Misconceptions of English Students on Education Statistic

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Keywords: Misconceptions, Students, Education Statistic.

Abstract: This study aims to identify the misconceptions of English students in the Education Statistics course which consists of descriptive statistics and inferential statistics. Research subjects are students of English semester IV class B State Islamic Institute of Curup Academic Year 2017/2018 selected by purposive sampling. Data collection techniques use written tests, interviews, and documentation. Test of data credibility in this research is using technique triangulation. The results showed that students' misconception in the use of parameters and statistics so that further difficulty in determining the use of formulas for both single data and groups data and misconceptions in the determination of hypotheses and statistical tests are used in accordance with the research problems given to result in the wrong research conclusions. Result of the concept of descriptive statistics are still weak and the students also have misconception in inferential statistics, so it is important to understand the basic concepts in descriptive statistics in order to avoid a greater misconception in inferential statistics because the two are highly interrelated. Students who are less rigorous in the process can also be a source of misconception of students in solving statistical problems both descriptive and inferential.

1 INTRODUCTION

Mathematics, in its very nature, is full of abstract representations. It is a hierarchical build-up of concepts, skills and facts. The successful learning of mathematics involves a systematic building up of such a hierarchy of concepts (Ruberu, 1992) and ideas need to be understood and woven together in order for concepts to build on one another (Ashlock, 2002). Mathematics is the study of quantity, structure, space, and change. Mathematicians seek out patterns, formulate new conjectures, and establish truth by rigorous deduction from appropriately chosen axioms and definitions (Schleicer & Lackmann, 2011). Mathematics is taught from concrete, semi-concrete, to abstract, and teaches concepts from simple to complex concepts. During the past decades, research on statistical literacy and statistics education has established itself as an important and rapidly growing research field (Callaert, 2002). Statistics is one of the branches of mathematics studied from Elementary to High School level which has many concepts, only at the college level, the statistics studied are more abstract and lead to research problems. Statistics in college is a knowledge related to ways of collecting data, processing, presenting, analyzing, and drawing conclusions based on data and analysis performed. The statistics section covers the methods and methods of collecting, presenting, processing and analyzing descriptive data called descriptive statistics and the part which involves drawing conclusions called inferential statistics (Setyo Winarni & Harmini, 2011). Both statistics are different types and different studies. However, there is interrelation between ability in inferential statistics and descriptive statistics: if the ability of descriptive statistics can be well controlled then the inferential statistics would be able to do well. Sutrisno & Murtianto (2016) argue that the mastery of descriptive statistics is desperately needed inferential statistics courses used in quantitative research.

Angle (2007) explained that many mathematical concepts can be understood only after the learner has acquired procedural skill in using the concept. More than often in schools, teachings of mathematics are more focused on rules, procedures and formulas used to arrive at the correct answers rather than teaching students' basic concepts. Skemp (Orton, 2004) suggests that mathematical concepts are structured hierarchically, one concept being the basis for other concepts. This means that the concepts in studying the material are interrelated, to learn a new concept must have to master the old concept first and in learning mathematics always happen that way. While Irawati

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et al. (2014) argued that the concept or material is an extension or deepening of the material that has been studied. It becomes very bad if the students are more and more teachers have a misconception or inappropriate to a certain mathematical concept or called misconception.

Holmes, Midema, Nieuwkoop, & Haugen, (2013) explained that misconceptions arise from the problem of conceptual misunderstanding. Errors come from calculations or minor accidents. On the other hand, Thompson & Logue (2006) describe misconceptions as ideas that provide a misconception about such ideas, objects, or events built on one's experience. Dzulfikar & Vitantri (2017) also explain that the misconception of mathematics can also be a mistake in the application of a rule or inappropriate generalization. When someone systematically uses the wrong rules or uses the right rules, but is used outside his application. (Suparno, 2013) also suggests that misconceptions are conceptual understandings that are inconsistent with scientific understanding or agreement of experts in the field. Essentially, misconceptions are different from errors. Luneta & Makonye (2010) defined an error is a mistake, slip, blunder or inaccuracy and a deviation from accuracy. While, Hansen (2011) also suggest that error is a mistake made by someone due to carelessness, misinterpretation of the problem, lack of experience in solving problems related to a given topic or due to the inability to check the answers obtained. Misconceptions and errors must not be seen as obstacles or 'dead ends' but must be regarded as an opportunity to reflect and learn. Teachers should recognize these misconceptions; prescribe appropriate instructional strategies to be more diagnostically oriented in order to avoid any subsequent major conceptual problems. Diagnosis should be continuous throughout instruction (Roselizawati, Sarwadi & Shahrill, 2014).

Based on several notions of misconception above, it can be concluded that misconception is a mistake in understanding concepts or concepts that are not in accordance with the concepts that have been put forward by experts.

Misconceptions are caused by a variety of things. Generally can be caused by students themselves, teachers who teach, learning context, way of teaching, and textbook (Suparno, 2013). The identification of misconceptions is important in order to locate misconceptions and their causes. Salirawati (2011) explains that to simplify the process of identification of misconception is categorized into three criteria that is not understanding the concept, misconception, and understand the concept. Irawati et al. (2014) mentions that the location of misconceptions experienced by learners is in re-state the concept, classify objects according to certain characteristics in accordance with the concept, example on a concept, using and utilizing and selecting a particular procedure or operation and apply the concept or algorithm on solution to problem. If these misconceptions occur continuously, it will result in low student learning achievement. Andini (2012) also points out that sustainable misconceptions if not addressed properly and addressed early may pose problems in subsequent learning.

The problem of statistical misconception of Tadris English students at IAIN Curup actually originated from the difficulties experienced by the students. Students basically also have gained the concept of statistics when in school. However, it is still often found difficulties when working on the matter of statistics. This can be caused by several things based on the observation results of the Tadris English students IAIN Curup academic year 2017/2018 are: 1) the student forgot and there is no understanding of the concept he has gained at the school level both at the primary and middle level; 2) majoring in current study is more about the science of English than science especially mathematics. In the Faculty of Tarbiyah English IAIN Curup is currently only studying the branch of mathematics is statistics and does not study other branches of mathematics such as basic mathematics, so it is very influential in understanding the symbols and mathematical notation; 3) the level of motivation and academic ability of different students, which cannot be equated with one another. Though studying statistics is very important because statistics will continue to be used until the preparation of Student Final Project in the form of thesis. Starting from the problem, then many students who have difficulty in learning to cause misconception both in descriptive and inferential statistics. Research conducted by Firmansyah (2017) also explains the same problem in studying statistics that students have varied learning ability statistics and students have a tendency of negative attitudes on the course. In another study, Maizam (2009) also explained that the topic in descriptive statistics is the scale of measurement, summation and presentation of data, relationships and correlations between two variables. Most students consider statistics to be nothing more than numbers and formulas with limited use in their daily lives or their future professions. In addition, some students believe that they understand statistics if they are able to declare and put numbers into the wrong formula because statistics are not

about inserting numbers into formulas, but a process for obtaining information (Chance, 1997 in Rumsey 2002) and performing calculations not the same as understanding the statistics (Gal, 2000 in Rumsey, 2002). For example, the student's ability to calculate standard deviations does not indicate a student's ability to understand what standard deviations and what is measured or how they are used. In addition, students also feel that the usefulness of educational statistics is limited only to answering in tests and exams. The type of Asian students, these students are also quite passive in the classroom. Statistical misconceptions have been observed among students on various topics including relationships and correlations, hypothesis testing. On the other hand, Zaidan, Ismail, Yosuf, & Kashefi (2012) also explained that some students exhibit misconceptions such as averages as a mean multiple, averages as the sum of values of variables, and averages can only be generated from a constant value and equal to that.

Based on these matters, the researchers are interested to follow up in the form of research. Researchers want to identify misconceptions of English students in the Education Statistics course which consists of descriptive statistics and inferential statistics. In this study, descriptive statistics are limited to conceptual misconceptions related to data presentation, data central tendency, and data dispersion. While inferential statistics are limited to misconceptions of concepts related to hypothesis testing.

2 METHOD

This research is a research with qualitative descriptive approach with subject 3 (three) students of fourth semester of Tadris English Faculty of Tarbiyah IAIN Curup academic year 2017/2018. In this research, researcher use purposive sampling that is technique of taking sample of data source with certain consideration. The main instrument in this study is the researchers themselves (Sugiyono, 2011). The instruments used are written tests and interviews. Test the credibility of the data using triangulation technique that is comparing the results of written tests with interviews.

3 RESULTS

In the methodology, the researcher used purposive sampling in sampling of data source that is 3 (three) students who most misconception based on written analysis. The three subjects were given a written test of the concept of descriptive and inferential statistics. These three subjects are presented in the following table:

Table 1: Research Subject.

No	Initial	M/F	Code
1	AG	F	1
2	DU	F	11
3	FA	F	18

In the Table 1, the initials containing AG, DU, and FA are the three students selected for data collection and interviewed further to locate misconceptions and their causes. For M/F column indicates student's gender while the code column indicates the student's absence number. Each misconception will be explained in this discussion. The following issues are used in this research instrument:

Calculate the mean, median, mode, variance, and standard deviation from the following data:

2	8	4	2	4	8	2	9	2	10
20	8	4	21	40	60	2	8	7	6

Figure 1: Question Item.

Here are the results of the work of the three research subjects:

1. Subject with initials AG

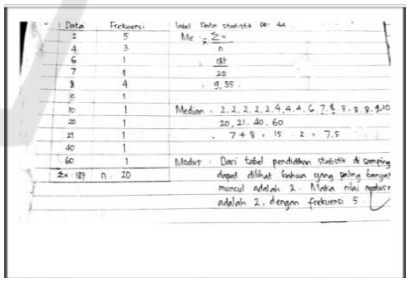

Figure 2: Misconception by AG about data presentation and central tendency.

Students are seen to be able to present data in the form of tables namely Single Data Frequency Distribution Table. It's just that in the use of notation is still a mistake. In the table looks $\sum x$ when it should be $\sum f.x$ because the data is presented in the form of frequency tables that have a frequency. Here students seem to misunderstand the concept of $\sum x$ and $\sum f.x$. If $\sum x$ is the sum of all known data, then $\sum f.x$ is the sum of the multiplication of each data with a lot of

data (frequency). This results in a false end result. Likewise, with the use of the average formula (mean) and notation that should be $\bar{x}$ and not Me. This shows that students cannot distinguish between the average notation $\bar{x}$ and median (Me).

In addition, in the median, the student also still looks not yet able to write and the median formula for even data is $Me = \frac{1}{2}\left(X_{(\frac{1}{2}n)} + X_{(\frac{1}{2}n+1)}\right)$. If the data given more number, then the student will more difficult to calculate. These misconceptions fall into the concept of presentation data size and central tendency data. As for the concept of data dispersion can be shown in the results of students as follows:

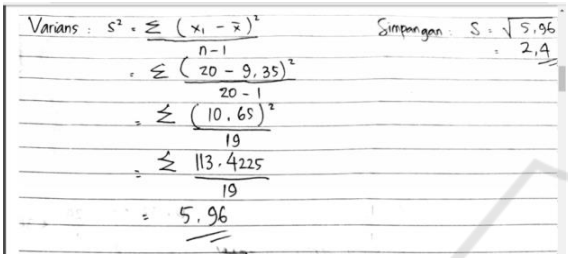

Figure 3: Misconception by AG about data dispersion.

In answer to the above variance, the student is quite good considering the formula and write it down. However, there is a slight disadvantage that in the previous table students have created a frequency distribution table, so students should write $\frac{\sum f(x-\bar{x})^2}{n-1}$ to make it easier and simpler to complete the calculation. For that, students should use auxiliary tables only tables that have been made developed again for the needs of calculation of standard deviation in order to facilitate the calculation of the difference in data with the average which then squared and facilitate multiplication with the frequency.

Then, the answer also shows that students are wrong in entering data. The student enters the value of n = 20 (n=$\sum f$) into the value of x in the formula when it should be x each is the data in the table, for example x_1 =1, x_2 = 2, etc., which is then summed, by therefore, it is necessary to multiply with frequency to facilitate calculation. Students also do not understand the sign of sigma in the formula, so at the end of the settlement gives wrong results. This gives researchers predictions to students that students have not understood the concept of using the $\frac{\sum f(x-\bar{x})^2}{n-1}$. If this continues, it leads to continuous errors when calculating statistical tests that require the calculation of variance and standard deviation.

Based on the student's conversation with the researcher about the above mistakes, the following information is obtained:

Students realize not yet understand the use of notation $\sum x$ and $\sum f.x$,, whereas the intended by the student is wanted to sum up the data by multiplying the data known by the number of frequencies each data. However, finally just add the data in the left column (figure 1) i.e. $\sum x$ =187, when it should be $\sum f.x = 227$.. Students do not realize that for data x_1 =2 it has a frequency of 5 and so on. As for the use of the symbol of the average, it is due to forget. Visible then students write back / justify the simbol $\bar{x}$ before the formula.

For writing the median symbol, students explain forgetting to write the symbol. As for the use of the formula, the student realizes it does not remember and does not understand the use of the median formula that has been given during the lecture. As a result, do not understand the concept, then be do not remember.

At the completion of the variance, the student realizes that he does not understand the settlement procedure. When entering the value of x, the student does not understand the value of x which will be included in the formula so that finally choose to enter the value of n. During this time students are accustomed to memorizing the formula given, without understanding how to use it. Whereas in the frequency distribution table, has written $\sum x$, where the data symbolized by x. In addition, the student is also unaware that the formula should be used by using frequency multiplication by the difference of data then squared i.e.., $\frac{\sum f(x-\bar{x})^2}{n-1}$ because the frequency is already known in the table, so it is not necessary sum up each difference in data with more than one frequency.

2. Subject with initials DU

For explanation of picture 4. In student initials DU, basically have been able to arrange settlement procedure systematically and count well. However, it is a mistake to write a notation for the number of N sample sizes that should be n, even if the value entered is the same. The difference is about where the data comes from, whether population or sample. In the use of notation, the average student is also still inconsistent with the notation that has been agreed by the expert that is $\bar{x}$. In addition, the students at DU are also unable to present data with frequency distribution tables in either single data or group data.

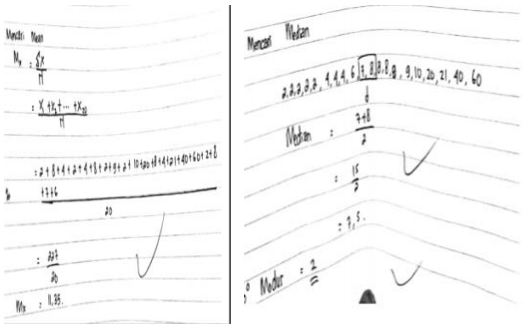

Figure 4: Misconception by DU about central tendency.

Basically, students not only learn about the centralization of data, but also about the location of data. In the student's reply, the student understands the location of the median in the location of quartile data 2 or symbolized by Q_2. Quartiles are a placement measure that divides a data group into four equal parts (Subana, Rahadi, & Sudrajat, 2000). Namely Q_1, Q_2, and Q_3. The location of Q_2 is the position in the middle of the data that divides the data into two parts. In the answer is seen students divided the data into two equal parts. Thus, the median value is written as the sum and division of the two data in the middle position. In fact, in the central tendency, has written the median formula for even and odd data so that students can more easily solve it. Worrying if the data provided in large numbers, students will have difficulty completing it even if it gives the same results. The formula for even n is $Me = X_{\frac{1}{2}(n+1)}$ and for n odd $= \frac{1}{2}\left(X_{(\frac{1}{2}n)} + X_{(\frac{1}{2}n+1)}\right)$. Researchers suspect students find it difficult to use the formula that is to understand the notations and enter the values.

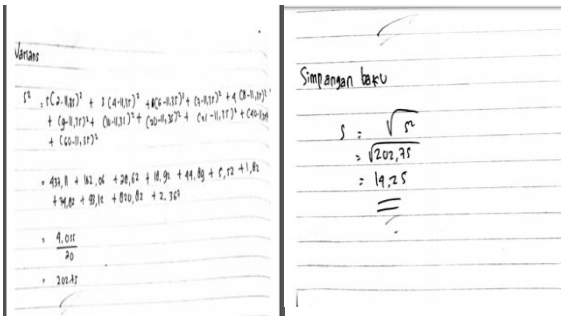

Figure 5: Misconception by DU about data dispersion.

In the student answer above, it appears that the student is not perfect in solving the problem that is not writing the formula first. At the completion, it was seen that students entered n only and not $n-1$. Even though it should use $n-1$ because this is the sample data where $\frac{\sum(x-\bar{x})^2}{n-1}$. Not only that, the calculations $(60\text{-}11{,}35)^2$ also experience errors so that the sigma (addition) of the difference and the square becomes wrong. As for writing the standard deviation formula is good is the square root of the value of variance. However, the final value is wrong because the value of the variance is also incorrect. Therefore, the calculation of the variance must be more precise so as not to result in the standard deviation value. Here it needs a good understanding of the concept to avoid errors in the next.

On the subject of initials DU, obtained interview results as follows:

a. Students understand the concept of calculating the average of summing all the data then divided by a lot of data and students also understand the difference of parameters and statistic that is N and n. However, the student is aware of his mistake in writing the notation for the number of data sizes that should use the n notation as it is the sample data.
b. After being interviewed about presentation of data in the table form. Students admitted better without using tables. However, when given more data, students are aware of the difficulty of counting. Moreover, calculate median for even and odd data. Students unable to remember the median formula well and students also do not understand the use of the formula. Students understand that median location is when the data is divided into two equal parts or called middle value.
c. Students realize less accurate in calculating and less thoroughly using the formula that should be $n-1$ but written into n. This is because students rush, but in paper graffiti has written the formula using n-1.

3. Subject with initials FA

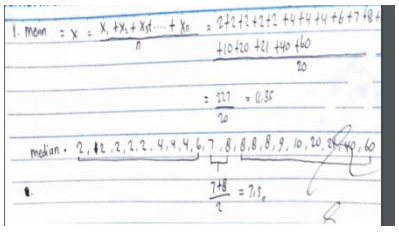

Figure 6: Misconception by FA about central tendency.

In the above point about the central tendency, the student has been able to calculate the mean (mean) of a data, although it does not use the formula agreed by the experts that $\bar{x} = \frac{\sum fx}{n}$. Likewise, with the median

value (Me), it appears that it does not use a mutually agreed formula. Researchers suspect students still do not understand in the use of these formulas. In addition, in the use of notation / symbol for the average, students also cannot write well. It can be seen from the way students write that writing *x*, it should be $\bar{x}$. For presentation data, students also can not present data in the table so that the written procedure is not systematic.

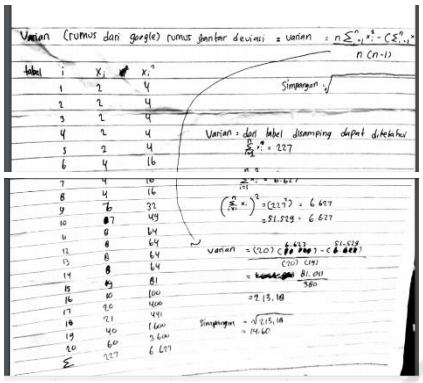

Figure 7: Misconception by FA about data dispersion.

When viewed from the student answers above, it can be explained that the students are not understanding the concept. Here also seen students do not use textbooks but using the formula from google. In writing the notation for the formula is not very clear as $\sum x_i$. So the settlement procedure is not clear. While the final result is correct. So, need further confirmation to the subject of research about it through interview.

Based on the mistakes made by the students, then obtained confirmation between the researchers and students initials FA as follows:

a. Students realize that they are weak in remembering and using existing formulas which should be used to calculate the average and median.
b. On the variance error, the student realizes not memorizing the variance formula and does not understand the use of the formula. When it was confirmed why the answer was correct and the process was wrong, the student testified that the answer was his friend's reply. Students are also even difficult to read his own writing that is not neat and unstructured.

In general, if simple concepts in descriptive statistics are not well understood, it will affect the completion of inferential statistical questions such as the following :

a. In a student with the initials AG, there are misconceptions such as error in using $\sum x$ and $\sum f.x$ not notation. This misconception is not actually bad because it actually contains the same meaning, only when the data is presented in the table and the frequency is not counted, it will produce a seriously error. Because it will result in the mean calculation and then will result in the use of the hypothesis test formula that is t test to see the average, $t = \frac{\bar{x}-\mu_0}{s/\sqrt{n}}$ with degrees of freedom n-1, which in the use of the formula requires an average value. If the incorrect value entered is incorrect, the calculated t test value is also false and then on hypothesis testing will lead to a false conclusion that is rejected or accepted based on the t_{count} and t_{table} values.

The following is the description of the student's answer which caused misconception in the work on the matter of $\sum f.x$and hypothesis test (in figure 7). After interviewed, the students gave information that initially when working the students are still confused to calculate the amount of data using that frequency is $\sum f.x$, so the results obtained are different from what is written when calculate the average that is 811. But then the students re-confirm the correct answer is $\sum f.x = 892$ because there is one data having frequency 2 that is value 81. Thus, it needs to be added back 811 and 81 so that it becomes 892, then the average calculation then become true and on the calculation of *t* test it also corrects.

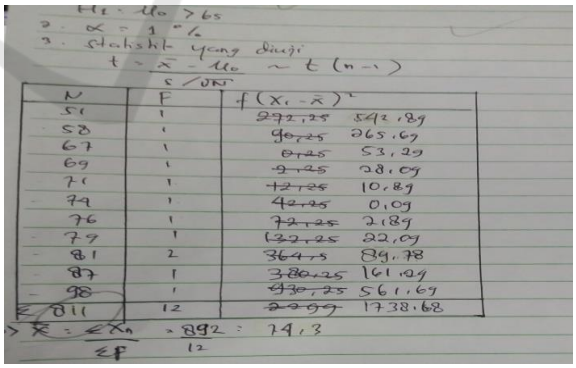

Figure 8: Answer of student in solving hypothesis test problem.

a. In students with initials DU, there are misconceptions in the use of parameters and statistics are *N* and *n*. The difference is about where the data comes from, whether population or sample. Such an error then continues while working on the inferential

statistics problem, the student still uses the *N* notation that shows the population data (as in figure 9).

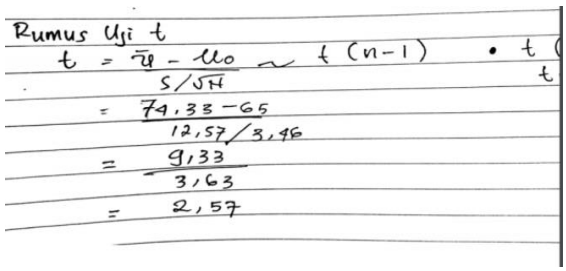

Figure 9: Answer of student in solving hypothesis test problem.

b. In students with the initials FA, there is a misconception in remembering and using formulas. This is due to material that has not been well mastered, incomplete understanding of a concept, and neat and structured writing difficulties.

In this research, we will look for suitability of written test analysis with interview result based on technological triangulation such as:

a. Misconception in the use and development of help tables is calculated as when calculating multiplication between data x and its frequency f and when calculating variance.
b. Students experience misconception on the use of $\sum x$ and $\sum f.x$ not notation. Basically, both formulas have the same meaning, but it becomes fatal when the frequency is not included in the calculation. Not only that, on the use of the formula $\frac{\sum f(x-\bar{x})^2}{n-1}$, the students also still have difficulties.
c. Misconception determines the use of parameters and statistics according to the origin of given data such as *n* and *N*, then n and *n-1*, which then leads to a miscalculation.
d. Misconception in entering *x* values, calculating data differences, and so on.
e. Misconceptions in the use of average symbols, medians, variance, and standard deviations such as $\bar{x}$, Me, Var, s^2, etc.
f. Misconceptions in remembering formulas and using formulas so often have difficulty when using formulas.
g. In inferential statistics, students still make many mistakes in calculations looking for variance and standard deviation, determine hypotheses, and test hypotheses, and conclusions. In the hypothesis determination, many students still do not understand how to write more than (>) and less than (<). This is as a result of the students not getting basic mathematics in previous lectures, so it cannot distinguish mathematical notation and cannot write what is meant in the matter of hypotheses to be proved (e.g. wanting to prove the average hypothesis of educational statistics value is more than 70). While the misconception that occurs when testing the hypothesis is a misunderstanding in determining the statistical test used and the use of these formulas involving statistics in descriptive statistics. Thus, if the concept of descriptive statistics is weak, then the process of hypothesis testing and the conclusion of students will experience a misunderstanding.

Misconceptions and learning Mathematics is a common occurrence different group (Mulungye M. et al., 2016). As an effort to overcome the problem of misconception that occurs in mathematics is to do remedial. They explained that teachers' knowledge on students' errors was investigated together with strategies for remedial teaching. Their studies also showed that teachers need assistance not only in error identification but also how the errors would be built in the whole process of learning.

4 CONCLUSIONS

Statistics in college is a knowledge related to ways of collecting data, processing, presenting, analyzing, and drawing conclusions based on data and analysis performed. The statistics section includes methods and ways of collecting, presenting, processing and analyzing descriptive data called descriptive statistics and parts which include drawing conclusions called inferential statistics. Both statistics are different types and different studies. However, interrelated where inferential statistics would be able to do well if descriptive statistics can be well controlled. Misconception is an error in understanding a concept or concept that is not in accordance with the concepts that have been put forward by experts. Misconceptions are caused by a variety of things. In general, it can be caused by students themselves, teachers who teach, learning contexts, teaching methods, and textbooks. The identification of misconceptions is important in order to locate misconceptions and their causes because sustained misconceptions if not addressed properly and resolved early may pose problems in subsequent learning. Misconceptions in educational statistics consist of misconceptions in the use and development of help tables of calculations, misconceptions in the use of $\sum x$ and $\sum f.x$ notations, misconceptions in determining the use of parameters and statistics,

misconceptions in entering *x* values, calculating data differences, misconceptions in using symbols average, median, variance, and standard deviation, misconceptions in remembering formulas and using formulas so that they often experience difficulties when using formulas, in calculating the search for variance and standard deviation, determining hypotheses, and testing hypotheses, and conclusions. The misconception of educational statistics is basically the mistakes that students have made when solving statistical problems related to data summation, data presentation, and so forth. However, it cannot be entirely the student's mistake, because misconception can be caused by several things such as teacher / lecturer, student / student, learning context, model / learning method, and textbook or other learning resources provided by the teacher / lecturer. In this study, misconceptions occur as a result of students' desire to learn and try hard to solve statistical problems are still very low, agree with the statement expressed by (Maizam, 2009) that most students consider statistics to be no more than numbers and formulas with limited use in everyday life. Furthermore, the lecturer's model / method also needs to be reflected in order to improve the mindset of the students in solving the statistical problems. The use of various textbooks or learning resources also needs to be agreed upon to make no difference in the use of notations and formulas and provide a good understanding of the basic concepts of notations and formulas.

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