetahuan. Terkait penguasaan statistik siswa perlu memiliki kemampuan literasi statistik berupa kemampuan dasar dalam membaca grafik, judul atau tema grafik, memberi makna pada satuan dari grafik, menemukan nilai atau satuan tertentu, menentukan nilai maksimum dan minimum ataua perbedaan keduanya. Penelitian ini bertujuan untuk mendeskripsikan kesalahan siswa dalam menyelesaikan tes literasi statistis serupa Asesmen Kompetensi Minimum (AKM) berdasarkan tahapan Kastolan. Jenis penelitian ini adalah penelitian kualitatif dengan desain studi kasus. Subyek penelitian ini adalah 5 siswa kelas 11 SMA di Banjarbaru, Kalimantan Selatan yang dipilih menggunakan teknik *purposive sampling*. Data dikumpulkan dengan menggunakan tes dan wawancara. Selama penelitian ditemukan kesalahan yang dilakukan siswa meliputi kesalahan konseptual, kesalahan prosedural, dan kesalahan teknis. Kesalahan siswa dalam menyelesaikan tes literasi statistis dapat berdampak pada kehidupan sehari-hari ketika berhadapan dengan data. Selain itu, kesalahan yang dilakukan siswa saat memecahkan masalah dapat menjadi tanda awal adanya hambatan belajar yang dialami siswa.

Kata Kunci: asesmen kompetensi minimum, kesalahan siswa, literasi statistis

High School Students' Errors in Solving Statistical Literacy Test Similar to Minimum Competency Assessment

Abstract

The importance of students' mastery of statistics is supported by the inclusion of this material in the mathematics curriculum since primary and secondary education. The role of statistics itself has penetrated into various professions and fields of science. Regarding statistical mastery students need to have statistical literacy skills in the form of basic skills in reading graphs, graph titles or themes, giving meaning to units of graphs, finding certain values or units, determining maximum and minimum values or the difference between the two. This study aims to describe students' errors in solving statistical literacy test similar to minimum competency assessment or asesmen kompetensi minimum (in Indonesian) based on the Kastolan stages. The type of this study is qualitative research with a case study design. The subjects of this research were 5 students of grade 11, a senior high school in Banjarbaru, South Borneo, selected using purposive sampling technique. Data were collected using tests and interviews. During the study, it was found that errors made by students include conceptual errors, procedural errors, and technical errors. Students' errors in solving statistical literacy test can have an impact on their daily life when they are dealing with data. Moreover, errors made by students when solving problems can be an early sign that there are learning obstacles experienced by students.

***Keywords**: minimum competency assessment; statistical literacy; students' errors*

INTRODUCTION

Studying statistics is learning about data collection, data processing, data analysis, and drawing conclusions based on data analysis (Ulpah, 2009). The role of statistics has penetrated all professions and fields of knowledge. Some of the results of the role of statistics include pharmaceutical products, airplanes, cars, computers, and other machines used in all fields. Schools have a very important role in improving students' statistical literacy skills. With the proper education, students with general literacy skills will be able to understand the reasons and how statistics are used to understand and interpret the world's complexities (Nikiforidou, Lekka, & Pange, 2010).

The importance of studying statistics is included in the mathematics curriculum for primary and secondary education in Indonesia. This is contained in the attachment to the Minister of Education and Culture No. 21 of 2016 concerning Content Standards for Elementary and Secondary Education, which states that one of the abilities that high school students must have in mathematics content is being able to compare and assess the effectiveness of various methods of presenting data. In addition, the annex to Permendiknas No. 22 of 2006 concerning content standards in education states that one of the competency standards that students must have is being able to use statistical rules, enumeration rules, and the characteristics of opportunities in problem-solving (Murod, 2019). Therefore, educators must strive to teach statistical content, especially to develop statistical literacy.

Statistical literacy ability in the context of statistics is the basic ability to read graphs, being able to read graph titles or themes, being able to give meaning to units from graphs, find specific values or units, read maximum values and minimum values or differences between the values of the existing graphs (Hafiyusholeh, Budayasa, & Siswono, 2017). In particular, Gal (2002) states two main interrelated components to define statistical literacy as follows: (a) the ability to interpret and critically evaluate statistical information and arguments related to data; and (b) the ability to discuss or respond to such statistical information, such as an understanding of the meaning of the information, perceptions of the implications of that information, or the possible conclusions are drawn. In order to develop students' statistical literacy in mathematics, it is important for them to engage in learning experiences that involve data collection, data analysis, and interpretation of statistical results. They should also be familiar with the use of relevant statistical software or tools to assist in data processing and analysis. In addition, the application of statistics in the context of mathematics must be related to real-world situations or other contexts so that students can see their usefulness and relevance in everyday life. The indicators regarding statistical literacy ability are described in Table 1 below (Maryati, 2019).

Table 1. Indicators of statistical literacy

No.	Indicators	Description
1.	Understand data	Able to read data and determine statistical quantities from data presented in the form of tables, graphs/diagrams.
2.	Interpret data	Able to explain the reasons for processing the data presented, and draw conclusions from the results of processing the data presented.
3.	Communicate data	Able to process data in the form of tables, graphs/diagrams, and present data in other forms.

Not every individual is aware and willing to develop statistical literacy ability when receiving education. This is evidenced by the learning loss that occurs in the statistical literacy abilities of mathematics education students, especially in the ability to understand data and communicate data (Noviantari, 2021). Based on interviews with teacher, there were not a few students who had difficulty reading data in the form of tables or graphs, resulting in students making errors in drawing conclusions about the data provided. In addition, the literacy skills of high school students who take the minimum competency assessment are still low in each indicator (Irwandi, Roza, & Maimunah, 2022). The minimum competency assessment or *asesmen kompetensi minimum* in Indonesian is a test from the national assessment program by the Ministry of Education and Culture of the Republic of Indonesia which is conducted to measure students' reading literacy and mathematical literacy (numeration).

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Statistical literacy is very easy to find in everyday life; news in newspapers, for example, always displays data in statistical form (graphs, tables, etc.). Apart from that, television, information media, technology, and software on smartphones that are integrated with data make Statistical literacy skills are undoubtedly important. In other words, statistics is a very important instrument for everyone to adapt to a world that is constantly evolving, where numerical data is increasingly found and presented.

Errors often occur in solving mathematical problems both in writing and orally. During the teaching process and in learning mathematics, students will face many obstacles because problem-solving in mathematics is a very complex skill (Zakaria, Ibrahim, & Maat, 2010). There is a study that analyzes students' errors in solving statistical material questions (Batanero, Godino, Vallecillos, Green, & Holmes, 1994; Kurniawan & Wahyuningsih, 2018; Sari, Sa'dijah, & Sukoriyanto, 2022). The results of the study indicated that students made conceptual and procedural errors. According to Kastolan, there are three types of errors made by students in solving problems, namely conceptual errors, procedural errors, and technical errors (Aini & Irawati, 2022). An explanation regarding the indicators of the three types of errors is presented in Table 2.

Table 2. Indicators of errors type based on Kastolan stages

No.	Types of Errors	Indicators
1.	Conceptual errors	Students fail to choose the correct concept, or students forget the concept that should be used. Students have chosen the concept correctly but cannot apply it correctly.
2.	Procedural errors	Students take steps that are not appropriate for solving problems. Students are not coherent in carrying out calculation steps.
3.	Technical errors	Students miscalculate. Students misunderstand questions. Students misread the data provided

Evaluation has a very important role in learning, especially in learning mathematics. One form of evaluation that can be carried out is to find out student errors in solving statistical literacy-based questions. This is done because of the importance of statistical literacy in the current era and to minimize student misconceptions in interpreting data from the results of the analysis that has been carried out. In the world of education, those who can carry out evaluations to achieve good statistical literacy skills are math teachers because statistics material is included in mathematics learning in schools, both in elementary, middle, and high schools. Teachers should pay attention to how students respond and errors made when solving problems (Andini & Jupri, 2017). Besides, there has been a previous study that examines students' errors in solving statistical questions, but there is no research that specifically examines student errors based on the type of Kastolan stages in completing statistical literacy tests, especially those that are similar to the minimum competency assessment and also there is the possibility of other errors that have not been identified. Therefore, this study aims to describe students' errors in completing statistical literacy tests similar to the minimum competency assessment based on the Kastolan stages.

METHODS

This study was qualitative research with a case study design. This research was carried out in the second semester of the 2022/2023 school year. The subjects of this study were five students in grade 11 at a senior high school in Banjarbaru, South Kalimantan, selected using purposive sampling technique. Data in this study were collected using test techniques and triangulation as data verification viz statistical literacy tests and interviews. On the test technique, Students were asked to answer 4 statistical literacy questions similar to the minimum competency assessment, which had previously been validated by 2 mathematics teachers.

To deepen and strengthen the information obtained from student test results, unstructured interviews were conducted (Nur'aini & Munandar, 2021). As for this research, the technical data

includes data reduction, data presentation, and conclusion. 1) at the data reduction stage, the researcher took samples that were rich in data to be examined in order to obtain five students who would be used as research subjects and interviews, 2) based on the results of subject selection, the results of student answers were presented in the results section with data analysis in the form of errors in solving questions literacy-based statistics, while the analysis used the recommendations for the types of errors proposed by Kastolan, 3) the results of the analysis of the five subjects were comprehensively summarized as a summary of the research results obtained. The data that has been collected will be identified and classified based on the type of Kastolan stages, which consists of conceptual errors, procedural errors, and technical errors.

RESULTS

The data in this study were in the form of student answers in solving statistical literacy questions similar to minimum competency assessment and results from interviews to obtain deeper information about students' answers. The data was analyzed to produce types of errors made by students, including conceptual errors, procedural errors, and technical errors. The following describes the mistakes made by students.

Conceptual Errors

Conceptual errors refer to the inability of students to choose the right concept to solve the problem, forgetting the concept that should be used, and not being able to apply the concept properly. Examples of conceptual errors made by students in solving statistical literacy questions similar to minimum competency assesment are as follows.

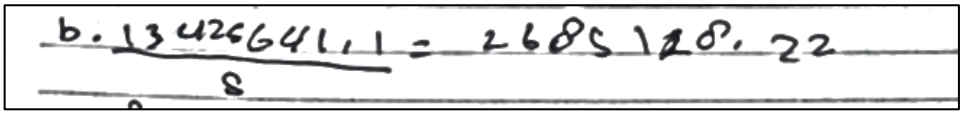

Figure 1. An Example of Conceptual Errors in Question Number 1b

Based on Figure 1, it can be seen that the students only did calculations arbitrarily without providing further information. Whereas in question number 1b, students were asked to determine whether it was true that there had been an increase in the net weight of salt imported by the main country of origin by the Indonesian government from 2017 to 2021. However, students did not provide an answer regarding whether this statement was true or false. When confirmed through interviews, the student admitted that he actually gave the correct answer regarding the statement because, based on the calculations that were done, it was true that there had been an increase from year to year. Based on the student's response, it can be seen that students forgot the concept that should be used, whereas in solving problem 1b, students did not need to do any calculations and only needed to read the information in the table carefully.

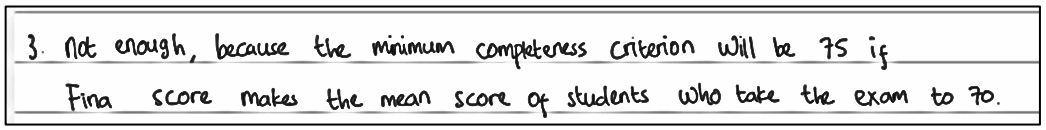

Figure 2. An Example of Conceptual Errors in Question Number 3

In Figure 2, it can be seen that the student only mentions the answers and reasons he believes without clear evidence or calculations. In fact, to be able to answer question number 3, students need to understand the concept of the mean to first calculate the score that Fina got on the follow-up exam, whether the score is above the minimum completeness criterion (or KKM in Indonesian) or not. However, students forget the concept that should be used in solving the problem, so the answers given are wrong.

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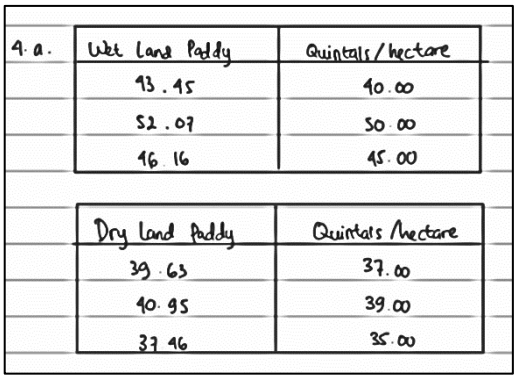


4.a.

Wet Land Paddy	Quintals / hectare
93.95	40.00
52.07	30.00
46.16	45.00

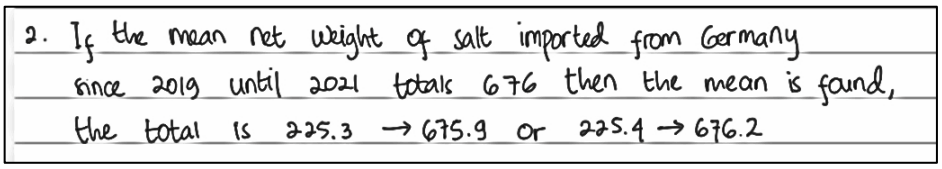
Dry Land Paddy	Quintals / hectare
39.63	37.00
40.95	39.00
37.46	35.00

Figure 3. An Example of Conceptual Errors in Question Number 4a

Other conceptual errors made by students can be seen in Figure 3. Figure 3 shows that students cannot apply the concept of presenting data in tabular form properly. In question number 4a, students are asked to present data from a graph in tabular form. However, because students could not apply the concept properly, students made two separate tables. This error can occur because students do not understand how to read the graphs given, so students cannot when asked to present them back in tabular form.

Procedural Errors

Procedural errors refer to student errors in taking the necessary steps when solving problems and incoherence in carrying out the steps in the calculations. Examples of procedural errors made by students in solving statistical literacy questions similar to minimum competency assessment are as follows.



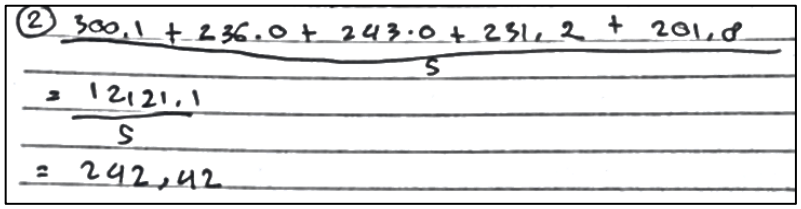
2. If the mean net weight of salt imported from Germany since 2019 until 2021 totals 676 then the mean is found, the total is 225.3 → 675.9 or 225.4 → 676.2

Figure 4. An Example of Procedural Errors in Question Number 2

Based on Figure 4, it can be seen that students were not coherent in carrying out the steps to calculate the mean net weight of salt where students wrote two answers, that is, 225.3 or 225.4 tons. Even though the student's answer of the mean net weight of salt is 225.3 tons, it are correct. This error can occur because students are confused about what they are doing or are not sure about the answers given at the beginning.

Technical Errors

Technical errors in this study refer to student errors in understanding the questions, student errors in calculating, and student errors when reading the information or data provided. Examples of technical errors made by students in solving statistical literacy questions similar to minimum competency assessment are as follows.



② $\frac{300,1 + 236,0 + 243,0 + 231,2 + 201,8}{5}$

$= \frac{1212,1}{5}$

$= 242,42$

Figure 5. An Example of Technical Errors in Question Number 2

In Figure 5, at a glance, it can be seen that students understand the concept of finding the mean well. However, students made a mistake from the start in adding up the net weight of salt imported from Germany, where students added up the net weight of imported salt from 2017 to 2021. Even though what was asked in the question was the mean net weight of salt imported from Germany from 2019 to 2021. When confirmed through interviews, the students didn't realize that what was asked was the mean import of salt from Germany from 2019 to 2021 only. Based on the student's answer, it can be seen that the students were not careful in reading the questions given, so the answers given were wrong even though the students actually understood the mean concept well.

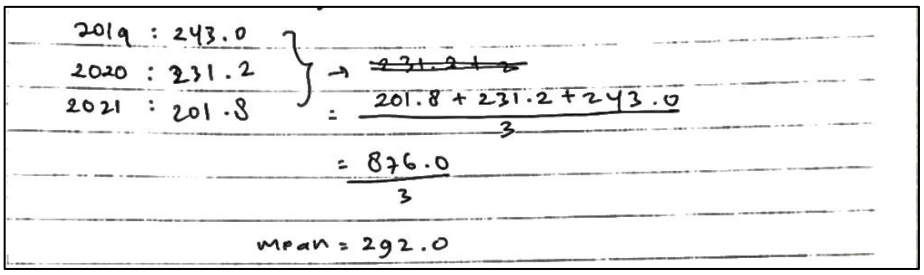


Figure 6. Another Example of Technical Errors in Question Number 2

Technical errors made by other students can be seen in Figure 6. Based on Figure 6, students make mistakes when calculating the mean net weight of salt. Students made a mistake when trying to add up the net weight data of salt imported from 2019 to 2021, resulting in an incorrect final result. This student's answer shows that the student was not careful in doing the calculations when solving the problem.

DISCUSSION

Conceptual Errors

Conceptual errors are errors related to students' ability to understand a concept. Based on research by Kartianom & Mardapi (2017), conceptual errors are the most common errors made by students compared to other types of errors. Furthermore, one of the most frequently encountered conceptual errors is in the basic concepts of statistical material. The conceptual error in the statistical literacy test, similar to the minimum competency assesment is in line with the conceptual error in the research by Sari, Sa'dijah, & Sukoriyanto (2022), where students do not understand statistical concepts well, so they give unfounded answers. The causal factor for the emergence of conceptual errors is that students only learn to memorize formulas without trying to understand the concepts being taught (Damayanti & Firmansyah, 2020). This is confirmed by Chamundeswari (2014), who states that conceptual errors occur when students cannot understand a mathematical concept meaningfully. The concept is something that must be understood by students when learning mathematics. However, if a concept is not well understood by students, then this will have an impact on students' ability to relate a concept to other concepts (Sari, Sa'dijah, & Sukoriyanto, 2022).

In this study, researchers found several conceptual errors that were still similar to the findings of previous researchers. The conceptual errors in question are: 1) students still misinterpret data from graphs to tables because knowledge about interpretation of student data is still lacking, 2) students still draw wrong conclusions because the evidence presented is irrelevant, that is, students should calculate the average first to be able to draw conclusions, 3) students do unnecessary calculations. Edo & Tasik (2022) revealed that students did not come up with concepts due to misunderstandings or a lack of understanding, the meaning and purpose of the questions were not understood, so routine learning made students only answer questions procedurally without understanding the true meaning of the questions. Regarding understanding the meaning of questions and routine procedural learning, Kurniawan & Suhendra (2022) also revealed that students work on questions without understanding the context and concepts that must be applied. Conceptual errors are often found in questions that present data interpretation. Rong & Mononen (2022) found that students had difficulty understanding the meaning of the questions, namely when reading information from graphs, tables, long texts, and

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other sources, so they got conceptual errors. Analyzing student errors, especially concepts, is needed and makes the basis of learning mathematics. Through error analysis, the teacher is no longer skeptical of student errors (Rushton, 2018). Thus, the findings of conceptual errors in this literacy problem can be used as a basis for teacher learning.

Procedural Errors

Procedural errors are errors that students make when taking steps to solve a problem. Simply put, procedural errors occur when students do not follow proper mathematical procedures when solving a problem (Brown & Skow, 2016; Lai, 2012). The procedural error in the statistical literacy test, similar to the minimum competency assessment, is consistent with the procedural error in the study by Afdila, Roza, & Maimunnah (2018), where errors occur when students do not write down the steps to solving a problem sequentially. In addition, procedural errors can also occur when students do not take appropriate problem-solving actions (Afdila et al., 2018; Ayuningsih, Setyowati, & Utami, 2020; Sari et al., 2022). These errors can occur because students are not used to solving new and contextual problems (Sari et al., 2022). This is consistent with the questions raised in this study. The procedural errors made by students in this study were the irrelevance of the results obtained with mathematical concepts, and students giving answers that were not based on clear mathematical calculation procedures. Lukman, Wahyudin, Suryadi, Dasari, & Prabawanto (2022) stated that in order to complete statistical literacy, students must be able to read and understand data and perform calculations according to statistical and mathematical rules. Procedural errors can be caused because students rush to answer questions and skip essential steps so they don't understand the questions correctly (Esterlina & Dahlan, 2023). Hidayat, Zubaidah, Munira, & Elizar (2023) found that almost 70% of students experienced procedural errors in solving math problems. Errors in these procedures are a contributing aspect that students' literacy skills are still low, Kalobo (2016) states that based on the teacher's experience, only one of three students can understand statistical literacy to the fullest. This is certainly influenced by the inability of students to solve statistical literacy problems using relevant procedures. Johannssen, Chukhrova, Schmal, & Stabenow (2021) argue that in solving statistical literacy problems, not only basic skills are needed, more than that high-level thinking must play a role so that valid conclusions can be obtained from existing data. Statistical literacy questions related to real-life contexts can create a critical link between conceptual and procedural knowledge so that they occupy more important areas than ordinary algorithms (Aydın & Özgeldi, 2019). Based on several interpretations of the research results, this study finds similar things and agrees that student errors in procedural matters must be addressed immediately by the efforts of the teacher, the curriculum, and the design of mathematics learning, especially statistics.

Technical Errors

Technical errors made by students in this study were errors in understanding the questions and making calculations. This is in line with research by Ayuningsih et al. (2020), Sari, Sa'dijah, & Sukoriyanto (2022), Ulfa & Kartini (2021), and Ramadhini & Kowiyah (2022) that technical errors made by students are calculation errors. Errors in understanding the questions can occur when students do not read the questions carefully and do not understand the meaning of the questions (Padmawati, Atmaja, & Noviyanti, 2022). Errors in calculating can occur when students tend to be in a hurry in calculating and do not re-check the final answers they get (Damayanti & Firmansyah, 2020; Sari et al., 2022). Therefore, it requires thoroughness and awareness from students so that technical errors can be avoided. In this study, the researcher found that students experienced technical errors when adding up the numbers and dividing them to get the average. Errors in mathematical calculations like this are often encountered by researchers. For example, Nelson & Powell (2018), who find that students have difficulty making correct calculations, errors in operations (both addition and subtraction), and result in other errors such as procedures and concepts. Good mathematical ability is needed to support students' literacy skills (Yuniawatika, 2018), thus in learning mathematics, technical errors like this must be minimized because statistics and mathematics are interrelated to solve a problem. The same thing was also expressed by Auliya (2019) that basic mathematical abilities such as counting,

subtracting, dividing, and multiplying must be mastered because statistical and mathematical abilities directly affect students' statistical literacy abilities.

CONCLUSION

Knowing errors made by students in solving a problem can be used as a consideration for teachers in designing learning on other materials, especially those related to statistics. Students also need to know their errors in solving a problem so they can correct them and not repeat the same errors. The results of this study indicate that students make conceptual errors, procedural errors, and technical errors in solving statistical literacy tests similar to minimum competency assessment. As for the conceptual errors made by students in the form of not using relevant concepts and not being able to choose the right solution steps, while procedural errors are related to the irrelevance of the results obtained with mathematical concepts, students give answers that are not based on clear mathematical calculation procedures, and technical errors are errors in mathematical calculations to calculate the average. The results of this study are in line with many studies regarding student errors. Statistical literacy is an ability that must be developed by students because it is often needed when facing problems in the real world. Errors made by students in solving statistical literacy tests can be used as a sign of learning obstacles experienced by students.

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