

# Students' Thinking Process When Experiencing Cognitive Conflict

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The aim of this study is to reveal the thinking process of elementary school students when experiencing cognitive conflict. This type of research is qualitative descriptive research and the data collection is from this research through test questions, direct observation and in-depth interviews on the subject of research. Problems given to students are non-routine questions in the form of open-ended questions that have more than one solution. The subjects of this study were two students who experienced cognitive conflicts, based on direct observation of the subjects who experienced curiosity, confusion, and thinking longer. The results showed that the thinking process that occurs when students experience cognitive conflict, are namely: (1) students can perform assimilation process to integrate the perception or new experiences into schemata, and (2) there are three stages of students' process of the accommodation, that is: first the students experience a lack of mastery of the conception they have, then create a new conception that is easy to understand, and then the conception is used to solve the problem by providing a sensible answer. The conclusion in this research is that there are stages in the process of accommodation that do not happen, that is: students who do not start with a sense of dissatisfaction, in this case, the initial conception that has been owned by students by the information provided.

## Introduction

Cognitive conflict occurs when two existing perceptions, arguments, or ideas contradict one another and can't find agreement. Cognitive conflicts are defined as conflicts between cognitive structures (i.e. structures that organise knowledge in the brain) with the environment (e.g. an experiment, demonstration, peers, book or other), or conflicts between conceptions in cognitive structures (Lee et al., 2003). If a child has finally become aware of the fact that he/she was holding two opposing views of the situation and was unlikely to be true, this condition is called a cognitive conflict or disequilibrium. Cognitive conflict is the tension created when new evidence is recognised by students and contrary to previous knowledge (Moody, 2008). Cognitive conflict is an individual consciousness of conflicting information, that impacts a

concept of the cognitive structure itself (Fraser, 2007). This impact can be constructive or destructive. When students are interested or interested in resolving these contradictions, the results are constructive, while students who are frustrated or depressed with the contradictions they face, can be destructive. Cognitive conflict is usually triggered by a discrepancy between the initial concept of the individual and the new concept he or she has learned.

Several studies ((Limon, 2001); (Kang et al., 2004); (Baser, 2006); (Peled and Suzan, 2011); (Chow and Treagust, 2013)) suggest cognitive conflicts are learning strategies in efforts that support conceptual change. Learning approaches used to encourage conceptual change in mathematical learning can involve cognitive conflict that puts students in a supportive environment, to confront preconceptions and then work towards the resolution and conceptual change (Chow and Treagust, 2013). An intense argument on the initial knowledge of students directing to "rearrange", "reorganise", or change their concepts (Limon, 2001).

Some experts have tried to observe cognitive conflicts and find signs of diverse cognitive conflicts. For example, (Berlyne, 1960) explains conceptual conflict to have something like: doubt, chaos, contradiction, peculiarity, conceptual odds, confusion, and irrelevancy. Discovering a doubt (reaction time), seemingly frequently, anxiety, and suspense are the signs that children are in situations of cognitive conflict (Smedslund, 1961). Measures of cognitive conflicts of students are gained by observing uncertainty levels and stored responses, using the same method as Berlyne (Zimmerman and Blom, 1983). Movshovitz-Hadar and Hadass, (1990) found the expression of students in a state of cognitive conflict, from discussions that were recorded. They said the student showed the expression of the passion of curiosity and the expression of an inner impulse to finish, as well as an expression of frustration, the expression of satisfaction by overcoming an inability to continue, and the expression of satisfaction with self-confidence. Tensions, doubts, and complete barriers in situations of cognitive conflict (Miller, 1944) were observed.

As a human being, one needs to take action to reduce the conflict (Kang et al., 2004). Piaget in (Kaasila et al., 2010) states that the schemata (cognitive structure) in the human brain develop through interactions with its environment, through assimilation and accommodation. Assimilation and accommodation are the thought processes invented by Piaget. When given a problem, then it is in the process of settlement that the students will use the thinking processes. In the thinking process there is a process between incoming information and the schema (cognitive structure) in the human brain (Subanji and Supratman, 2015). Assimilation is a process that involves the interpretation of experience regarding an existing knowledge structure. Accommodation is a process of enhancing knowledge, through modification of existing knowledge or existing knowledge structures, modified to accommodate and adapt to the presence of new experiences. Because the assimilation process can be directly accepted by the students, so in this study, the researchers focused on the process of accommodation to see changes in the structure of knowledge possessed by students. Some students use existing concepts to agree with new experiences (Ponser, et.al. 1982). This type of the first phase of

concept change is called assimilation. Often, the students' concept is not enough to get students to absorb some new experiences correctly. So, students must replace or set the general concept. The shape of this concept change is called accommodation. Accommodations can occur in two ways, i.e. modifying existing schemes to match the given stimulus or forming a new scheme appropriate to the given stimulus (Hoppes and Segal, 2010).

The equilibrium in Piaget's theory refers to cognitive conflict (Lee et al., 2003). Students have their initial knowing as a structure or scheme. Then, they have to deal with the new concept that is partially or entirely different from their schemes. When the balance between assimilation and accommodation occurs freely (without conflict), it is said that the cognitive structure is in equilibrium with the environment (Blake and Pope, 2008). Conversely, if this does not happen to a person, then it is said that they experience cognitive imbalance (disequilibrium) or cognitive conflict. The state of equilibrium given by external stimuli will result in a state of disequilibrium. Then the state of disequilibrium, which later gives rise to the process of assimilation and accommodation, is a process to develop one's schemata. Cognitive imbalance or cognitive conflicts occur due to lack of data, so that the information obtained does not match the knowledge or cognitive structure (schemata) owned, so that existing information cannot be assimilated. Consequently, the process of accommodation also does not occur to the information.

Based on the above explanation, the research needs to be done to describe the thinking process of students when experiencing cognitive conflict. It is important for this to be explored, because there is a possibility of a different thinking process from each student experiencing cognitive conflict. Also, no studies have looked at students' thinking processes while experiencing cognitive conflicts. The benefits of this research are to know when the students are experiencing cognitive conflicts; it can be determined that the approach or appropriate learning model for cognitive conflict conditions can benefit students in understanding the concept of mathematics. The research focused on the discussion of Piaget's thinking process, namely the process of assimilation and the process of student accommodation since the subjects chosen were students who experienced cognitive conflicts that challenged the occurrence of thought processes.

## **Method**

This type of research is qualitative descriptive research, which describes students' thinking process when experiencing cognitive conflict.

The subjects of the study were VC students from 27 Vocational Schools. From 27 students only one student answered the question correctly, two students started the process with the correct process but the problem was not resolved, fourteen students answered wrongly, and ten students did not answer the questions. The researcher selected two students who started the problem with the correct stages but did not solve the problem. Also, the reason for the selection of two subjects, was when the researchers conducted direct observation, students experienced

cognitive conflicts (curiosity, confusion, and thinking longer). The two subjects will be given S1 and S2 code.

The mathematics problem used to be tested was a non-routine question with an open-ended question form. The problem was designed with the aim that researchers could find out whether students have cognitive conflicts in the process of completion. The problem is as follows: Ardi has three pairs of drumsticks of different sizes. Each drumstick A is 30cm long, each of the B's drumsticks is 400mm in size, and each of the C drumsticks is 3.5cm in length. If Ardi wants to keep the three pairs of drumsticks into a container that contains a maximum length of 0.75 m, then how many containers are needed to store all the drumsticks? How much is the length of the drumsticks apart from each container? What is the length difference between the drumsticks from the container that contains the maximum length with minimum length? Explain! Note: The diameter of the container is equal to the diameter of one stick.

There are six stages in this research. First, it gives a unit-related problem of length and the problem is a non-routine question with an open-ended question form. Second, it makes a direct observation of the reaction that occurs when working on a given problem. The focus of observation on the four components is the introduction of contradictions, attracting attention, anxiety and cognitive assessment of the situation. Is the subject in doubt, surprised or strange about the given problem? Then does the subject become interested in abnormal situations (attract attention, curiosity, attention), become worried about abnormal situations (confusion, pressure), or reassess abnormal situations (postponing or thinking longer)?

**Table 1:** Operational Definitions of Measurement Components of Cognitive Conflict

Stage	Components	Operational Definition
Cognitive conflict stage	Recognition of the contradiction	Recognising one's conceptions are not consistent with the results of the experiment/discourse/textbook, etc. (doubt, surprise, strangeness)
	Interest	Being interested in the anomalous situation (interest, curiosity, attention)
	Anxiety	Being anxious about the anomalous situation (confusion, agony, depression)
	Cognitive reappraisal of the situation	Reappraising the anomalous situation; the cognitive conflict and the problem (suspend attention, think a little longer, seek more reasonable base)

Source: (Lee et al., 2003)

Third, analyse the four components that appear in the subject of research based on the test results given and also based on direct observation. Fourth, determine the subject, based on the results of the analysis, who experienced cognitive conflict. Fifth, triangulation of data to confirm the results of the analysis by conducting interviews that are not structured and in-depth (in-depth interview), associated with the thinking processes that occur in students who experience cognitive conflicts, then do data reduction that is not needed after the interview. Sixth, concluding the results of the analysis based on test results, direct observation, and interviews, so data is obtained about the thinking process of students when experiencing cognitive conflict.

**Table 2:** Indicators of Thinking Processes

Piaget Stage	Indicators
Assimilation	a. Integrating perception, concept, or a new experience into an existing scheme in mind
Accommodation	a. Modifying an existing scheme to match a given stimulus b. Form a new scheme that corresponds to the given stimulus

## Results and Discussion

The most important thing in the development of a child's thinking is equilibrium. Equilibrium is an internal mechanism, which regulates one's self when faced with external stimuli or challenges. External stimulation creates an imbalance (disequilibrium) or cognitive conflict in one's thinking. This cognitive conflict is challenging for the thinking process, namely the process of assimilation and accommodation.

### *Thinking Process in Subject*

Beginning of the process of completion of test questions, S1 realised in the thinking process that the question tests given had been previously studied, and then tried to recall what was already known. Especially S1 realised that she might have done this kind of thing before. S1 also provided the thought process to recall what is known when solving problems like this. S1 could recall what had been done but forgot how to solve the problem. In this case of S1 there had been a process of assimilation. This is evidenced by the findings of interviews between researchers with S1 as follows:

*Researcher: "Have you ever studied this subject?"*

*S1: "Yes. I think I've done this kind of thing too. But ... but not all I remember. "*

*Researcher: "Related to this subject, what do you still remember?"*

*S1: "Order the ladder from top to bottom, and if it goes down one ladder then multiplied by 10, if it goes up one ladder then divided by 10".*

During the completion time of the test, S1 experienced stages of disequilibrium on what to do first. S1 then adjusted her thinking process to create the settlements plan, starting from summing the entire length of the existing drumsticks into the same unit, which is the meter unit.

S1 realised, if the matter was mentioned, that each drumstick was in the form of a pair then should each drumstick could be multiplied by two, because of the assumption that each pair of drumsticks had the same length. By creating a new scheme that matched the stimulus provided from the thinking process, S1 had been in the process of accommodation on the thinking process. This is evidenced by the findings of interviews between researchers with S1 as follows:

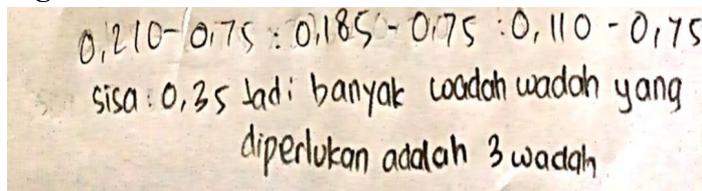
*Researcher: "What do you understand from the given problem?"*

*S1: "Uhhh, I think .. actually I feel confused so .. what .. for it was asked .. a stick or two sticks so .." (form a new scheme)*

Furthermore, S1 modified the existing scheme to match the stimulus provided in its thought process. If mentioned in a pairing problem, this means that there are two sticks that have the same length in each drum A, drum B, and drum C. In this condition there is a process of accommodation on the thinking process of S1 (modify the existing scheme).

S1 modified the existing scheme to find the container used to store all the sticks so that all the drumsticks possessed must be summed before the length of the drumstick is changed in meters adjusting to the unit length of the drum storage container. S1 experienced a mistake in the process, and this was realised by S1 during the interview. Here also it could be seen that S1 experienced the process of accommodation in the thinking process. This could be seen from the interview between researchers with S1 as follows:

**Figure 1.** Answer Sheet S1



0,210 - 0,75 : 0,185 - 0,75 : 0,110 - 0,75  
sisa : 0,35 jadi banyak wadah wadah yang  
diperlukan adalah 3 wadah

*Researcher: "Are you sure that your answer is correct?"*

*S1: "Confused. The answer is two containers, but then there will be the rest. So later there is a stick that is not stored, then to store all the sticks .. uhm .. requires three containers" (modify the existing scheme).*



*Researcher: "How did you get that answer?"*

*S2: "After summing all the length of the drumsticks, I divide the length of all the drumsticks with the length of the container. But before I rounded the length of the container to 0.8 meters. So easy to share it. After that I divide 2.1 by 0.8. Then I can 3. But ... should be less, because the container may not result in a coma then I round it up to 3 ". (modify existing schemes).*

At the beginning of the process of completion of tests on the subject of research used existing knowledge, when there was a problem or question. This is in accordance with the opinion of the Piaget, that a child brings new knowledge into their schemes (Ultanir, 2012). This condition indicates that the research subject can integrate new perception experiences into the existing scheme in mind. This is consistent with (Ponser, et.al. 1982) which says some students use existing concepts to agree with new experiences, referred to as assimilation.

Differences in the process of completion of questions given occurred on both subjects of the study. Both are in the accommodation process but not with the same problem. As, the first research subject was still confused, determining whether the drum sticks are one or two sticks. In the face of this condition, the research subjects formed a new scheme to conform to the information or knowledge (Hoppes and Segal, 2010), so as to make different ideas for working on the problem. This condition states that the subject of research had not understood the problem well, so the information obtained from the problem cannot be directly used, except through the process of forming a new scheme first. In this case the subject of research experienced dissatisfaction with the conception he had (Ponser, et.al. 1982). Research subjects collect information previously owned, then solved the problem. In the end the subject of the study said that each drumstick A, B, and C were two pieces. In this case also the subject of the research was to create a new concept so that it could be understood (Ponser, et.al. 1982). The subject of the study understood how the information provided could be constructed to explore the possibility of generating a new concept in his thinking. Then they adopted a new concept which had the capacity to solve the given problem. The second research subject could understand how information could develop enough new concepts to explore the possibility of solving the existing problems. Then also each new concept adopted must have the capacity to solve the given problem. If not, then there would be no reasonable answer. It made sense also that the result was consistency of concepts with knowledge or other information (Ponser, et.al. 1982). In this condition, the second research subject did not begin the accommodation process with a sense of dissatisfaction, because the initial concept was already possessed in accordance with the information provided.

The first question in the research, the student also experienced the process of accommodation on the same problem, that is when the research subjects determine the container used to store all the sticks. In answering this question, the research subject modified an existing scheme to match with the information already given on the question (Hoppes and Segal, 2010). Initially the subject of research was to summate all existing sticks, by first changing the unit of all sticks into the meter. After obtaining the length for all the sticks in the meter, the study subjects

reduced the length of the entire drum with the length of the storage container. The process of reduction was done twice. Then there was the remaining length of the drumstick that had not occupied the storage container. The research subjects then experienced confusion to put the remainder into which storage container. In this case the subject of research experienced dissatisfaction with the existing concept of the subject of research, to understand how to draft a new concept, that would be enough to answer the existing problems (Ponser, et.al. 1982). Finally, by modifying the existing knowledge scheme, the research subjects wrote down the answer that the container needed to store the entire drumsticks amounted to three containers. In this section, the subject of research should be able to understand how the information can be compiled into a new concept that is enough to explore the possibilities that existed in the problem. Each new concept raised by the research subject could solve the given problem to elicit a reasonable answer (Ponser, et.al. 1982). If not, then there would not be a reasonable answer. This made sense also results from the consistency of concepts with other knowledge (Ponser, et.al. 1982). On the question, there were three questions, but both research subjects were only able to solve one question by experiencing errors in the process of summing the length of the entire drumstick.

### **Conclusion**

Based on the above discussion, students with cognitive conflicts may integrate perceptions or new experiences into the schemes already in their minds. Then, with the process of accommodation, students who experience cognitive conflicts in solving math problems, was characterised by experiencing dissatisfaction with the concept they already had. After they experienced the dissatisfaction, the students created a new concept that was easily understood by themselves. Then the new concepts of emerging students can be used in problem-solving to provide a reasonable answer. Although there are students who do not start with a sense of dissatisfaction, in this case the initial concept was that the students already had the information provided.

### **Acknowledgments**

Acknowledgments are delivered to the Postgraduate of Mathematics Education, State University of Malang.



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