

## Research article

# E-Learning: Analysis of Student Teacher Errors in Statistics Problems

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## Abstract.

Statistics is taught in schools, but students commonly make mistakes when faced with statistical problems. This study aimed to describe the errors made by student teacher candidates when solving statistical problems using e-learning media. A qualitative descriptive approach was used. Questionnaires and interviews were used to collect the data. 20 students were asked questions via e-learning media. Based on student errors, 4 students were selected for interviews. These interviews were conducted via WhatsApp. The APOS mental mechanism was used in the error analysis tool, which had five stages: interiorization, coordination, reversal, encapsulation, and de-encapsulation. According to the findings, the three biggest mistakes were made during the de-encapsulation, reversal, and encapsulation stages. To overcome student errors, online computer-assisted learning using moving object animation is recommended.

**Keywords:** e-learning, student teacher candidate errors, statistics

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## 1. Introduction

Statistical science is widely applied in various fields of life, including: health, government and education [1]. The percentage between the number of people vaccinated against Covid-19 and the availability of drugs during a given year can be calculated statistically. The science of statistics is also used for quick counts during the election of the president and vice president. In addition, in the field of statistical science education can also be used for the value and development of student learning outcomes [2]. Therefore, statistics need to be taught not only for students but also for student teacher candidates in universities.

Student teacher candidates need to understand the concept of statistics. In fact, not all students can solve the given statistics problems. Whereas student teacher candidates one day have to teach statistics material to their students. In fact, student teacher candidates still make many mistakes when given statistical problems [3].

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Research into the error analysis of student teacher candidates is important so that the causes, processes of occurrence and similar errors can be minimized. Student teacher candidates someday are expected to become professional teachers. Professional teachers can improve students' understanding of concepts into meaningful understanding. Meaningful understanding makes students not easily forget concepts and can solve problems when they have reached a higher level [4].

This researcher uses the stages of mental mechanism as an error analysis tool. The reason the researcher uses the mental mechanism stage is because this stage can be applied to analyze student errors in college [5-7]. Research related to student errors in solving math problems using the stages of mental mechanisms for the last ten years has discussed a lot about numbers, plane shapes, calculus, and algebra [5-9]. In this study, the researcher wanted to analyze student errors in statistical material. So the purpose of the study was to analyze student errors and the causes of their occurrence when solving statistical problems using the stages of mental mechanisms.

## 2. Method

This study aims to describe student teacher errors in statistical problems. The focus of this research is on the process of errors related to statistical problems in terms of mental mechanisms. The research used a qualitative approach and an exploratory descriptive type. According to Rahmawati [10] qualitative research can explore the problems that occur. The exploration carried out is to describe the occurrence of student errors in statistical problems in terms of mental mechanisms.

Prospective subjects in the study were 20 students of mathematics education from one university in Malang. The selection of interview subjects can be seen in Figure 1.

The instruments used in the research are: a) statistical questions given online through E-learning media, b) interview guidelines, and c) field notes. Students work on the questions online and then the answers are photographed and sent to the E-learning media. The questions used to uncover student errors in statistical problems can be seen in Figure 2.

Interviews were conducted by researchers online using whatsapp telephone. Field notes are used to record student answers during interviews.

The qualitative data analysis procedures used include: observing all data, reducing data, categorizing data, interpreting data and drawing conclusions [11]. Error analysis follows the mental mechanism stages of APOS. The stages of mental mechanism consist of interiorization, coordination, reversal, encapsulation and de-encapsulation [8].

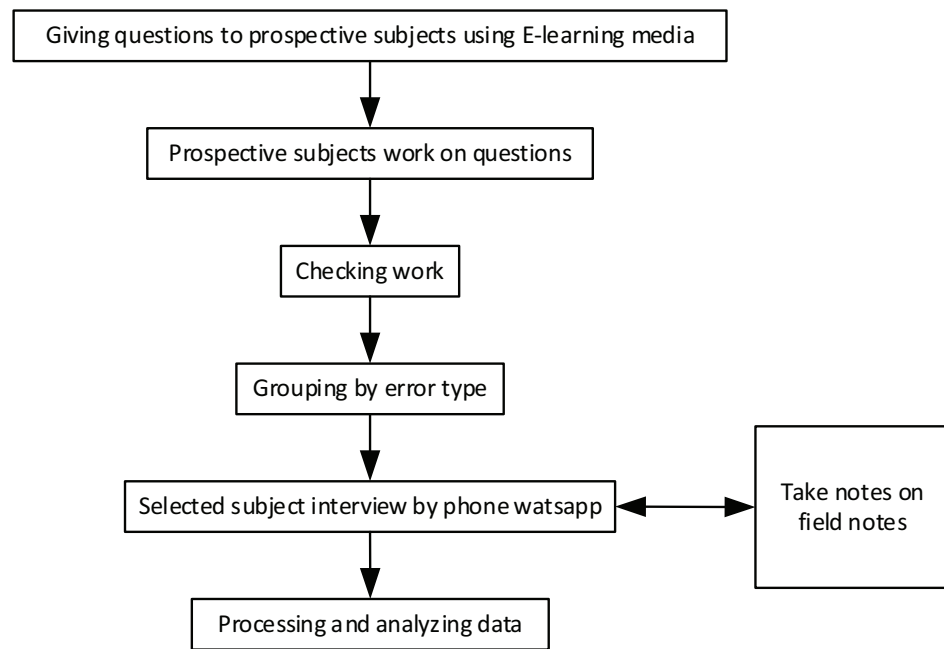
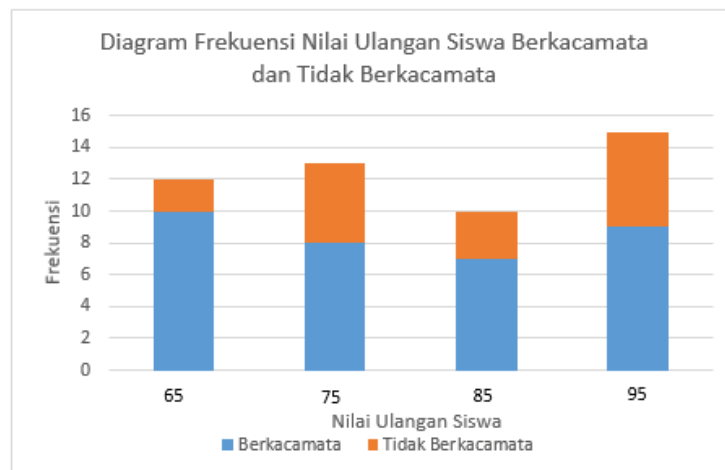


Figure 1: Selection of Interview Subjects.

Nilai ujian siswa yang berkacamata dan yang tidak berkacamata dapat digambarkan seperti gambar diagram batang di bawah ini.



Apabila D1 merupakan median untuk nilai ujian kelompok berkacamata, D2 merupakan median untuk nilai ujian kelompok tidak berkacamata, dan D median untuk nilai ujian seluruh siswa, maka berapakah D+D1+D2?

Figure 2: Statistics Problems (Adaptation of Mathematics Olympiad Problems).

### 3. Result and Discussion

Based on the results of the work of 20 student teacher candidates, 7 people answered correctly, and 13 people answered incorrectly. Answers 13 people who answered incorrectly were grouped by type of error and obtained 4 types of errors. Furthermore, 4

interview subjects were selected based on the type of error that occurred. The selection of subjects is not only based on the same type of error, but also based on the students' good communication skills when conducting interviews [12]. The following describes the process of student errors according to the stages of mental mechanisms.

### 3.1. Subject 1 (S1)

The answer to subject 1 can be seen in Figure 3.

Handwritten student work showing a table and calculations:

Nilai	65	75	85	95	jumlah
berkacamata	5	8	7	9	34
tidak berkacamata	8	9	10	9	31
Semua	18	12	17	19	

$D = 65, D_1 = 65; D_2 = 85$   
 Nilai  $D + D_1 + D_2 = 65 + 65 + 85 = 215$

Figure 3: Answer Error S1.

The error in the S1 answer can be described according to the stages of the mental mechanism in Figure 4.

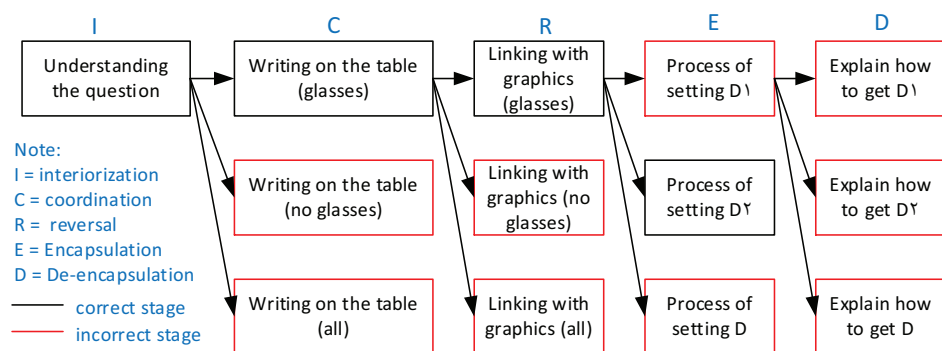


Figure 4: The process of occurrence of S1 errors based on the stages of mental mechanisms.

Based on the answer, S1 experienced an error at the coordination stage, namely representing the data table of students who did not wear glasses and the overall student data. This causes an error in the reversal stage. However, S1 works correctly at the encapsulation stage D2 (process of setting D2). Meanwhile, at the de-encapsulation stage, S1 cannot explain how to get D1 (median 1), D2 (median 2) and D (overall median).

The results of the interview showed that S1 did not remember the statistical material that he had previously studied. Subject 1 made up while setting  $D_2$  and coincidentally the answer is correct. This result is in line with the research of Turgut & Turgut [13] which states that students will succeed in learning mathematics when they understand the material conceptually and can explain how to get answers to the questions given.

### 3.2. Subject 2 (S2)

S2 made an error as shown in Figure 5.

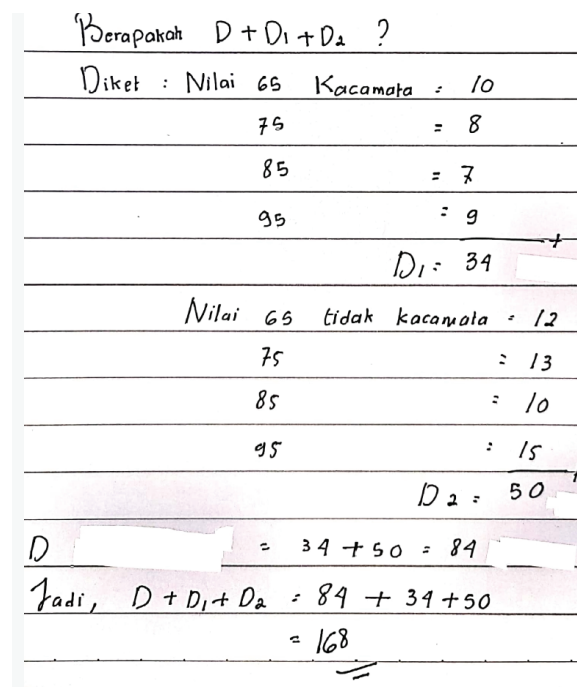


Figure 5: Answer Error S2.

The error in the S2 answer can be described according to the stages of the mental mechanism in Figure 6.

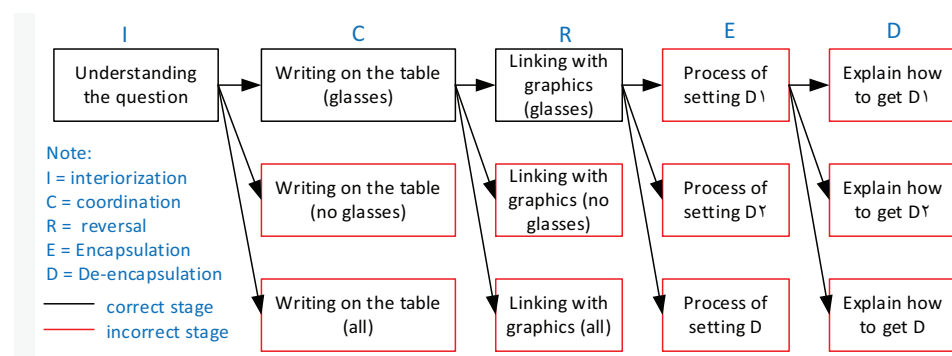


Figure 6: The process of occurrence of S2 errors based on the stages of mental mechanisms.

The results of the questions and interviews with S2 showed errors according to the stages of the mental mechanism which were almost the same as S1. The difference is S2 in the encapsulation stage made an error when setting the median  $D_1$ ,  $D_2$  and  $D$ . Subject 2 made an error by writing down the number of frequencies when setting the median. Based on the results of the S2 interview, he had forgotten the histogram graph. This result shows that S2 forgot to relate to the previous material (reversal stage) [8]. Subject S2 also made an error at the encapsulation and de-encapsulation stages. In addition, S2 also did not understand statistical material significantly. Meaningful learning is needed so that students do not forget the material that has been studied previously [4].

### 3.3. Subject 3 (S3)

S3 made an error as shown in Figure 7.

Handwritten work for Subject 3 showing errors in calculating the median and sum:

$$D = \frac{75 + 85}{2} = \frac{160}{2} = 80$$

$$D_1 = \text{data ke } 16 \text{ dan } 17 = 75$$

$$D_2 = \text{data ke } -2 = 85$$

$$D + D_1 + D_2 = 80 + 75 + 85 = 240$$

Figure 7: Error in the answer S3.

S3 answer errors can be described according to the stages of the mental mechanism in Figure 8.

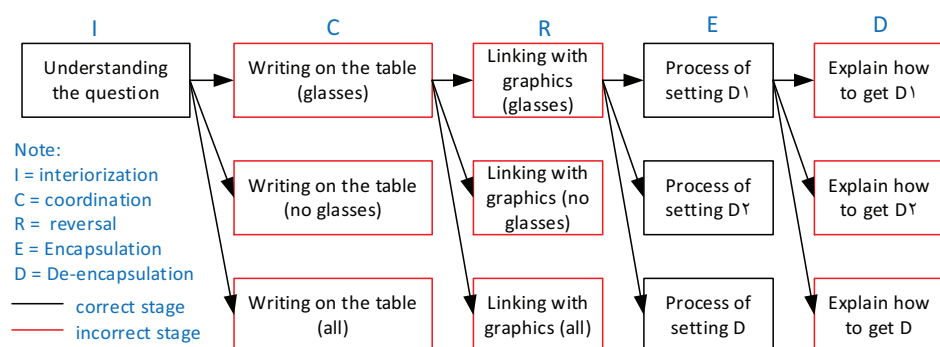


Figure 8: The process of the occurrence of S3 errors based on the stages of mental mechanisms.

S3 made an error at the coordination, reversal, and de-encapsulation stages. S3 coincidentally performs correctly at the encapsulation stage. Subject 3 had forgotten the

formula for finding the median when interviewed. This result is in line with the opinion of Gürefe [14] and Meylasari, Sujadi & Subanti [15] who said that many prospective teachers were unable to explain the formulas used when solving math problems.

### 3.4. Subject 4 (S4)

S4 made an error as shown in Figure 9.

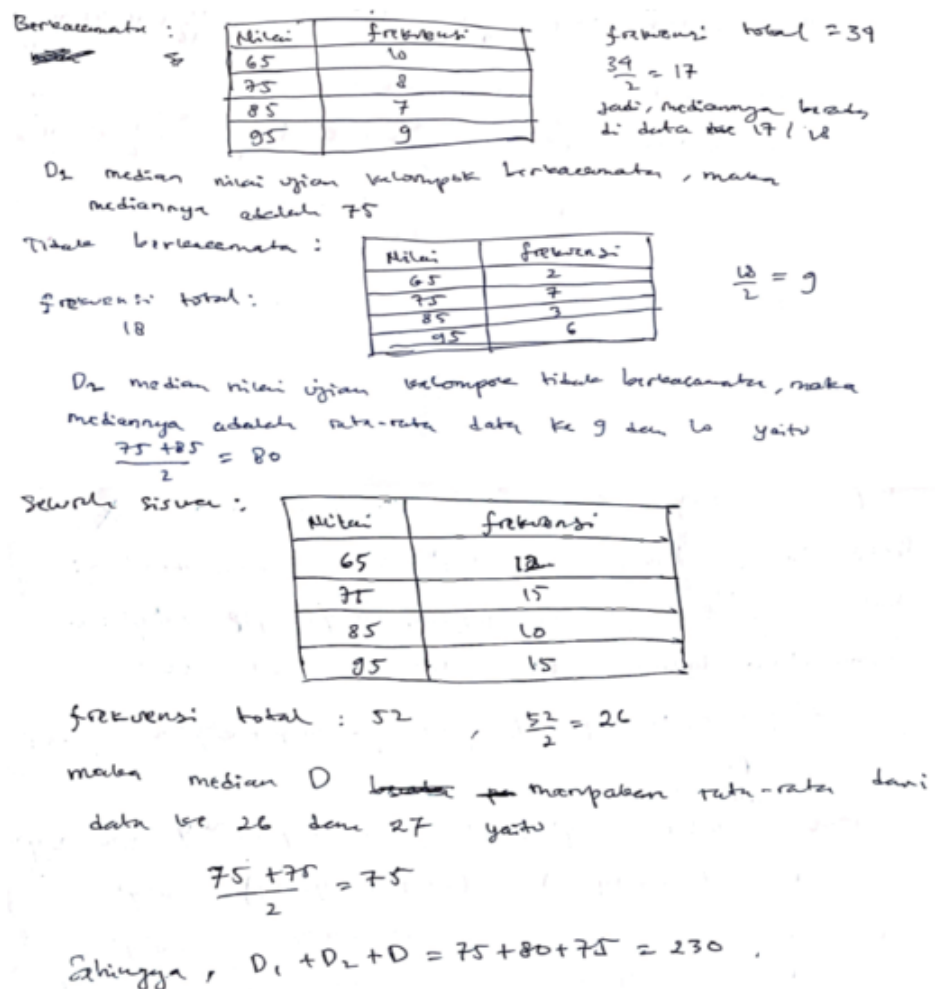


Figure 9: Error answer S4.

The error in the S4 answer can be described according to the stages of the mental mechanism in Figure 10.

The error made by S4 is also almost the same as S1's error, the difference lies in the correct encapsulation stage of S4 in the process of setting D1. The results of the interview show that S4 still remembers the formula for the median of even data. Subject misrepresented the number of frequencies on the histogram graph into the table to

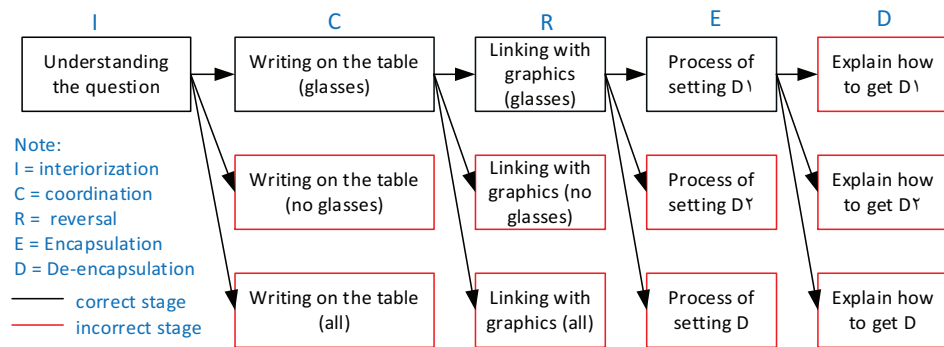


Figure 10: The process of the occurrence of S3 errors based on the stages of mental mechanisms.

find the median 2 (D2). An error when assigning D2 causes an error when assigning D. The interview results show that S4 did not re-check the final answer. This result is in accordance with the opinion of Iskak, Kusmayati, Fitriana [16] who said that inaccuracy from one representation to another caused errors in the final answer.

In general, the most errors in S1, S2, S3 and S4 occurred at the de-encapsulation stage. This happens because subject 1 incorrectly assigned D1 and D, subject 2 incorrectly assigned all answers, and subject 4 incorrectly assigned D2 and D so that they experienced an error at the de-encapsulation stage [8]. In addition, subject 1 correctly assigned D2, subject 3 correctly assigned D1, D2 and D and subject 4 correctly assigned D1 but could not explain how to get the final answer so they experienced an error at the de-encapsulation stage.

### 4. Conclusions

Based on the results of student work and interviews, the biggest error lies in the de-encapsulation stage. The next error is in the reversal and encapsulation stage. Factors causing errors include students who have forgotten the histogram graph material, forgot the median formula, thought the problem was difficult and did not remember the statistical material they had studied at school. Further research is recommended to develop moving animation media to better understand students related to statistical material.

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