Prima: Jurnal Pendidikan Matematika
Vol. 7, No. 1, January 2023, pp. 1-14
P-ISSN: 2579-9827, E-ISSN: 2580-2216
Web: http://jurnal.umt.ac.id/index.php/prima

ANALYSIS OF STUDENT ERROR BASED ON NEWMAN'S PROCEDURE IN SOLVING HOTS TYPES REVIEWING FROM COGNITIVE STYLE FI and FD

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Abstract

The purpose of this study was to determine the types of errors and the causes of errors made by students in solving HOTS type questions for SPLTV material based on Newman's procedure in terms of the cognitive style of class X students of Senior High School number six Denpasar. The method of this research is a qualitative method. The data was collected by means of the HOTS test, GEFT, interviews, and documentation. The subjects of this study were students of class X IPA 1 SMA Negeri 6 Denpasar which were then grouped based on cognitive styles, namely Field Independent (FI) and Field Dependent (FD) students and the number of errors in each cognitive style in answering HOTS questions was categorized into 3, namely errors quite complex, complex, and very complex. The average percentage of FI student errors is 38.88%. The average percentage of FD students' errors is 55.55%. The errors of students with cognitive style FD are more than students with cognitive style FI. The causes of errors in the subject of FI are (1) less calm in working on questions, (2) lack of knowledge of the steps that must be taken to solve problems, (3) lack of time in solving problems. completion process, and (4) no re-checking of written answers. The causes of FD student errors are (1) incomplete in reading the questions, (2) in a hurry to finish quickly, (3) not knowing what is known in the questions implicitly, and (4) not checking again.

Keywords: Error analysis, Newman procedure, HOTS, Cognitive Style

INTRODUCTION

The 21st century demands that Human Resources (HR) have three important abilities including the ability to think critically, think creatively, and solve problems (Pratiwi, 2019). However, in Indonesia, higher order thinking skills in mathematics is still low. This is evident from the results of research (Wibowo et al, 2016) which states that students are less able to solve problems that are required to think at a higher level. As a result, students make many mistakes in solving HOTS type questions. The results of observations at SMA Negeri 6 Denpasar showed that students did not understand the material that had an impact on errors in solving problems, especially HOTS type questions.

The results of students' work in answering HOTS type questions showed that students did not understand the problems in the questions as evidenced by students experiencing errors in the problem transformation stage, the completion process, and writing the final answer. In the transformation stage, students write mathematical models that are not in accordance with the problem. In doing the counting process students experience errors, especially in performing fractional operations. This affects the stage of writing students' final

Received: August , 2022; Revised: december, 2022; Accepted: December, 2022

answers which are less precise. Based on these problems, it is necessary to have a solution to find out the errors and causes of student errors by analyzing errors through student responses in solving HOTS questions.

In this study, the procedure which is used to analyze student errors is the Newman procedure. In the last 4 years research on the analysis of student errors in solving math problems, has become an important study and has been studied by many researchers (Amalia, 2017; Kuswanti et al, 2018; Afriani et al, 2019; Arsyda, 2020). The results of research conducted by (Amalia, 2017) showed that students with the FI cognitive style in solving story questions made mistakes at the process skill stage and the answer writing stage (encoding). The results of research from (Kuswanti et al, 2018) showed that the most student errors in solving SPLTV problems were errors in transforming problems, processing skills, and writing final answers.

The results of research conducted by (Afriani et al., 2019) showed FD type student errors in essay tests and cognitive tests on flat-sided geometrical materials including reading errors, problem understanding errors, and transformation errors. Errors were made by FI type students included reading errors, understanding errors, and process skill errors. The results of the study (Arsyda, 2020) showed that in solving SPLDV questions, students with FD cognitive style had more errors than students with FI cognitive style.

None of these studies examined student errors in solving HOTS type questions on SPLTV material in terms of students' cognitive style. In addition, all these studies obtained data offline, while in this study the data were taken offline and online. The results of White's research (in Anggreni, 2020) show that the error analysis method can activate students in the learning process in the classroom. Based on the essay above, the researcher was interested in conducting a study entitled "Analysis of Student Errors Based on Newman's Procedures in Solving HOTS Type Questions in terms of FI and FD Cognitive Styles".

RESEARCH METHODS

This research was conducted at SMA Negeri 6 Denpasar in the academic year 2021/2022 from October to November 2021. This type of research is qualitative. The subjects of this study were students of class X IPA 1 SMA Negeri 6 Denpasar which were grouped based on cognitive styles, namely Field Independent (FI) and Field Dependent (FD) students and the

number of errors in each cognitive style in answering HOTS questions was categorized into three, namely errors quite complex, complex, and very complex so that the number of research subjects is six. The instruments used in this study were GEFT (Group Embeded Figure Test), HOTS (Higher Order Thinking Skill) type questions, and interview guidelines. GEFT was used to determine students' cognitive style, HOTS type questions were used to determine student errors in solving HOTS questions, and interview guidelines were used to determine the causes of student errors in solving HOTS type questions. The data analysis technique used in this research was descriptive qualitative with the following stages.

1. GEFT Test

   GEFT results that have been answered by students would be checked by researcher. If students answered incorrectly, they would be given a score of 0 and if they were correct, they would be given a score of 1. Students classified as FD were students who got a score of 0-11 and students classified as FI were students who got a score of 12-18. This scoring guide refers to the research of Rifqiyana, et al (2016).

2. Essay Test

   1) Data Reduction

      In each of the FD and FI groups, students were divided into 3 categories based on their errors, namely the category of quite complex, complex, and very complex errors. Then one student was taken from each category based on the error so that the research subject was six students after that analyzed the errors using the Newman procedure and then interviewed.

Table 1. Category Number of Students Errors

Number of Errors	Category
1-10	Quite Complex (QC)
11-20	Complex (C)
21-30	Very Complex (VC)

   2) Data Presentation

      The presentation of data in this study is to present the results of the work and interviews of students who were research subjects, then analyzed to find out

errors made by students, furthermore it could be concluded so as to be able to answer the problems in this study.

3) Conclusion Drawing

The conclusions in this study were obtained from comparing the students' work analysis and the results of interviews with research subjects so that errors and their causes could be known in solving HOTS type questions for SPLTV material.

4) Data Validity

In this study, the data validity test used was source triangulation. According to Patton (in Moleong, 2004: 330), triangulation of sources means comparing and re-checking the degree of trust in information obtained through different times and tools in qualitative research. This can be achieved by comparing the observed data, interview data, and research subjects.

RESULT AND DISCUSSION

The results of the GEFT test showed as many as 13 students with the FI cognitive style and 21 students with the FD cognitive style. After the researcher gave the GEFT test, the researcher gave the HOTS test. The results of the HOTS test showed that 13 students with FI cognitive style were used as research subjects and 12 students with FD cognitive style were used as research subjects. This was because two students did not take the HOTS test and seven students who could only do less than three questions so that the answers were not representative to be used as research subjects. The following is the number of errors of FI and FD students.

Table 2. Number of Students Based on Their Errors

	FI	FD
QC	11	9
C	1	2
VC	1	1

Description:
QC : Quite Complex
C : Complex
VC : Very Complex

Table 3. Students Error Percentage of FI and FD

Error Stages	FI	FD
Reading Error	0%	33,33 %
Understanding Error	27,78%	44,44%
Transformation Error	38, 89%	55,55%
Process Skill Error	55,55%	66,67%
Final Answer Writing Error	72,22%	77,78%
Average	38,88%	55,55%

Based on Table 3 the average percentage of FD errors is greater than the average percentage of FI errors. The results of tests conducted in class X IPA 1 SMAN 6 Denpasar in solving HOTS type questions for SPLTV material, interviews were conducted on 6 research subjects including subjects from the FI group with fairly complex errors (S1), subjects from the FI group with complex errors (S2) , subjects from the FI group with very complex errors (S3), subjects from the FD group with moderately complex errors (S4), subjects from the FD group with complex errors (S5), and subjects from the FD group with very complex errors (S6). The results of the HOTS test from S1 are as follows.

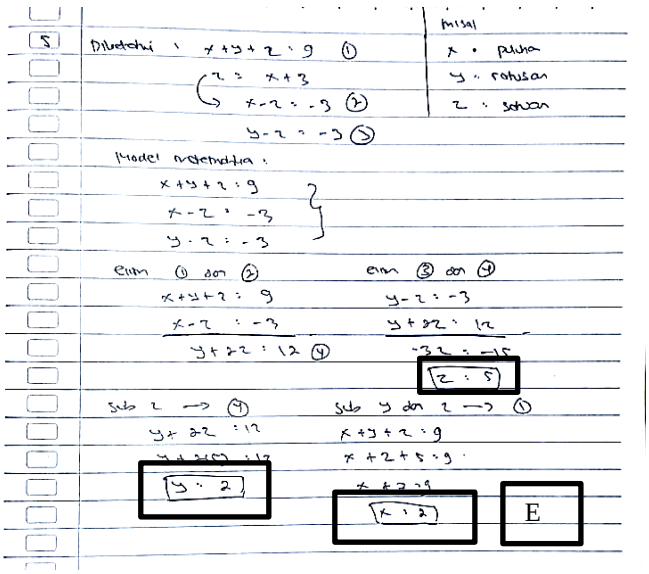

Figure 1. The Answer of S1

The causes of errors made by S1 are presented in the form of excerpts of interviews between researcher and S1 as follows:

R : "Why is the solution process only to determine the value of x, y, z?"
S1 : "I forgot to combine the three to make it a number Miss."

R : "Okay, what number should be there?"
S1 : "225 Miss."
R : "Did you check the answer you wrote?"
S1 : "No, Miss. I panicked seeing the short time, so I focused on what was important, I just answered and I was nervous because I had to be on camera from the beginning to the end of the test."

From the interview excerpt above, it can be seen that S1 has been able to pass through the stages of reading, understanding, transforming, and processing. However, S1 did not write down the final answer. This was because there was no checking of the answers that have been obtained and immediately proceed to the next question.

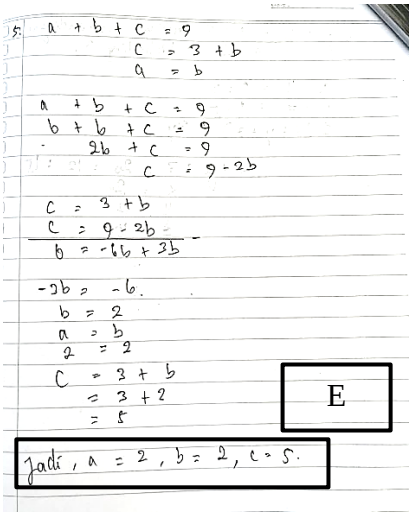

Figure 2. The Answer of S2

The causes of the errors made by S2 are presented in the form of excerpts of interviews between researchers and S2 as follows.

R : "How could you write the final answer like this?"
S2 : "I thought that was correct. I mean the hundred was 2, the ten was 2 and the unit was 5."
R : "You should form a number from the values of hundreds, tens, and units, that is the number 225."
S2 : "Oh I see, I did a mistake."
R : "Did you check the answers you wrote?"
S2 : "No Miss, that's all there is still something missing but the time is up so I don't have time to check."

From the interview excerpt above, it shows that S2 has been able to pass through the stages of reading, understanding, transforming, and processing. The S2 error was writing the

final answer that was not in accordance with the request in the question. This was because S2 already felt right about the answers that have been obtained and did not re-check.

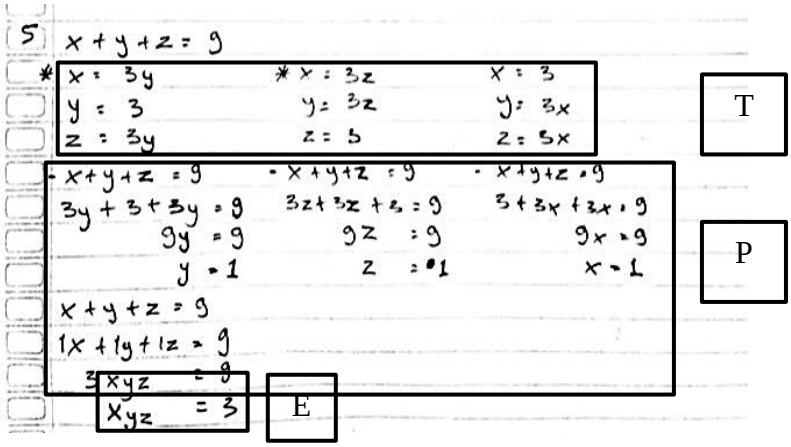

Figure 3. The Answer of S3

The causes of the errors made by S3 are presented in the form of excerpts of interviews between researcher and S3 as follows.

R : "How could you write a mathematical model like this?"
S3 : "Yes Miss, I don't understand the meaning of the problem. So, I just tried it, the point was that the result must be 9."
R : "Why can be $3y + 3 + 3y = 9y$?"
S3 : "Yes, I already knew it was wrong, but I continued because I didn't know the next process. So, I just kept trying it, as the point was that it's finished."
R : "Did you check the answers you wrote?"
S3 : "No Miss."
R : "How do you know if the answer was right or wrong?"
S3 : "Yes, I'm just sure that my answer was correct"

From the interview excerpt above, it shows that S3 experienced errors at the stage of understanding up to the writing of the final answer. This was because S3 did not understand the questions and did not know the process that must be carried out.

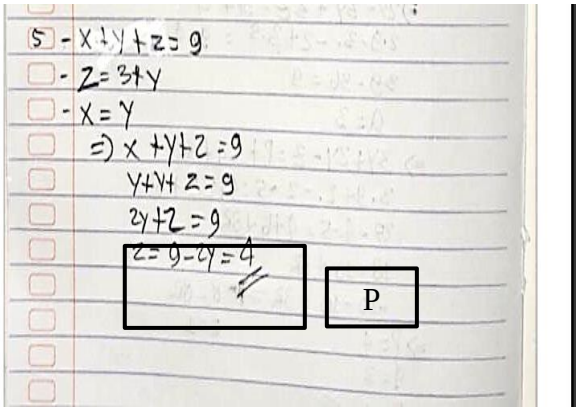

Figure 4. The Answer of S4

The causes of the mistakes made by S4 are presented in the form of excerpts of the interview between the researcher and S4 as follows.

R : "Where did you get the number 4?"
S4 : "9 – 2 Miss."
R : "9 – 2 that's the result 7 not 4, and there it is written 9-2y. You shouldn't be able to do the subtraction process because there is a y variable there. Why don't you write down the completion process?"
S4 : "It's because I didn't understand that's why I didn't continue it."
R : "Did you check the answers you wrote?"
S4 : "No, I didn't."

From the interview excerpt above, it can be seen that S4 was already in the transformation stage. However, S4 was unable to retell the meaning of the problem and did not understand the steps that must be taken in the completion process and did not understand algebraic concepts in arithmetic operations.

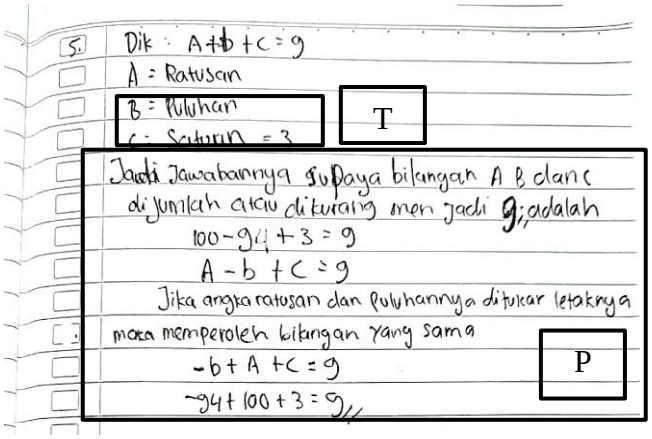

Figure 5. The Answer of S5

The causes of the mistakes made by S5 are presented in the form of excerpts of the interview between the researcher and S5 as follows.

R : "How could you write like this?"
S5 : "I didn't understand the sentences in the problem. What I understood from that question, I was asked to find three numbers which when added up the result is 9 and the numbers must have hundred, ten, and unit so I chose 100, 94, and 3."
R : "But there you were doing a subtraction operation, why was it like that?"
S5 : "That's because I wanted the result could be 9."
R : "Did you check the answers you wrote?"
S5 : "No, I didn't."

From the interview excerpt above, it shows that S5 experienced errors at all stages. This was because S5 did not understand the words in the questions and misunderstood the meaning of the questions which affected the final answer. S5 also did not re-check the answers that have been written.

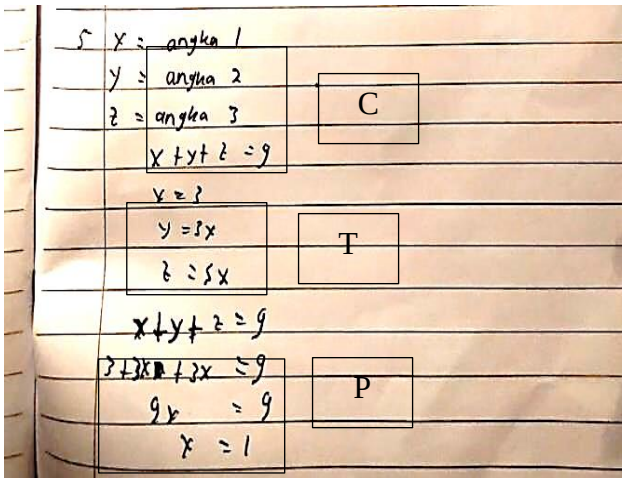

Figure 6. The Answer of S6

The causes of the mistakes made by S6 are presented in the form of excerpts of the interview between the researcher and S6 as follows.:

R : "How could you write like this?"
S6 : "II have no idea how to solve this problem, so I just made it up. Because time is almost up, so I just finish doing what's important."
R : "Did you check the answers you wrote?"
S6 : "No, I didn't"
R : "How do you know if the answer was right or wrong?"

S6 : “I already felt that my answer was wrong, because I didn't follow the formula for doing it.”

From the interview excerpt above, it shows that S6 only understood part of the problems in the questions and did not know the process of how to solve the problems. This causes S6 to write a process that has little to do with the problem in the question. The cause of the S6 error was not understanding the meaning of the words in the problem.

Based on the results above, it was found that the FD group students made more mistakes than the FI group students. The FI group students experienced an error in understanding the problem of 27.78%, a transformation error of 38.89%, a process skill error of 55.55%, and an error in writing the final answer of 72.22%. The highest error in the FI subject was at the stage of writing the final answer. The causes of errors in the FI subject were not calm in working on the questions, in a hurry to finish quickly, not knowing the steps that must be taken to solve the problems, not being careful in arithmetic operations, lack of time in the completion process, and not checking back on the final answers. This is reinforced by the results of research from Amalia (2017), Hartati (2018), and Arsyda (2020) that students with the FI cognitive style tend to make mistakes at the process skill stage and the final answer writing stage (encoding).

The three subject FD group students had errors in all stages, namely reading problems by 33.33%, understanding problems by 44.44%, transformation by 55.55%, process skills by 66.67%, and writing final answers by 77.78 %. The highest error in the subject of FD was at the stage of writing the final answer. The mistakes were made by the FD group and were caused by not being calm in working on the questions, rushing to finish quickly, not understanding the meaning of the questions, not knowing what was known in the questions implicitly, not being able to retell the contents of the information in the questions, not knowing the steps involved that must be done to solve the problem, less thorough in arithmetic operations, lack of time in the completion process, and not re-checking the final answer that has been written. This is reinforced by the results of Pratiwi's research (2017) which showed that the mistakes that were often made by students with FD cognitive style were problem transformation errors, process skill errors, and writing errors in the final answer.

Students from the FD group had more errors than the FI group as seen from the average percentage of FI and FD errors. The average error percentage for FI was 38.88% and FD was 55.55%. This was caused by students with FI cognitive style. It is easier to parse complex things and it is easier to learn natural science and mathematics than students in the FD group. This is reinforced by the results of Hassan's research (2020) which showed that FI students had a more detailed level of understanding of mathematical concepts. FI subjects were able to re-explain the information contained in the questions in more detail than FD subjects. Therefore, the error of FI was less than that of FD.

CONCLUSION

Based on the results of data analysis and discussion of this study, it can be concluded that the types of student errors in solving HOTS type questions were:

1. Reading Error

   The type of the subjects' reading error of the FD group was that students read the questions incompletely and did not interpret the words in the questions correctly. Problem reading errors were only found in group FD subjects. The cause of reading errors was that students were in a hurry to work on the questions.

2. Understanding Error

   The types of errors in understanding the problems of students in the FI group were less able to understand the problem and the meaning of the questions and were wrong in writing examples. While the types of errors in understanding the problems of the FD group students were not understanding the problem and the meaning of the questions, being unable to retell the information in the questions, and not knowing what was known in the questions implicitly. Errors in understanding the problems in the FI and FD group students were caused by students who only read the given questions once and did not understand the questions more deeply and students were also in a hurry to finish their work quickly.

3. Transformation Error

   The types of errors of the FI group students in the transformation stage were writing errors in writing the mathematical model and the mathematical model written

was not in accordance with the problem in the problem. The errors of the FD group students in the transformation stage were that the mathematical model did not match the problem in the problem, was wrong in substituting variable values, and the mathematical model that was written was only partially or incomplete. The cause of the transformation stage error in FI students was that students were wrong in the stage of understanding the problem and students were not careful. While the causes of the transformation stage errors in FD students were misunderstanding the questions, reading incomplete questions, and not knowing what was known in the questions implicitly.

4. Process Skill Error

   The types of errors in the FI and FD groups in the process skills stage were incorrect in arithmetic operations, only partially completing the completion process, and carrying out the completion process that was not in accordance with the problem in the problem. The causes of errors in the process skills of FI and FD students were that students do not know the steps that must be taken to solve the problem, were less careful in arithmetic operations, lack of time in the completion process, and due to errors in the previous stage.

5. Final Answer Writing Error

   The types of errors in writing the final answers of FI and FD students were writing errors in writing the final answer, not writing the final answer, the final answer that was not in accordance with the problem in the question, and not re-examining the written final answer. The cause of writing the final answer was that students were less focused, less thorough, in a hurry, and there was no re-examination of the final answers.

Based on the conclusions above, there are several suggestions put forward by researchers including the following.

1. The teacher should introduce more HOTS type questions so that students will be more trained and more systematic in solving them.
2. Students must be more active in digging for information such as asking questions, discussing, and looking for other sources related to HOTS type questions.

ACKNOWLEDGMENTS

The author would like to thank the Ministry of Education and Culture-Research and Technology for research grants through the Indonesia Innovation Talent Program in 2021.

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