

ANALYSIS OF STUDENTS' THINKING STRUCTURES REGARDING PERSONALITY TYPES IN SOLVING MATHEMATICAL PROBLEMS THROUGH DEFRAGMENTATION

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Abstract. The extrovert-introvert personality type has different energy sources for the individual, which affects the difference in thinking structures that will be obtained in solving problems. The thinking structure is the internal representation of students' mental activities that describes the flow of solving mathematical problems. Therefore, the mistakes made by students in solving mathematical problems require proper resolution, one of which is defragmentation. The purpose of this research is to analyze students' thinking structures related to personality types in solving problems through defragmentation. The approach used in this research is qualitative with a descriptive research type. Subject selection was carried out using purposive sampling technique with criteria being students who have extrovert-introvert personality types regarding mistakes in understanding and transformation. The research data consisted of answers, recordings of semi-structured interviews, and students' think-aloud results. The analysis techniques used are data reduction, data presentation, and conclusion drawing. The results show that defragmentation can help students with extrovert-introvert personality types to understand mistakes and perform transformations to reorganize their thinking structure. This is evidenced by the completeness of students' thinking structures from the stages of reading, understanding, transforming, analyzing, and evaluating.

Keywords: Personality Type, Thinking Structure, Defragmentation

Abstrak. Tipe kepribadian ekstrovert-introvert memiliki sumber energi yang berbeda bagi individu tersebut, sehingga hal ini berdampak pada perbedaan struktur berpikir yang akan diperoleh dalam menyelesaikan masalah. Struktur berpikir merupakan representasi internal dari aktivitas mental siswa yang menggambarkan alur penyelesaian masalah matematika. Oleh karena itu, kesalahan yang dilakukan siswa dalam menyelesaikan masalah matematika memerlukan penyelesaian yang tepat, salah satunya adalah defragmentasi. Tujuan dari penelitian ini adalah untuk menganalisis struktur berpikir siswa mengenai tipe kepribadian dalam menyelesaikan masalah melalui defragmentasi. Pendekatan yang digunakan dalam penelitian ini adalah kualitatif dengan tipe penelitian deskriptif. Pemilihan subjek dilakukan dengan teknik purposive sampling dengan kriteria yaitu siswa yang memiliki tipe kepribadian ekstrovert-introvert mengenai kesalahan dalam pemahaman dan transformasi. Data penelitian berupa jawaban, rekaman wawancara semi terstruktur dan hasil think aloud siswa. Teknik analisis yang digunakan adalah mereduksi data, menyajikan data, dan menarik kesimpulan. Hasil penelitian menunjukkan bahwa defragmentasi dapat membantu siswa yang memiliki tipe kepribadian ekstrovert-introvert untuk memahami kesalahan dan melakukan transformasi untuk menata kembali struktur berpikirnya. Hal ini dibuktikan dengan lengkapnya struktur berpikir siswa dari tahap membaca, memahami, mentransformasi, menganalisis dan mengevaluasi.

Kata Kunci: Tipe Kepribadian, Struktur Pemikiran, Defragmentasi

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INTRODUCTION

Personality is the whole way an individual reacts and interacts with other individuals. Personality has often been studied by several theories so that various types or kinds of personality emerge in learning. Carl Gustav Jung stated that personality types are divided into two, namely *extrovert personality types* and *introvert personality types*. *Extrovert* personality types are generally people whose attention is more directed outside themselves, namely to other people, to society (Subtinanda & Yuliana, 2023) .

Introvert personality types are people whose attention is more directed towards themselves, towards their "I". According to Sumadi Suryabrata, *extrovert personality* is influenced by the objective world in the form of the world outside of himself. Aspects of thoughts, feelings, and actions are determined by the environment, both social and non-social environments (Sugestian & Astrella, 2022) . Based on these differences, it can be stated that *extrovert-introvert personality types* have different energy sources for their own individuals, thus impacting the differences in the thought structures that will be obtained in solving problems.

Problem solving is an integrated process of learning mathematics and an inseparable part of the learning program (Sukiyanto., 2020) . Mathematical problem solving is stated as a complex cognitive activity that involves many processes, in addition to solving problems, students must integrate cognitive, metacognitive, and self-regulation mechanisms from various strategies (Hadi et al., 2022) . When students want to solve mathematical problems, students must go through several steps in solving mathematical problems, including: *reading* , *comprehension* , *transformation* , *process skill* , and *encoding* . The ability to solve mathematical problems always involves cognitive and metacognitive processes so that students are expected to be able to determine the strategy to be used and prepare alternative strategies if they experience difficulties or changes in the situation in the process of solving the problem (Sukiyanto, 2020) .

Several studies that have been conducted in schools state that in the largest proportion of errors, around 70% of the errors made by 7-year-old students are in mathematics problems that are specifically at the level of understanding problems and transformation problems. From the results of other studies, it also shows errors of less than 5% of initial errors, and this condition also applies to errors in analyzing problems that are mostly related to standard numerical operations (Zahra, 2019) . Mihendra., (2014) showed that students who experienced reading errors *were* 50%, comprehension errors *were* 38.46%, analysis errors were 3.85%, and errors in *writing* the final answer (*encoding error*) were 7.69%.

Difficulty in solving mathematical problems is always experienced by students which results in students making mistakes or failing to solve mathematical problems (Wibawa et al., 2018) . One of the factors that influences students' mathematical problem solving errors is the thinking structure they have (Sukmaangara & Prabawati, 2019) . The thinking structure is an internal representation of students' mental activities that describe the flow of solving mathematical problems (Khaatimah et al., 2017) . The thinking structure is also interpreted as a flow diagram that is described through the coding of students' thinking processes in solving problems (Gunawati & Nisman, 2021) . Thinking is a mental activity that occurs in the brain as an effort to solve mathematical problems (Nasution, 2018) . The mental activities that occur can be in the form of remembering, understanding, transforming, analyzing, evaluating, and writing the final answer.

Based on initial observations that have been made, students who experience errors in their thinking process cannot solve the given mathematical problems. This has an impact on students when solving the next mathematical problem (Nazihah, 2018) . To overcome problems in the student's thinking process, it can be done by structuring the student's thinking structure into a complete thinking structure so as to achieve a deep understanding of solving mathematical problems (Wulandari & (Placeholder1)Gusteti, 2021) .

One of the treatments that can be done to overcome students' thinking structure errors is by providing defragmentation. Defragmentation of thinking structure is defined as a process of structuring students' thinking into a complete thinking structure so as to achieve a deep understanding of the stages of solving the given mathematical problems (Bahrudin, 2019) . According to research conducted by (Septian et al., 2018) states that defragmentation of thinking structures aims to rearrange the thinking structures that occur in students. Defragmentation more specifically refers to changes in thinking structures due to intervention from others. The intervention carried out in defragmentation is an assistance from others to rearrange the thinking structure when making mistakes in solving problems. Therefore, researchers will conduct research entitled "Analysis of Student Thinking Structures Against Personality Types in Solving Mathematical Problems Through Defragmentation".

METHOD

The approach used in this study is qualitative with a descriptive research type. This study was conducted on 5th semester students in the information technology education study program and the information technology study program totaling 30 students. The selection of subjects was taken through the results of the personality type questionnaire that had been given, based

on the results of the questionnaire, students who had extroverted personality types and introverted personality types could be grouped. Then the two groups of extroverted and introverted personality types were given test sheets, through the results of the test questions, the researcher grouped student errors based on error categories adopted from Aisyah (2019), namely 13 students who had extroverted personality types experienced errors in understanding and 14 students who had introverted personality types experienced transformation errors in solving the problems given.

The subjects taken in this study were students who have an extrovert personality type towards understanding errors and students who have an introvert personality type towards transformation errors. This is because students who have an extrovert personality type who experience understanding errors will have an impact on the next problem-solving stage, as well as students who have an introvert personality type who experience transformation errors, so they need treatment that is in accordance with the students' thinking needs. In this study, the treatment given was defragmentation. Then the subjects were given a test instrument in the form of 1 story question which was done by *thinking aloud* with the help of a voice recorder. The research data consisted of students' answers to the story question test, recordings of semi-structured interviews and students' *think aloud results*. *Through these three data, the category of mathematical problem-solving errors will be seen based on Newman's theory.*

The results of the analysis of the research data are used to determine the structure of students' thinking. This is known through indicators of stages of thinking that have not been fulfilled due to subject errors, so that it becomes a guideline for researchers to defragment the structure of thinking so that students can complete the structure of thinking in solving mathematical problems. Then the data obtained is analyzed through techniques, namely reducing data, presenting data, and drawing conclusions.

RESULTS AND DISCUSSION

Data Structure of Extroverted S1 Thinking Against Misunderstanding in Solving Mathematical Problems Before Defragmentation

S1 Extrovert is a subject who has an extrovert personality type towards misunderstanding in solving mathematical problems (Newman, 1977). This is because S1extrovert can only identify or determine known information in solving mathematical problems, but S1 extrovert does not understand what is actually being asked in the problem with the various provisions given. The following presents the answers, results of *think aloud recordings* and semi-

structured interviews related to the thinking structure of S1 extrovert towards solving mathematical problems.

Based on the results of *think aloud*, it is known that after reading the problem, S1 extrovert identified information on the given problem. S1 extrovert revealed that the first to fourth rows of seats consist of 25 seats, 35 seats, 50 seats, 70 seats and the number of rows of seats in the fifth and sixth are unknown. Then S1 extrovert explained the price of the most expensive first row ticket with a ticket price difference of Rp. 10,000.00 with the committee wanting to obtain funds of Rp. 22,500,000.00, on condition that all audience seats in the building are fully occupied. Furthermore, from the information that has been conveyed above, it proves that S1 extrovert is able to fulfill the stage of remembering to solve mathematical problems. then S1 extrovert conveys the information asked in the problem, namely the cheapest ticket price, so to find out the cheapest ticket price, the number of seats in the fifth and sixth rows in the building must be determined, namely 95 and 125 seats. This proves that S1 extrovert is able to identify information in the given mathematical problem

Then, at the stage of understanding, S1 extrovert is able to determine the number of seats in the fifth and sixth rows by identifying the difference in seats in the first, second, third, and fourth rows, but S1 extrovert does not determine the total number of seats in the building. This explains that S1 extrovert is unable to know what is actually being asked in the problem with the various provisions given and S1 extrovert is also unable to connect the problem with the material obtained previously, so it can be said that S1 extrovert has not fulfilled the stage of understanding the problem perfectly. Thus, of course S1 extrovert has also not fulfilled the stage of transforming, analyzing, and evaluating.

Further explanation related to S1 extroverts who have not been able to fulfill the stages of understanding, transforming, analyzing, and evaluating in solving mathematical problems is because S1 extroverts do not determine the total number of seats in the building. For more details, see the following answer excerpt.

Baris: 1, 2, 3, 4, 5, 6

= 25, 35, 50, 70, ..., ...

= 95, 125

Misal = a harga tiket kursi termurah

Figure 1. Excerpt of S1 extrovert's answer determining the rows of chairs in a building

Based on Figure 1, it is known that S1 extrovert is able to determine the number of seats in the fifth and sixth rows, namely 95 seats and 125 seats, but S1 extrovert does not determine the total number of seats in the building. This causes S1 extrovert to make a mistake in the next stage, namely the stage of implementing the plan in solving the mathematical problem. Then at the stage of implementing the plan, after determining the number of seats in the fifth and sixth rows, S1 extrovert makes an analogy with (x) as the cheapest ticket price asked in the problem. This is proven from the answer for more details can be seen in Figure 2.

Handwritten work on a piece of paper:

Baris: 1, 2, 3, 4, 5, 6, ...

$= 25, 50, 75, \dots$

$= 95, 125$

Misal = a harga tiket kursi termurah

$= \cancel{10000} : 22.500.000 : 10.000$

$a = 2.250$

Figure 2. S1 extrovert's answer fragment analyzes the number of seats with the difference in ticket prices

Based on Figure 2, it is known that extrovert S1 is able to make an analogy with (x) as the cheapest ticket price, but extrovert S1 makes a mistake in determining the difference in ticket prices on two adjacent rows, namely $x = 22,500,000 : 10,000 = 2,250$, so that S1 has not been able to fulfill the stage of understanding the problem so that it has an impact on the final answer obtained.

Data Structure of Extroverted S1 Thinking Against Misunderstanding in Solving Mathematical Problems During Defragmentation

Based on the answers, the results of *think aloud* and interviews before defragmentation, it is known that S1 extroverts can break down information into simpler ones related to what is known in the problem, but S1 extroverts make mistakes in connecting the problem with the previously obtained material, which results in mistakes in determining the total number of seats. , so that S1 extroverts have not been able to meet the understanding stage in solving the problem. The error has an impact on the next stage in transforming the problem, so the researcher provides defragmentation of the thinking structure through the process of *disequilibrium*, *conflict cognitive*, and *scaffolding* to rearrange and complete the stages of S1

extrovert thinking towards solving mathematical problems. The process of providing defragmentation can be seen in the picture below.



Figure 3. Process of Providing Extrovert S1 Defragmentation for understanding errors

The researcher started by providing defragmentation through *disequilibration* and *scaffolding* to direct S1 extroverts to express their understanding of the given problem, so that they can correct the mistakes made. The defragmentation provided by the researcher aims to complete the stages of completion that were not previously carried out in solving the problem. After the researcher provided defragmentation through the process *disequilibration* and *scaffolding* S1 extroverts were asked to correct the mistakes made with the understanding they had.

After a few minutes, S1 extrovert shows the results after the improvements made related to the total number of seats in the building. Before determining the cheapest ticket price so that the committee obtains funds of Rp. 22,500,000. then continued with S1 making an analogy that (x) is the cheapest ticket price. This is proven by the answer snippet below.

Boris	Jumlah kursi
1	25
2	35
3	50
4	70
5	95
6	125
Jumlah	400

- selisih harga tiket 10.000
- Jumlah Perolehan dana 22.500.000
dikanya harga tiket paling murah
- jawab -
maka 0. harga tiket paling murah

Figure 4. Extrovert S1's answer fragment determines the total number of seats after defragmentation

Based on Figure 4, it shows that S1 extrovert can complete the answer by determining the total number of seats in the building after being given defragmentation. S1 extrovert realizes that to determine the cheapest ticket price, the total number of seats in the building must first be determined. This is supported by the results of the interview that S1 extrovert is able to complete the answer by determining the total number of seats in the building, in addition S1 extrovert assumes (x) is the cheapest ticket price. So based on the indicators of the stages of thinking, S1 extrovert can fulfill the stage of interpreting/understanding the problem.

Regarding the error made by S1 extrovert at the stage of implementing the plan in setting the difference in ticket prices on two adjacent rows of seats, the researcher provided defragmentation of the thinking structure through the process of *disequilibration*, *conflict cognitive*. The researcher asked S1 extrovert to correct the error in setting the difference in ticket prices on two adjacent rows of seats and then continued with the analysis of the cheapest ticket price by performing multiplication and addition operations on each row of seats with the difference in ticket prices on two adjacent rows of seats. As for the results of the improvements made, S1 extrovert was able to fulfill the stage of implementing the plan and analyzing the problem after being given defragmentation. This can be seen in the following extrovert S1 answer excerpt.

$$- \text{baris } 6 + \text{baris } 5 + \text{baris } 4 + \text{baris } 3 + \text{baris } 2 + \text{baris } 1 = 22.500.000$$

$$- 125a + 25a + 35b + 70a + 140b + 50a + 150b + 35a + 140b + 25a$$

$$= 22.500.000$$

$$= 400a + 650b = 22.500.000$$

$$- 400a + 650 \cdot (10.000) = 22.500.000$$

$$= 400a + 6500.000 = 22.500.000$$

$$- 400a = 16.000.000$$

$$a = \frac{16.000.000}{400}$$

$$= 40000$$

Jadi harga tiket terendah 40000

Figure 5. Snippet of extrovert S1's answer determining the cheapest ticket price after being given defragmentation

Based on Figure 5, it can be seen that S1 extrovert is able to fulfill the stages of applying and analyzing in solving the given problem. Then the researcher again provides defragmentation through *scaffolding* to direct S1 extrovert to carry out the evaluation stage in solving mathematical problems by making conclusions or final answers to the solution. S1 extrovert is able to make conclusion or final answer to the problem related to the cheapest ticket price asked. So based on the indicators of the S1 extrovert thinking stage, it can fulfill the

evaluation stage after being given defragmentation. This is also supported by the following extrovert S1 answer snippet.

Jadi harga tiket ternuloh 40000
dengan Anita memperoleh dana sebesar 22.500.000

Figure 6. snippets of extrovert S1 answers making conclusions after being given defragmentation

Based on Figure 6, it can be seen that S1 extrovert can fulfill the evaluation stage in solving problems. Therefore, S1 extrovert can complete and rearrange the thought structure that is owned from the remembering stage to the evaluation stage completely after being given defragmentation through the *disequilibrium process*, *conflict cognitive*, and *scaffolding*.

Introverted S2 Thinking Structure Data Against Transformation Errors in Solving Mathematical Problems Before Defragmentation

Introvert S2 is a subject who has a transformation error in solving mathematical problems (Newman, 1977). This is because introvert S2 can only identify or describe known information in solving mathematical problems and can connect problems with previously obtained material, but introvert S2 makes a mistake in setting the difference in ticket prices on two adjacent rows of seats so that S2 makes an error at the problem transformation stage. The following are the answers, results of *think aloud recordings* and semi-structured interviews related to the thinking structure of introvert S2 in solving mathematical problems.

Based on the results of *think aloud*, it is known that after reading the problem, S2 introvert describes the known information related to the number of rows of seats in the building from the first to the fourth row, namely 25 seats, 35 seats, 50 seats, and 70 seats. While the difference in ticket prices for two adjacent rows of seats is Rp. 10,000.00 with the committee wanting to obtain funds of Rp. 22,500,000.00 on condition that all audience seats in the building are full. Furthermore, from the information presented above, it proves that S2 introvert is able to fulfill the stage of remembering to solve mathematical problems. then S2 introvert conveys the information asked in the problem, namely the cheapest ticket price, so that for the cheapest ticket price, the number of seats in the fifth and sixth rows in the building must be determined, namely 95 and 125 seats. This proves that S2 introvert is able to identify information in the given mathematical problem according to the indicators of the stages of thinking.

Next, at the stage of understanding S2 introverts are able to determine the number of seats in the fifth and sixth rows, namely 95 and 125 seats, and continue by determining the total number of seats in the building, namely 400 seats. This is proven by the following figure 7 of the results of the S2 introvert answer cuts.

Baris 1,2,3,4,5,6
 Kursi: 25 35 50 70 95 125
 Selisih: 10 + 15 + 20 + 25 30
 Kapasitas Total = 25 + 35 + ... + 125
 = 400 tempat duduk

Figure 7. The answer fragment of S2 introvert determines the number of chairs in the building.

Based on Figure 7, S2 introvert is able to determine the number of seats in the fifth and sixth rows, namely 95 and 125 seats, and is able to determine the total number of seats in the building, namely 400 seats. This proves that S2 introvert is able to connect problems with previously obtained materials. Therefore, according to the thinking stage indicator, S2 introvert can meet the understanding stage in solving mathematical problems. Then in the transformation stage, S2 introvert is able to make an analogy with (x) as the cheapest ticket price asked, but S2 introvert makes a mistake in determining the difference in ticket prices on two adjacent rows of seats. This error also has an impact on the next stage, namely the stage of analyzing and writing the final answer in solving the problem. For more details, see Figure 8 of the S2 introvert answer fragment.

tiket termurah: x
~~70000~~
 $= 125x + 95(x+10) + 70(x+10) + 50(x+10) + 35(x+10) + 25(x+10) = 22.500$
 $= 400x + 950 + 700 + 500 + 350 + 250 = 22.500$
 $= 400x + 6.200 - 22.500$
 $400x = 16.300$
 $x = 37$

Figure 8. S2 introvert's answer fragment analyzes the number of seats with the difference in ticket prices.

Based on Figure 8, it is known that the cheapest ticket price found by S2 introvert is $400 + 6,200 - 22,500 = 37$. This result is known from the analysis results carried out by S2 introvert on each row of seats multiplied by the difference in ticket prices in two adjacent rows, namely $125x + 95(x + 10) + 70(x + 10) + 50(x + 10) + 35(x + 10) + 25(x + 10) = 22,500,000$, so

that the cheapest ticket price is 37. This proves that S2 introvert made a mistake in determining the difference in ticket prices in two adjacent rows of seats which has an impact on the stage of analyzing and writing the final answer in solving mathematical problems.

Data Structure Thinking S2 Introvert Towards Misunderstanding in Solving Mathematical Problems During Defragmentation

Based on the answers, the results of *think aloud* and interviews before defragmentation, it is known that S2 introverts can identify or describe information that is known and asked in solving mathematical problems and S2 introverts can connect problems with previously obtained materials so that S2 introverts are able to determine the total number of seats in the building by first determining the number of seats in the fifth and sixth rows. For more details, see Figure 9 of the S2 introvert answer fragments below.

The image shows handwritten mathematical work on a piece of paper. The calculations are as follows:

$$\begin{aligned} & \text{baris 6} + \text{baris 5} + \text{baris 4} + \text{baris 3} + \text{baris 2} + \text{baris 1} = 22.500,00 \\ & - 125 \times 95 + 95000 + 70 \times 140000 + 50 \times 150000 + 35 \times 140000 + 25 \times 120000 = \\ & = 22.500,00 \\ & - 400 \times 650000 = 22.500,000 \\ & - 400 \times 6500.000 = 22.500.000 \\ & = 400 \times 6500.000 - 22.500.000 \\ & - 400 \times = 16.000.000 \\ & \quad \quad \quad x = \frac{16.000.000}{400} \end{aligned}$$

Figure 9. S2 introvert answer fragment determines the cheapest ticket price after being given defragmentation

Based on Figure 9, it can be seen that S2 introvert is able to fulfill the understanding and analysis stage in solving the given problem. However, S2 introvert made a mistake in setting the difference in ticket prices on two adjacent rows of seats, so that S2 introvert has not been able to fulfill the stage of implementing the plan in solving the problem. The error has an impact on subsequent errors in solving in the analyzing and evaluating stages. Therefore, the researcher provides defragmentation of the thinking structure through the process of *disequilibrium*, *conflict cognitive*, and *scaffolding* to rearrange and complete the stages of S2 introvert's thinking towards solving mathematical problems. The process of providing defragmentation of S2 introvert can be seen in Figure 10 below.



Figure 10. The process of giving introverted S2 defragmentation to transformation errors

The researcher began by providing defragmentation through *scaffolding* to direct introverted S2 to carry out the evaluation stage in solving mathematical problems by making conclusions or final answers to the solution which can be seen in the results of the introverted S2 answer snippets below.

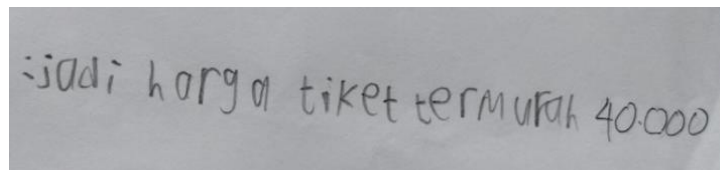


Figure 11. S2 introvert's answer fragment draws a conclusion after being given defragmentation.

Based on Figure 11, it can be seen that S2 introverts can fulfill the evaluation stage in solving problems. Therefore, S2 introverts can complete and rearrange the thought structure they have from the remembering stage to the evaluating stage completely after being given defragmentation through the *disequilibrium process*, *cognitive conflict*, and *scaffolding*.

CONCLUSION

Based on the results of data analysis and discussion, it can be concluded that providing defragmentation to students who have extrovert-introvert personality types through the process of *disequilibrium*, *cognitive conflict*, and *scaffolding* can help students to complete or rearrange their thinking structures towards problem solving. The thinking structure possessed by extrovert students towards understanding errors is only able to fulfill the remembering stage, but at the understanding stage, extrovert students can only determine the number of seats in the fifth and sixth rows by determining the difference between the seats in the first and fourth rows, but students do not determine the total number of seats in the building so that it can be said that they have not been able to fulfill the understanding stage perfectly. Likewise at the transforming, analyzing, and evaluating stages, so that students need defragmentation through

the *disequilibrium process*, *cognitive conflict*, and *scaffolding* to correct errors at the understanding stage, and to rearrange the thinking structure at the applying, analyzing, and evaluating stages into a complete thinking structure.

The thinking structure possessed by introvert students towards transformation errors is only able to fulfill the remembering and understanding stages, but at the transforming stage students are able to make an analogy for the cheapest ticket price asked, but make a mistake in determining the difference in ticket prices for two adjacent rows of seats, so that this has an impact on the analyzing stage in determining the cheapest ticket price asked. Therefore, it can be said that the thinking structure possessed by students towards transformation errors has not been able to fulfill the stages of implementing plans, analyzing, and evaluating, so students need defragmentation through the *disequilibrium process*, *cognitive conflict*, and *scaffolding* to correct errors at the implementing plan stage, and to rearrange the thinking structure at the analyzing and evaluating stages into a complete thinking structure.

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