Defragmenting Student Construction Holes in Solving System of Absolute Value Equations

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ABSTRACT

Constructing concepts is one of the processes in learning mathematics. Making mistakes in constructing concepts is often experienced by students in solving mathematical problems, errors in constructing concepts that can be experienced are construction pits. Construction holes can occur if the schemes that are formed in the thinking structure of students have not been fully constructed or not, students cannot construct concepts properly and completely. This research is a descriptive study with a qualitative approach that aims to defragment the students' construction holes in solving systems of equations in the linear absolute value of one variable. The subject of this study was a class X high school student who fit the indicator for defragmenting the construction pit that is answering correctly but there was a construction process that was not appropriate and students answering correctly but the concept was not fully constructed. Data collection was carried out using test and interview instruments and analyzed ie reducing data, presenting data and drawing conclusions. The validity of the data is done by passing triangulation by comparing test results with interview results. From the results of this study it was found that students 'construction holes were located when simplifying absolute values and determining the values of x_1 and x_2 were therefore given defragmenting by providing conflict cognitive to sensitize students' mistakes in simplifying absolute values and then new schemes emerged through scaffolding so that schemes were not constructed in a constructional manner. complete when determining the values of x_1 and x_2 can be completely constructed.

Keywords: *Defragmenting, Hole Constructions, The System Of Equations Of Linear Absolute Value Of One Variable.*

Defragmenting Lubang Konstruksi Siswa dalam Menyelesaikan Sistem Persamaan Nilai Mutlak

ABSTRAK

Mengkonstruksi konsep merupakan salah satu proses dalam belajar matematika. Melakukan kesalahan dalam mengkonstruksi konsep sering kali dialami oleh siswa dalam menyelesaikan masalah matematika, kesalahan dalam mengkonstruksi konsep yang dapat dialami adalah lubang konstruksi. Lubang konstruksi bisa terjadi apabila skema yang terbentuk dalam struktur berpikir siswa belum terkonstruksi secara utuh atau siswa tidak

dapat mengkonstruksi konsep dengan baik dan lengkap. Penelitian ini merupakan penelitian deskriptif dengan pendekatan kualitatif yang bertujuan untuk mendefragmenting lubang konstruksi siswa dalam menyelesaikan masalah sistem persamaan nilai mutlak linier satu variabel. Subjek penelitian ini adalah siswa kelas X SMA yang sesuai dengan indikator untuk mendefragmenting lubang konstruksi yaitu menjawab benar namun terdapat proses konstruksi yang tidak sesuai dan siswa menjawab benar namun konsep tidak terkonstruksi secara utuh. Pengumpulan data dilakukan dengan menggunakan intrumen tes dan wawancara dan dianalisis menggunakan 3 tahapan, yaitu mereduksi data, penyajian data dan penarikan kesimpulan. Keabsahan data dilakukan dengan cara melalukan triangulasi yaitu membandingkan hasil tes dengan hasil wawancara. Dari hasil penelitian ini ditemukan lubang konstruksi siswa yang terletak pada saat menyederhanakan nilai mutlak dan menentukan nilai x_1 dan x_2 dari suatu persamaan. Oleh karena itu, perlu diberikan defragmenting dengan memberikan conflict cognitive untuk menyadarkan kesalahan siswa dalam menyederhanakan nilai mutlak kemudian dimunculkan skema baru melalui scaffolding agar skema yang tidak terkonstruksi secara lengkap pada saat menentukan nilai x_1 dan x_2 dapat terkonstruksi secara lengkap.

Kata Kunci: *Defragmenting, Lubang Konstruksi, Sistem Persamaan Nilai Mutlak Linier Satu Variabel.*

1.   Background.

The learning mathematics, students actively construct knowledge or relate knowledge by accommodation or assimilation [1][2][3]. Constructing the concept is a process in learning mathematics. The process of learning mathematics will not go well when students experience mistakes and difficulties in the process of constructing concepts [4]. Students often experience difficulties in understanding concepts, abstracting concepts and connecting math problems with everyday life which results in students not being able to solve problems correctly. There are several mistakes in constructing the concept, including: "true" and "false" Pseudo Construction, Mis-Logical Construction, Mis-analogical Construction, and Construction Holes [2][5]. Pseudo Construction is a concept construction error that occurs when students answer a problem as if it is correct but not in accordance with the substance of the concept and as if it is false but can convey it correctly through reflection [4]. There are two possible results of the work of students who experience Pseudo Construction, namely "correct" pseudo-construction and "false" pseudo-construction. Mis-Analogical Construction is a concept construction error that occurs when students cannot analogize a problem to another concept [6]. Mis-Logical Construction is a concept construction error that occurs when students form assumptions that they think are correct even though they are actually false and illogical and because students cannot understand the questions given. Construction holes or Hole Constructions are conceptual construction errors that occur because the schemes formed in the structure of students' thinking have not been constructed as a whole [7].

There are several studies that discuss the construction holes experienced by students in solving problems. Construction holes occur in students when solving a problem. This construction hole occurs because the construction process in the structure of students' thinking is not appropriate, students also experience errors in constructing concepts so that concepts are not completely constructed [8]. Construction holes occur when students are false in learning the initial concept and cannot construct the next concept [9]. Students who experience construction holes, their thinking structures can be reorganized by defragmenting. Defragmenting is restructuring thought processes [10]. Defragmenting is a process of rearranging the complete structure of students' thinking in order to achieve a deep

understanding and be able to solve problems faced by students [9][3]. Defragmenting can be done in the following ways: (1) Scanning, namely providing an overview in the form of a cognitive map regarding students' thinking processes in solving problems. Students are given the opportunity to work on solving problems while expressing aloud what they think. At this stage students are not given intervention and are left to work and express what they think. (2) Check for some errors, namely checking the parts that have errors and determining the cause of the source of the problem. (3) Repairing, namely repair and arrangement in accordance with the errors that occur. (4) Give a change to re-work, which is to provide opportunities for students to re-work the problems they faced before. (5) Certain the result, namely ensuring that the answers given are correct and questioning what was done or understood.

Defragmenting can improve the structure of students' thinking through processes of disequilibration, cognitive conflict and scaffolding [11]. Disequilibration is the process of correcting student errors caused by an imbalance in the state of mind through asking questions that cause students to be confused and think about their answers again and then compare them with scientific concepts which will produce the correct answers. Disequilibration has occurred in each individual and can be raised by providing assistance in the form of reflection on student work. Cognitive conflict is assistance made to correct mistakes that occur in students by providing different questions and examples so that students experience conflicts in their minds and get the right answers. While scaffolding is sufficient assistance given to students [5][12]. Scaffolding is given to students so that students can digest information and are able to relate information when solving problems [13][14][15].

Defragmenting construction holes can be done by providing cognitive conflict and creating a scheme through scaffolding so that a scheme that is not completely constructed can be constructed properly. In addition to research that discusses construction holes, there are several studies that discuss defragmentation carried out to overcome student errors in constructing concepts and construction holes. The errors in constructing concepts that occur are logical thinking and construction holes, construction holes are caused by unconstructed schemes in the student's thinking structure so that they fail to provide the correct answers and correct these errors by using defragmenting by providing cognitive conflict [16][14] . Therefore, this research was carried out with the aim of defragmenting students' construction holes in solving the problem of a system of one variable linear absolute value equations.

2.   Methods

This research use a descriptive qualitative approach. Research that uses a qualitative approach will aim to understand what has been experienced by the subject or behavior observed by researchers in a special natural context, which becomes the main data subject in research using a qualitative approach are words or actions through the process of observations and interviews conducted by researchers [17]. In this study the resulting data will be in the form of words or verbal in nature obtained from the interview process and image data obtained from the results of student work. The subject of this study was a class X high school student who fit the indicator for defragmenting the construction pit that is answering correctly but there was a construction process that was not appropriate and students answering correctly but the concept was not fully constructed. This study will describe the location of the students' construction holes in solving the system problem of one-variable linear absolute value equations and will also describe the defragmenting process carried out to overcome the construction holes. The determination of subjects in this study was to select students who had been identified as experiencing construction holes in solving absolute value equation system problems and adjusted with indicators to defragment construction holes experienced by students. Students as research subjects were selected based on the results of a written test

which showed that these students experienced construction holes and interview results that matched the indicators for defragmenting construction holes. The intended indicator is that students answer correctly but there is a construction process that is not appropriate and students answer correctly but the concept is not completely constructed.

Data collection procedures in this study were written tests and interviews. The purpose of the written test was to find out whether students in solving the system problem of one variable linear absolute value equation experienced construction holes, while the interview aimed to find out the structure of thinking of students who experienced construction holes in solving mathematical problems so they could determine the defragmenting process to be carried out. Interviews were carried out based on guidelines designed to make it easier for researchers to gather information or data from the results of written tests that have been carried out and become a reference in conducting interviews [18].

In the interview session, the subject will be given the freedom to express what is on his mind when solving problems or what is often called thinking out loud [3]. Then the results obtained will be used as data to describe the structure of students' thinking. In this interview session, it will be seen the location of the construction holes experienced by students and their causes. After knowing the location of the construction holes, the researchers defragmented it so that the construction holes could be resolved. The data analysis technique steps used are in accordance with Miles and Hubberman's analysis flow which includes data reduction, data presentation, and conclusions [17]. In this study, data reduction was carried out by summarizing and sorting the important data to be used, presenting the data into narrative text and drawing conclusions to explain the results of presenting the data. The validity of the data in this study was carried out by triagulation, namely comparing the results of data from students' written tests and the results of interviews.

3   Results and Discussion
3.1 Result

Errors in the construction of this concept are often experienced by students in solving problems, one of the causes is the low absorption of students towards mathematical material. The research data was obtained from the results of written tests and interviews that had been conducted by the subject. The data will show the location of the concept construction errors, namely the construction holes experienced by students in solving the problem of a system of one variable linear absolute value equations. Based on the test results carried out by the subject, the construction hole occurred when the subject simplified the absolute value and the process of determining the x_1 and x_2 values. The following are the results of the subject's answers:
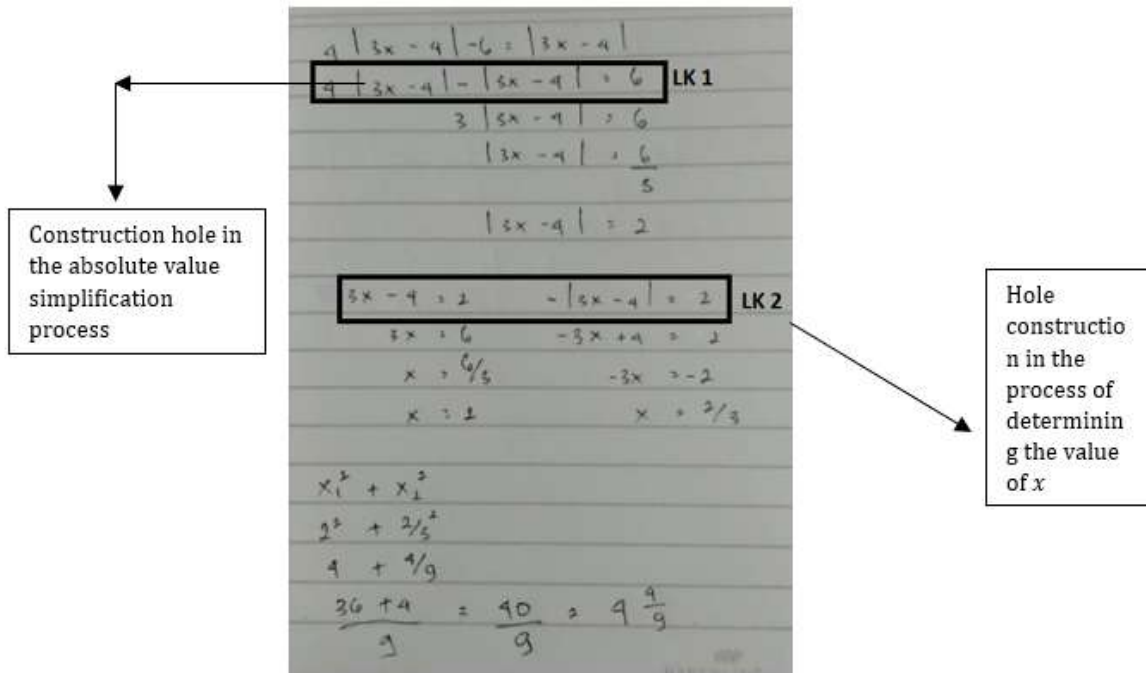
Picture 1 Contruction Hole Students' Task

Figure 2 is the result of a written test done by students. In the figure it can be seen that students simplify the absolute value by combining the same absolute value on the right side, then subtracting the absolute value, then dividing the left side by the coefficient of the absolute value on the right side. From this student's answer it can be seen that the student experienced a construction hole because the student could not construct the concept obtained in its entirety. The concept that cannot be constructed completely in this case is the concept of adding operations and there are also incomplete steps or procedures in student work. For more details, the following are the results of interviews with students:

Researcher : *"How did you do this? Try to explain!"*
Subject : *"Here I have 3 processes ma'am, which on my own I operate the absolute value ma'am so that it is not long so that it can be simplified, I mean ma'am. Because the problem has the same absolute value on both sides, so I made one by combining |3x-4| the one on the right becomes 4 |3x-4| - 6 so the result is 4 |3x-4| - |3x-4| = 6. After it becomes one, I subtract bu so the result is 3 |3x-4| = 6 and I moved the 3 again so that |3x-4| =6/3 or |3x-4| = 2 like that, then in my opinion, the 6 will move so they don't mix with the absolute one, ma'am, let it be |3x-4| you can find the value of x" (not sure what was said)*

The results of the interview also reinforce that construction holes occur in the absolute value simplification process. The subject thinks that the way to simplify the absolute values in the problem is to combine them into one absolute value and then subtract it so that the absolute values are simpler. This makes the subject experience a construction hole because the subject is still unable to construct the concept of adding operations properly. Subject could not explain correctly that the way to simplify absolute values is to add addition operations or other operations. The reasons given by the subject are still incorrect by stating that simplifying by combining absolute values into one. In the student's answer there are

procedures or steps that are still lacking or incomplete. Based on what was said by [5] that when students cannot construct concepts properly and intact, these students will experience construction holes. It's the same with subjects who still can't construct the concept of adding operations completely.

Then the construction hole is located when students determine the value of x_1 and x_2. In this process the subject uses the definition to complete the absolute value. the answers given by the subjects were correct, but after being traced through the interview sessions, there were construction holes that occurred to students when determining the values of x_1 and x_2. The following are the results of interviews regarding the construction hole.

Researcher: *"What method did you use to determine the value of x_1 and x_2? Try to explain"*

Subject   : *"I'm using the definition of an absolute value, ma'am, right, there's only one absolute sign, so I'm doing it using the definition of an absolute value. After simplifying it to become $|3x - 4| = 2$ so look for the value of x using the absolute value definition"*

Researcher: *"Why use a definition? Why not use another way? Or just use it that way?"*

Subject   : *"There's only one absolute, but there's also a value, so I'm using an absolute definition, right? $|f(x)| = c$ so it can be solved with a definition, if you want to use another method I don't know ma'am I just did it using a definition, I don't think you can use another method. There's another way to get the square root, ma'am, but that's usually used if the absolute is on the right side and the left side"* (confused about what you're saying and not sure)

Researcher: *"then try to explain further"*

Subject   : *"then use the definition to be an absolute value $|3x - 4|$ is 2 and -2, then the absolute value is |3x-4| counted one by one and found the value of x is 2 and 2/3, that's it ma'am.*

The results of the interview above stated that the subject determined the value of x_1 and x_2 by using the definition of absolute value because he thought the form of the absolute value was $|f(x)| = c$ and can only be solved using the definition of absolute value. This clearly shows that the subject is again experiencing a construction hole because it mentions the form of the absolute value $|f(x)| = c$ can only be solved using definitions. In this case the subject cannot properly construct the concept of absolute value definition by using the square root $(\sqrt{x^2})$.. In the structure of the subject's thinking there is a schema that is still incomplete, the incomplete schema is the form of the absolute value $|f(x)| = c$ can be solved in another way besides using the definition by using the square root $(\sqrt{x^2})$.

The subject experienced a concept construction error/construction hole because he could not properly construct the concept definition and square roots, which resulted in an incomplete schema in the subject's thinking structure [2], namely students were able to solve problems correctly but the construction process in the structure of students' thinking is not appropriate and there are schemes that are still incomplete. The following is the structure of the subject's thinking in solving the problem of a system of linear absolute value equations for one variable (**Picture 2**).
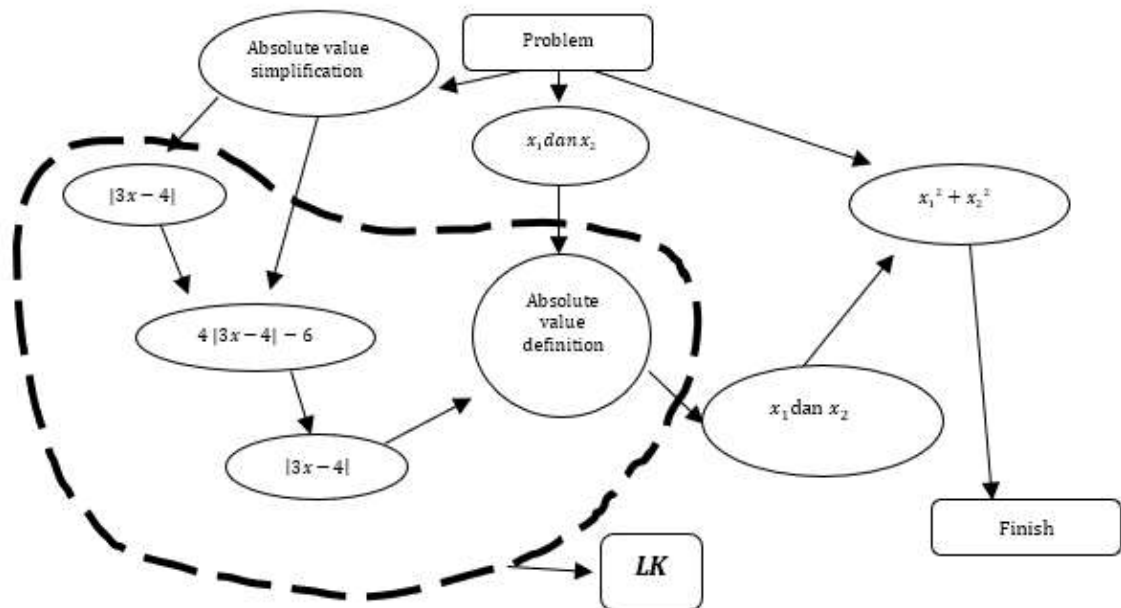
Picture 2. The structure of the subject's thinking

The picture is an illustration of the structure of students' thinking in solving the problem of a system of equations of one variable linear absolute value. In the structure of the student's thinking there is a schema that is still incomplete and not well constructed by students. In the process of simplifying absolute values and the process of determining absolute values, there are construction holes so that students experience difficulties in constructing the next concept or even experience errors in constructing the concepts obtained. Based on the structure of thinking of students who still do not construct concepts properly and there are incomplete schemes, it can be concluded that these students experience construction holes.

After knowing the location of the construction hole experienced by the subject in solving the system problem of one variable linear absolute value equation, the defragmenting process will be carried out to overcome the construction hole. defragmenting is done during the interview session with the subject. In the interview session, the subject will be given cognitive conflict to make the subject aware of the mistakes experienced by the subject then bring up a scheme through scaffolding. The following is the result of an interview with the subject:

> Researcher: "Then how come you can suddenly make one absolute right and left?" (*Cognitive conflict*)
> Subject: "Um that's not me I said it was moved (confused)" (**Construction hole**)
> Researcher: "Indeed, the way to move the segment like that? If, for example, I move the segments I move the 4th and 6th to the left, how about?" (*cognitive conflict*)
> Subject: "(pause for a moment) Ummm how about ma'am"
> Researcher: "Do you still remember the addition or subtraction operations?" (*Scaffolding - schematic appearance*)
> Subject: "Remember ma'am. (pause for a moment).... oh yes, ma'am, this uses the addition of the subtraction operation, ma'am. means it's subtracted by |3x-4| first, ma'am." (*cognitive conflict*)

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Researcher: "Yes. Then the next one is number 6, is that correct? What's the 6/3 one too?"

*Subject : "The 6 means using the addition of the addition operation bu, then the 6/3 means the addition of the division operation right mom."(**Scaffolding-schematic appearance**)*

*Researcher: "Are there any other answers besides those written on your work sheet? If so, show me!" (**cognitive conflict**)*

Subject: "Loh really there is another answer ma'am? In my opinion, yes, this is the answer.

Researcher: "Do you only use one way to solve the problem?"

*Subject : "I don't know ma'am, but I think I only use this, ma'am, I only use the definition of absolute value" (**Construction Hole**)*

*Researcher: "Can't you use square roots to solve the problem?" (**Scaffolding – schematic appearance**)*

*Subject : "Yes ma'am, give it the form |f (x)| = c? (**cognitive conflict**)*

*Researcher: "Yes, you try to use the square root to determine the value of x, if the result is the same, it means you can" (**Scaffolding - schematic appearance**)*

Based on the interview results above, the defragmenting process was carried out to address LK1 and LK2 simultaneously. The researcher provides several cognitive conflicts to make the subject aware of the mistakes made by the subject. This cognitive conflict is carried out by providing several questions that provoke the subject to think again about the results of the subject's answers. Cognitive conflict also helps researchers to show the subject that the reasons given by the subject in the absolute value simplification process are still not correct. In the process of determining the values of x_1 and x_2, the researcher also provided cognitive conflict to make the subjects aware that in solving absolute values, they did not only use my definition, even though the form of these absolute values was $|f(x)| = c$. In addition to providing cognitive conflict, the researcher came up with a new scheme by doing scaffolding. This new scheme arises because there are schemes that are still not completely constructed by the subject. The emergence of this new scheme helps the subject in solving problems so that the construction holes experienced by the subject can be resolved. The scheme that emerges in this research is that the absolute value equation form $|f(x)| = c$ can be solved using $\sqrt{x^2}$ (square root).

The mistakes made by the subject are included in the error in concept construction because the subject cannot properly construct the concept of absolute value, there are still unconstructed concepts, namely forms of absolute value and ways of solving these absolute value forms. In addition to not constructing the concept as a whole, the subject is also unable to construct the concept completely as evidenced by the concept of adding operations which is still not constructed by the subject. The researcher provides scaffolding to the subject by showing a schematic. The appearance of this scheme is done so that a scheme that does not yet exist and is incomplete can be constructed properly and completely. The scheme that appears is the addition of operations and absolute value settlement using the quadratic property.

The defragmenting carried out by this researcher is the same as the defragmenting carried out[9] [19], namely carrying out the defragmenting process through the emergence of schemas which are carried out through scaffolding to bring up students' thinking schemes and cognitive conflict is carried out to awaken students' misconceptions. Based on the results of this research, research can suggest that the constructive holes experienced by students can be overcome by defragmenting through scaffolding and cognitive conflict. The conducted research on defragmenting thinking structures in solving geometric problems and producing

construction holes experienced by students that could be overcome by defragging through scaffolding, a little different from what was done by researchers, namely researchers adding cognitive conflict to students so they could make students aware of the mistakes experienced by students [7].

After defragmenting, the subject becomes aware of the mistakes made and can complete a scheme that has not been completely constructed. The following will describe the structure of the subject's thinking after the defragmenting process is carried out on the subject's thinking structure:
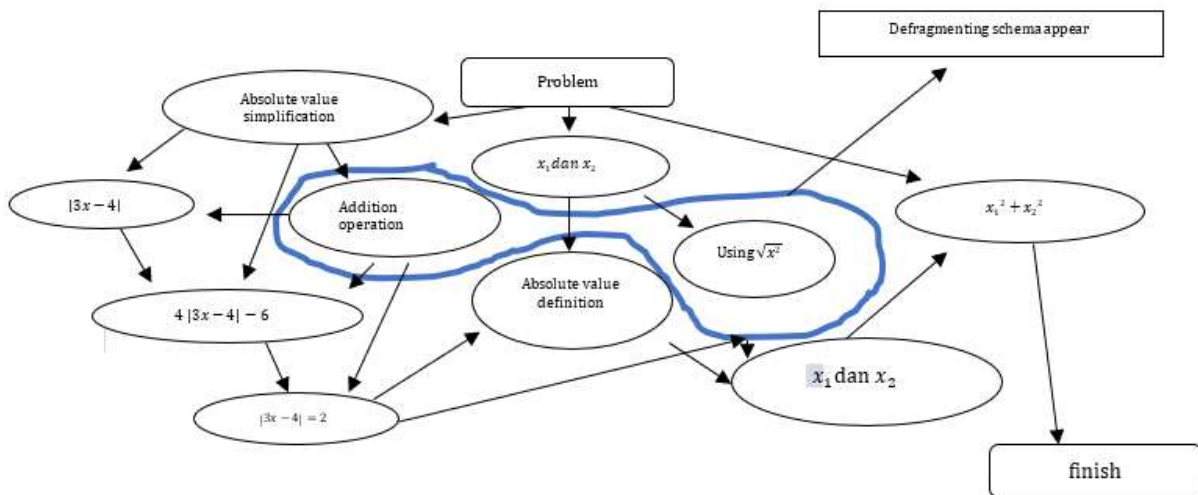
Picture 3. The Student's thinking structure after defragmenting

Figure 3 is an illustration of the structure of students' thinking after defragmenting to overcome the construction holes experienced by students in solving the problem of a system of equations of one variable linear absolute value. The blue circle in the picture shows a new scheme that appears in the structure of students' thinking, namely determining the value of x using the square root theorem and constructing the concept of adding operations in the process of simplifying absolute values. After defragmenting the structure of students' thinking, a complete scheme is obtained and the concept construction becomes correct. The students often experience difficulties in understanding concepts, abstracting concepts and associating math problems with everyday life [6].

3.2 Discusion

Based on the results of data analysis carried out by the researcher, it is known that the subject experienced construction holes in solving the problem of a system of equations of one variable linear absolute value. The location of the construction holes experienced by the subject was during the process of simplifying absolute values and when determining the values of x_1 and x_2. In the absolute value simplification process, the subject experienced a construction hole because he could not give the right reason. This shows that the subject cannot construct the concept that is obtained as a whole. This statement is in accordance with what was found that when students cannot construct concepts correctly and the concepts constructed in students' thinking structures are not intact, these students experience errors in constructing concepts called construction holes [16] [20]. The students experience construction holes is that students can solve problems correctly but the construction processes that exist in the structure of students' thinking are not fully formed [1][3].

The location of the next construction hole is when determining the x_1 and x_2 values. The results of the subject's answer in determining the values of x_1 and x_2 are correct, the subject determines the values of x_1 and x_2 using the absolute value definition. The subject experienced a construction hole because during the interview session the subject was still unable to distinguish between the absolute value form which can be solved using definitions, the absolute value form which can be solved using $\sqrt{x^2}$ (square root) or the absolute value form which can be solved use both ways. The subject cannot relate the concept of absolute value definition with the concept of square root to solve the problem of a system of equations of one variable linear absolute value, which means that the subject cannot construct the concept obtained correctly which results in an incomplete scheme in the subject's thinking structure. The schemes in the structure of students' thinking that have not been constructed properly will result in students experiencing conceptual construction errors, namely construction holes. The construction holes occur in students when the initial concept learned is false and cannot construct the next concept [9]. This is different from the results obtained by researchers in this study. This study shows that the initial concept learned by the subject is correct but the subject is still unable to construct the next concept completely and results in the subject experiencing a concept construction error called a construction hole. In this study, the subject's thinking structure also contained a schema that had not been completely constructed. This is the same as the results of research conducted [7].

The construction hole experienced by the subject in solving the system problem of one-variable linear absolute value equations is caused by the existence of a concept or scheme that is not completely constructed in the structure of his thinking. The students' thinking structures that are lacking or incomplete can be repaired by restructuring students' thinking processes so that students' thinking processes become correct and intact so that students do not experience mistakes in solving math problems. The thought process restructuring meant is defragmenting [19]. Defragmenting is a process of rearranging the thinking structure of students so that the thinking structure that was originally incomplete can be repaired to become intact and correct. Therefore the defragmentation process was carried out by the researcher to overcome the construction holes experienced by the subject.

The defragmenting can correct structural thinking errors in solving problems. In his research, he stated that defragmenting construction holes can be overcome by doing scaffolding[2]. The defragmenting is carried out based on several stages, namely scanning, checking some errors, repairing, giving a change to rework and certain the result. Defragmenting by researchers to overcome construction holes is carried out based on the stages suggested [2].

The defragmenting process carried out by the researcher is to provide cognitive conflict to make the subject aware of the misconceptions experienced by the subject. This cognitive conflict is carried out by providing several questions that provoke the subject to think again about the results of the subject's answers. Cognitive conflict also helps researchers to show the subject that the reasons given by the subject in the absolute value simplification process are still not correct. In the process of determining the values of x_1 and x_2, the researcher also provided cognitive conflict to make the subjects aware that in solving absolute values, they did not only use my definition, even though the form of these absolute values was $|f(x)| = c$. In addition to providing cognitive conflict, the researcher came up with a new scheme by doing scaffolding. This new scheme arises because there are schemes that are still not completely constructed by the subject. The emergence of this new scheme helps the subject in solving problems so that the construction holes experienced by the subject can be resolved. The scheme that emerges in this study is that the absolute value equation form $|f(x)| = c$ can be solved using a definition or by using $\sqrt{x^2}$ (square root).

The defragmenting carried out by this researcher is the same as the defragmenting carried out by Aisya (2019), namely carrying out the defragmenting process through the emergence of schemas which are carried out through scaffolding to bring up students' thinking schemes and cognitive conflict is carried out to awaken students' misconceptions. Based on the results of this research, research can suggest that the constructive holes experienced by students can be overcome by defragmenting through scaffolding and cognitive conflict. The defragmenting thinking structures in solving geometric problems and producing construction holes experienced by students that could be overcome by defragging through scaffolding, a little different from what was done by researchers, namely researchers adding cognitive conflict to students so they could make students aware of the mistakes experienced by students.

4   Conclusion

Based on the results of the research and discussion, it can be concluded that the conceptual construction error experienced by the subject is a construction hole that lies when the subject simplifies the absolute value and determines the values of x_1 and x_2. In the simplification of the absolute value of the construction hole, this occurs because the subject cannot construct the concept of adding operations in full or in full, the subject cannot construct the concept of adding operations in full by mentioning adding operations by moving segments. The subject also could not construct the concept of the definition of absolute value and the square root theorem properly, this was seen because the subject still could not relate the concepts between the square root concepts. The defragmenting process was carried out to repair the construction holes experienced by the subject in solving the problem of a system of one variable linear absolute value equations. Repair or defragmenting is done by providing limited assistance through scaffolding and cognitive conflict. Cognitive conflict is carried out by asking several questions which cause the subject to rethink the answer and realize the mistakes experienced by the subject. Then the researcher did scaffolding to bring up a scheme that was still incomplete in the subject's thinking structure. The newly emerged scheme will be used to improve the subject's thinking structure so that the subject's thinking structure becomes complete.

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