

Challenges in Solving Contextual Problems in Statistics Using the TEFA Approach Among Vocational Students

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ABSTRACT

This study explores the challenges faced by vocational students in solving contextual problems in statistics using the TEFA (Teaching Factory) approach, aimed at enhancing their analytical and problem-solving skills—competencies that are highly valued in the industrial world. The purpose of this research is to analyze the difficulties students encounter when solving TEFA-based contextual problems in statistical topics. The subjects of this study were 38 tenth-grade students from class X TO 9 at SMK Kesatrian Purwokerto, selected based on their even semester daily test scores. The students were categorized into three groups: high (HC), medium (MC), and low (LC), based on the class average and standard deviation. This research employed a qualitative descriptive method. The findings revealed that students in the high category were generally able to understand statistical concepts and accurately calculate the mean, median, and mode. However, some students in this group did not sort the data from smallest to largest when calculating the median. Students in the medium category had difficulty recalling how to compute the mean, often resulting in incorrect answers; although the mode was correct, the median was not. Meanwhile, students in the low category acknowledged that they lacked understanding of how to calculate the mean, median, and mode.

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INTRODUCTION

Maths is a very important subject because it can solve everyday problems and is very much needed. Maths has a significant role in students' lives solving problems that students face every day (Bolstad, 2023). Learning mathematics involves communication between students and teachers. Learning is essentially a teaching and learning process, which includes communication between instructors and students (Alenezi et al., 2023). The learning process is very important and needs to be considered, planned and prepared. Learning is the key to the success of education (Al-adwan et al., 2021; Onu et al., 2024).

Teacher and student factors can cause mathematics learning problems. One factor that can cause mathematics learning problems is a lack of understanding of learning strategies and approaches. Many alternative teaching approaches seek to integrate

mathematics and learning. Assessment can provide constructive feedback for teachers and students. (Atkinson et al., 2022). One way to make learning meaningful and useful for students is to provide contextual maths problems (Polman et al., 2021). Maths teachers and vocational students can collaborate on a doable project that can take place inside or outside the maths classroom. (Christidis et al., 2024; Dalby & Noyes, 2015). Mathematics and its concepts are found in all the diverse processes and relationships in many areas of engineering, both theoretically applied to descriptions and in the phenomenological representations and spatial settings in which these professionals work (Santos, 2023). One of the problems faced by vocational students in statistical material. Contextual learning in mathematics education on the theme of statistics can be done by linking statistical concepts to students' daily lives (Weiland, 2017). For example, teachers can invite students to collect data about their favourite hobbies or activities, then process the data using graphical representations such as bar charts or pie charts (Nolan & Perrett, 2016).

Statistics is a branch of mathematics that covers the process of collecting, processing, studying, and drawing conclusions from data analysis. (Laccourreye et al., 2021). Elsewhere, statistics is used for the process of making decisions based on precise data. Statistics plays a role in things like maths scores, the number of male and female students, shoe sizes, height, and weight, and the employment rate of the population in per cent (Sorby et al., 2022). The problem in learning mathematics is that the teacher's role is not only to provide lessons to their students but also to understand and examine students' desires, abilities, and intelligence (Velázquez & Méndez, 2021). One of the innovations to overcome the problems of learning mathematics for vocational students is Teaching Factory-based learning (TEFA).

Teaching factory (TEFA) is a concept-based vocational learning in service and production that refers to industry standards and procedures. The programme is implemented in an industry-like setting. The implementation of teaching factory in vocational high schools can overcome the competency gap between industry needs and student competencies. (Rentzos et al., 2014). TEFA is a learning strategy that produces graduates who are professionals in their fields, develops a modern concept curriculum, demonstrates solutions that are suitable for dealing with the industrial world, and provides technology from industry that collaborates with students and educational institutions to produce graduates who are able to meet the needs of the industrial world. (Kementerian Pendidikan Kebudayaan Riset dan Teknologi, 2023).

TEFA-based learning materials are determined by industry needs and integrated with the school curriculum. Industrial learning uses the learning process as an approach to training in an industrial environment by adopting renewable industrial knowledge and

technology to create innovation in improving critical thinking skills in solving a production problem (Hennig et al., 2019). The advantage of using this model in learning in vocational education is that students' practical ability (skills) will be guaranteed to reach a professional level (Prianto et al., 2021). The indicator of determining the average value of data with a percentage error of 80% and the indicator of analysing data with a percentage error of 83% included in the high category has the largest errors made by students. Students do not understand the basic concepts of statistics, perform statistical manipulations, communicate problems with mathematical models, and use mathematical models. The novelty of this study lies in its focus on identifying specific errors made by students in the context of TEFA (Teaching Factory) based learning.

The results of TEFA-T-based mathematics learning mentioned that students' TEFA-T metacognitive confidence skills were still low (Maksum et al., 2022). This causes students to still hesitate in integrating mathematics and TEFA learning practices. Previous research can be addressed by combining mathematics learning statistical methods and TEFA so that students can understand and apply. This research provides insight into students' conceptual understanding and the difficulties they face in the application of statistical theory. The average exam results show that students can solve statistics problems by 69%. Students faced difficulties or errors because they did not understand the statistics material correctly and faced a type of learning difficulty (Mediyani & Mahtuum, 2020). Research on exact subjects such as physics or mathematics is difficult to align with industrial production schemes (Pahmi et al., 2023). In addition, research in TEFA-based vocational schools only examines Edupreneur and contextualised mathematics learning curriculum towards TEFA-based production activities has not been researched. (Prasetyono et al., 2023). Previous research shows that the implementation of TEFA is still a problem and has not been able to support the learning process of mathematics in vocational students. It is suspected that the learning model applied by the teacher is not optimal and the teacher does not implement it with industry-related practices. Therefore, researchers have a solution to solve the problems of vocational students in statistics subjects, namely the TEFA-based contextual method. The purpose of this research is to analyse the problematics of solving TEFA-based contextual problems in statistics material for smk students. After the analysis, it is expected that teachers can provide learning motivation and students can solve statistical problems well.

METHOD

This research was conducted at SMK Kesatrian Purwokerto, Banyumas Regency. The subject of this research is class X students of Automotive Engineering Expertise Concentration (TO). The subjects in this study were selected based on the even semester

daily test scores in class X TO 9 SMK Kesatrian Purwokerto which consisted of 38 students, the grouping of subjects was distinguished based on groups of students with high categories In the context of the aforementioned study, the number of subjects in each category may vary depending on the student population being studied. The researchers selected the following subjects: High Category Students (HC): 3 students; medium Category Students (MC): 3 students; low Category Students (LC): 3 students ing the class daily test average and standard deviation . This research uses a qualitative with descriptive methods. This approach was chosen because the research aims to explore in depth the problematics of Teaching Factory-based contextual problem solving (TEFA) in vocational students of Statistics material. The data collection method used the following techniques. First, the researcher gave a written test in the form of TEFA-based contextual questions related to statistics material designed to measure problem solving ability. Second, researchers conducted semi-structured interviews after the written test to find out more about students‘ contextual problem solving, including students’ steps in answering the problems given, the difficulties faced, and students' reflections on the problem solving process.

After the data was collected, the researchers used triangulation, which is combining data from various sources through tests and interviews, and clarifying the data based on problem-solving indicators consisting of:

Table 1. Problem Solving Indikator (Rahayu et al., 2022)

No.	Stages	Indicator
1	Read and understand the problem	<ol style="list-style-type: none"> 1. Able to read the question 2. Able to understand the problem and write the known things from the problem correctly 3. Able to explain the information provided
2	Problem Ability	<ol style="list-style-type: none"> 1. Able to read and write problem-solving questions 2. Able to solve problems through mathematical models, images, algebraic symbols, diagrams, graphs and writing
3	Constructing a problem-solving strategy	<ol style="list-style-type: none"> 1 Able to formulate problem solving strategies, write and interpret the formulas used correctly. 2 Able to write the sequence of strategies in solving the problem in order and complete by using the elements given, the mathematical model that has been made

	before and the ability of the problem presented.
4 Solving the problem	<ol style="list-style-type: none">1. Able to solve problems, perform mathematical calculations appropriately according to selected formulas, strategies and skills2. Able to determine the final answer correctly according to the formula, strategy and skill chosen and determine the final answer based on the question given.

This was followed by identifying problematic patterns that emerged. Furthermore, at the data presentation stage, the researcher presents the data in the form of narrative text. The researcher interprets the data and relates it to the theory of contextual problem solving based on TEFA, formulates the main problems faced by students in the problem solving process on statistical material and develops recommendations to overcome problems. To ensure the validity of the data, researchers used method triangulation by comparing data obtained from various data collection methods (tests and interviews). The following are the test questions for the ability to solve contextual problems in Statistics material

Present the data obtained in the practice of measuring liquid accumulators in the TSM workshop, then determine the mean, median and mode of the data!

RESULTS AND DISCUSSION

Research on the application of contextual learning in statistics in mathematics education of vocational students showed high, medium and low categories are known through the answers of mathematics tests and interviews given. Observations showed that during the learning process, students became more active and motivated, and were able to collaborate in groups to complete tasks involving statistical analysis.

Group of students with High Category (HC)

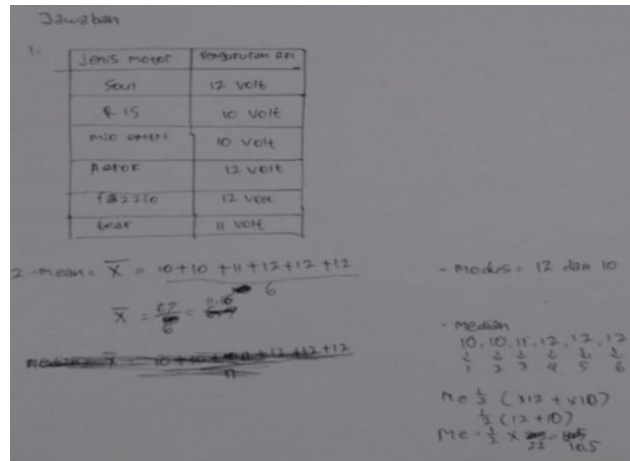


Figure 1. Question answers of subject HC

The high category answers (HC) showed that the process of solving contextual problems seemed to have not written the title of the data taken at the Motorcycle Engineering workshop (TSM), able to read and write problems, build solution strategies and solve contextual problems related to the mean, median, and mode (Figure 1). However, there was an error in building a contextual problem solving strategy, namely writing and interpreting the median formula for even data used incorrectly. HC interpreted the median as 12, even though there were 6 data obtained by HC. This interpretation error became the starting point for errors in the next steps. In the process of solving contextual problems, HC did not write the inconsistent average, median and mode formulas, but the steps planned by students showed the flow of the problem in stages. The following is an interview with the subject:

Researcher : 'I will ask you to explain how you learnt about mean, median, and mode using the TEFA method?'

HC : 'Of course! In learning, we directly applied these concepts through real projects. For example, when we collected practical data to measure the accumulator of motorbikes that stopped at the motorcycle engineering workshop.'

Researcher : 'Interesting! How did you apply the mean in the project?'

HC : 'We calculated the mean to find out the average number of motorbike accumulator available in the motorbike engineering workshop that function normally every day. every day.'

Researcher : 'Then, what about the median? When did you find it important to calculate it?'

- HC : ‘Medians are very useful when there are extremes in the data. For example, if one day production is very high, the median gives a more accurate picture of our day-to-day performance.’
- Researcher : ‘What about mode? What role does it play in your data analysis?’
- HC : ‘The mode helps us to know the motorbike products with the most types of accumulators produced.’
- Researcher : ‘Do you feel that your understanding of these three concepts is better after using the TEFA method?’
- HC : ‘Absolutely! The hands-on practice made me understand better how and when to use mean, median, and mode in data analysis.’
- Researcher : ‘Let me ask you about your answers to the mean, median and mode questions. Can you explain how you understand the information in the question?’
- HC : ‘The question given, I understand that the total frequency of the data is 67 then to calculate the average frequency 67 is divided by a lot of data, a lot of data that I took there are 6 types of motorbikes of various brands, the final result is 11.16.’
- Researcher : ‘Good. How do you determine the mode and median from these data observations?’
- HC : ‘I understand that if I determine the mode, I look for data that often appears, in other words, the 12 and 10 volt battery measurements belong to different vehicles. Median, I don't understand how to calculate it, mum.’

The interview results show HC's ability in the process of interpreting information and applying problem solving strategies, but there are problems in applying mathematical concepts according to the context of the problem. In the aspect of evaluating the strength of the method applied, there are also some weaknesses in HC's contextual problem solving process.

The results of the study are presented in a table, after students make observations and practice measuring accumulators in a motorbike workshop using a digital battery analyser. The conclusion drawn is only a numerical answer without further interpretation does not show a deep understanding of the problem at hand. This is in accordance with the results of the interview that HC often has difficulty seeing the relationship between the mathematical calculations I do with real-life applications. HC used to only focus on getting the numbers requested in the problem without writing down the available formulas.

This limitation in evaluating the method resulted in some undefined errors and inaccurate final results. HC explained in the interview that the student did not have confidence that the answer was correct, so HC did not perform the problem solving correctly. Based on Figure 1. Shows the student's contextual problem solving process that HC appears to be able to calculate the average correctly. HC did not show any effort to evaluate the correctness of the method or result obtained, for example by checking whether the mean, mode, and median were correct (Kusmaryono et al., 2022; La Salvia et al., 2021).

Group of students with Medium Category (MC)

The medium category answers (MC) of a study on contextualised learning on statistics in mathematics education for vocational students showed that although there was progress in concept understanding, there were still some challenges. In the medium category (MC) model, many students had difficulty in determining the median of a given data set, with some making mistakes in calculating it. In addition, the correct use of units, such as those of motorcycle batteries, was often overlooked in data analysis. This suggests the need to strengthen teaching on the importance of details in data processing. However, students did respond positively to contextualised learning, stating that this approach made it easier for them to understand the relevance of statistics in everyday life. Students in the medium interest category demonstrated proficiency in solving the given problems and fulfilled all the criteria. However, at some other stages, their approach was still less structured. From that, it can be concluded that students with a medium level of interest are able to complete each step of problem solving, although it has not been done systematically and optimally (Sofyan et al., 2024).

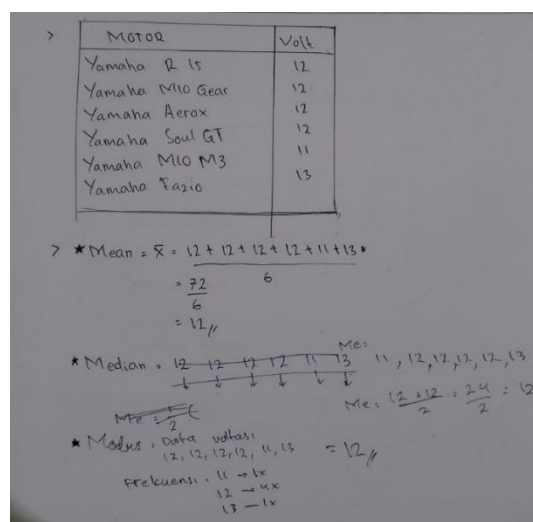


Figure 2. Question Answers of Subject MC

Figure 2 Showing several points of problem solving contextual problems in the medium group, including students writing answers that are not correct in the motorbike sentence and the voltage power on the motorbike battery. In the medium category, explaining the error in writing the problem, the medium group showed an error in setting the strategy, this student did not write the mean formula correctly, this student instead worked directly, this student had sorted the data to calculate the median, namely sorting the smallest data to the largest data. Besides that, in MC there is an error in writing the formula, this student did not write the formula so that the results obtained were wrong. Students in the medium group in calculating the mode is correct, namely looking at the most frequency table that can be used as the mode value. The following is an interview with the following subject.

- Researcher : ‘Good morning, MC. Thank you for joining us for this interview. Let's start by discussing your experience using the TEFA method. How do you think this method helps with understanding mathematical concepts?’
- MC : ‘Good morning! In my opinion, the TEFA method is very helpful. By applying concepts such as mean, median, and mode in collaborative projects, I find it easier to understand them.’
- Researcher : ‘Interesting! Can you give an example of how you applied the concept of mean in the project?’
- MC : ‘Sure! We calculated the mean to determine the average number of motor accumulators available in the workshop. This helped us get a clear picture of our needs.’
- Researcher : ‘What about median and mode? Do you feel these concepts are also easier to understand after using the TEFA method?’
- MC : ‘Yes, I do. The median is very useful when there are extreme data points. For example, if production is very high on one day, the median provides a more accurate picture. Meanwhile, the mode helps me identify the best motor products to pair with the accumulators.’
- Researcher : ‘In previous research, it was found that students involved in collaborative projects tend to be more capable of applying concepts. Do you agree with this finding?’
- MC : ‘I completely agree! I feel that the practical experience I gained through this project strengthened my understanding. I could see how the concepts were applied in real-life situations.’

- Researcher : ‘How do you assess your readiness in understanding these concepts compared to other students?’
- MC : ‘I feel quite prepared. Perhaps because I am more focused and receive support from my peers in the group. We help each other.’
- Researcher : ‘Do you feel that this collaborative teaching method is more effective than the traditional methods you have experienced?’
- MC : ‘Yes, I think the collaborative method provides more opportunities for discussion and practice. This makes the learning process more enjoyable and less boring.’
- Researcher : ‘Thank you, MC, for the interview. This provides valuable insights into the effectiveness of the TEFA method in improving mathematical understanding.’
- MC : Thank you too! I’m glad to share my experience.’

Group of students with Low Category (LC)

The low category answers (LC), contextual learning on statistical material in mathematics education of vocational students shows a low category (LC) in mastering the concepts of mean, median, and mode. Many students do not understand how to calculate the three measures of data centering, which results in difficulties in applying the concepts in real situations. Although the contextual approach is designed to relate the material to everyday life, students still have difficulty in linking theory with practice, so their understanding of data and statistical analysis is limited. These results suggest the need for further intervention in teaching methods, including the use of more varied strategies and additional support to improve students' understanding of basic concepts in statistics.

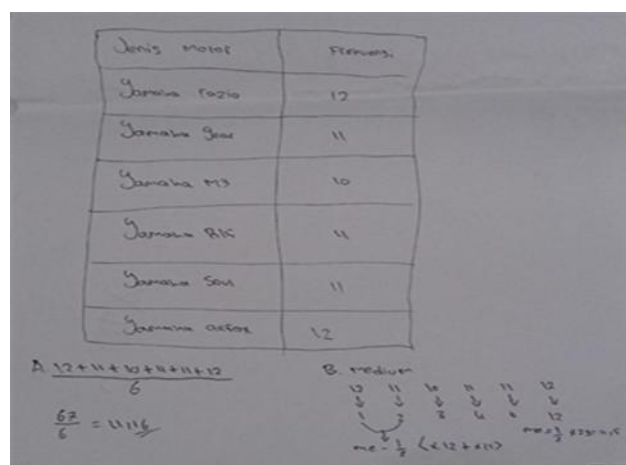


Figure 3. Question Answers of Subject LC

Figure 3 shows several points above the process of solving low-category contextual problems. LC answer shows the problematic ability to solve contextual problems in writing in the frequency column does not write the Volt unit to show the unit of measurement of the motor battery, then the LC subject in building a strategy makes a mistake in not writing the mean calculation formula (average), so that the results obtained are wrong to solve the problem, LC answer shows the problem of building strategies and solving problems does not write the mode, and LC answer shows the error in building a strategy to calculate the median, the subject writes the data based on the order of writing the table even though the median is sought by sorting the data from the smallest to the largest data, then the median formula is written for even data, LC answer shows an error in solving the problem by not writing the final result of the median calculation. The following is an interview with the source.

- Researcher : ‘Good morning, LC. Thank you for taking the time for this interview. Let's start by discussing your understanding of the concepts of mean, median, and mode. How was your experience learning using the TEFA method?’
- LC : ‘Good morning. I feel that the TEFA method makes some mathematical concepts easier, but I still feel that I don't fully understand them, especially the median and mode.’
- Researcher : ‘Interesting! You mentioned that you can calculate the mean. Can you explain how you applied it in your project?’
- LC : ‘Yes, I calculated the mean to determine the average number of motor accumulators in the workshop. But I felt confused when calculating the median and mode.’
- Researcher : ‘What difficulties did you encounter when calculating the median?’
- LC : ‘I didn't sort the data, so I'm not sure if the results are correct. And for the mode, I don't know how to determine its value accurately.’
- Researcher : ‘Do you feel there are shortcomings in the learning you received when using the TEFA method?’
- LC : ‘Yes, I didn't use a calculator when calculating the mean and didn't record the mode results. That made me confused. Additionally, the collaboration between subjects made me stressed.’
- Researcher : ‘In previous studies, many students reported that active methods like TEFA improved their understanding. Why do you think your experience was different?’
- LC : ‘Maybe because I wasn't cognitively ready for those concepts. I also felt the support from teaching wasn't enough to help me.’

- Researcher : ‘Do you feel you need more practice or experience in applying those concepts?’
- LC : ‘Of course! I think with more practice, I could understand those concepts better.’
- Researcher : ‘Thank you, LC, for your honest answers. This provides valuable insights for our research.’
- LC : ‘You’re welcome!’

DISCUSSION

Analysis of students' contextual problem solving skills showed that there were significant variations between groups of students in the high, medium, and low categories. Students in the high category (HC) were able to understand and apply statistical concepts such as mean, median, and mode, although there were still errors in interpreting the formulas. This shows a good basic understanding, but still needs improvement in the aspect of evaluating results. Students in the moderate category (MC) showed more limited ability than HC. Students often do not write down the formulas needed to calculate statistics, which results in errors in the final results. This indicates that although KS students understand the process, the lack of skill in writing down the steps of problem solving is the main obstacle.

The low category (LC) students showed greater difficulty in contextual problem solving. Students tended to be unable to relate the concepts learned to real-life applications. This suggests the need for a more in-depth approach to help LC students understand the material better. The use of TEFA method in learning statistics is proven to have a positive impact on students' understanding. Through real projects, students can directly apply statistical concepts, which makes them more interested and motivated. However, challenges remain, especially in helping students overcome difficulties in writing down formulas and solving strategies.

Interviews conducted with students provided additional insights into how they understood the material. HC students revealed that hands-on practice improved their understanding, while MC and LC students still experienced confusion. This shows that hands-on interaction and reflection on the learning process is very important (Lu et al., 2021).

The importance of strengthening contextualized learning strategies is clear. Students need to be given more opportunities to practice with problems that are relevant to everyday life. Students not only learn theory, but also how to apply it in real situations. Success in contextual problem solving is also influenced by support from teachers. Teachers are expected to provide constructive feedback and help students identify areas

that need improvement. This will facilitate a more effective and efficient learning process. (Dong et al., 2025; Mahmuti & Thaqi, 2025).

CONCLUSION

Based on the results of the study, it shows that students in the high category can understand the concept well, and correctly calculate in calculating the mean, median and mode, the weakness of this category is to find the median in the high category there are still those who do not sort the data obtained from the smallest to the largest data. Medium category students cannot remember to use the average formula (mean) well, and do not answer the mean correctly, the mode is correct, but the median is not correct. Low category students know the concept of calculating the average in calculations is still weak as well as calculating the median and mode.

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